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www.econometeoreticasiaplicata.ro; www.ectap.ro

Reception of texts: economia.ta@edeconomica.com

ISSN 1841-8678 (Print)
ISSN 1844-0029 (Online)

How do immigration impact unemployment and economic prosperity? An extensive investigation from the OECD nations

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Abstract. *Acknowledging the fact that immigration crisis is one of the most debated and challenging phenomena, especially in most of the OECD countries, this study involves a utilisation of the panel econometric techniques like Panel Error Correction Model, FMOLS and DOLS to empirically analyse the direction of the effects of immigration on native unemployment, in both the short and the long run, in aggregate. The analysis has been performed on a sample of 33 OECD countries between 1990 and 2017. The results suggest that immigration reduces unemployment in the short as well as the long-run. The impacts of immigration on unemployment are confirmed with a series of robustness tests using different estimation techniques and combination of regressors.*

Keywords: immigration; unemployment; OECD; panel error correction model.

JEL Classification: C1, F2, J6.

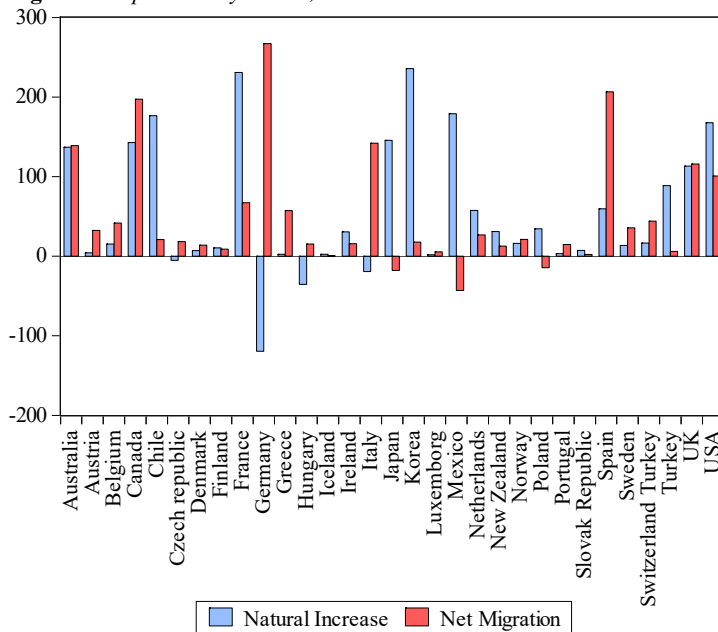
1. Introduction

“Remember, remember always, that all of us, and you and I especially, are descended from immigrants and revolutionists.”

Franklin D. Roosevelt
(Former U.S. President)

The immigration crisis engenders a broad spectrum of social challenges for policymakers throughout the globe. During the past two centuries, the countries of the New World⁽¹⁾ were conventionally known to be the nations that have been lucrative to immigrants from all over the world. From the later part of the 20th century, the situation started evolving significantly with the participation of the Old Europe⁽²⁾ countries in the influx of immigrants. During the last decades, most OECD countries witnessed a surge in the international migration. As a matter of fact, the number of foreign-born in the OECD nations shot up to more than 100 million as compared to just over 75 million a decade earlier (OECD-UNDESA, 2013). Immigrants are the prime constituent of the population in the majority of the OECD countries. They contribute tremendously to the population growth, compared to the natural increase (excess of births over death) in the previous decades (Figure 1). The migration flows are likely to continue at a sustained rate in terms of the aging and the contracting working-age population, in the decades that will follow.

Figure 1. Population dynamics, 1990-2014



Source: Authors' calculation; Demographic and Population Statistics, OECD (2011).

However, there always existed a political and public concern about the repercussions of international migration in context of the economic scenarios in the host countries. Soaring inflows of migrants face strong oppositions on the grounds that continuous addition of international workers to the domestic labour force leads to public resources being diverted

to the immigrants, increases unemployment, depresses wage, makes it harder for unemployed native workers to find jobs and results in declining employment of low-skilled national workers due to enhanced competition in general and especially in times of economic downturns such as the last sub-prime crisis⁽³⁾. Public opinion polls entrench these claims (European Social Survey, 2002; US Bureau of Labor Statistics, 2009).

While public scepticism and political propaganda against immigration seem incessant, the link between immigration and unemployment is not so straightforward, and actually contradicts popular beliefs to a significant extent. The impacts of immigration on the dynamics and equilibrium of the labour market is in fact more complex; it is impossible to understand without taking into account the characteristics of the international migrants and the economic conditions existing in the receiving countries. The labour market role of international worker varies with respect to the stage of the economic cycle. Furthermore, the link between unemployment and immigration also depends on the analysis timescale. Starting from the Solow-Swan framework, theoretical models imply that long-run positive unemployment effects of immigration exist if native and international workers are imperfect substitutes.

An increase in degree of substitutability between workers will lead to the emergence of negative short-run effects and possible long-run effects will tend to disappear (though in the short-run, immigration can contribute towards fixing labour market imbalances and cyclical fluctuations).

Also, in the long-run, immigration can contribute to dampening the impacts of rapidly demographic ageing and to augmenting human capital. Countries, where native and migrant workers complement each other because of the national high-skilled workers, resemble the standard Solow-Swan case where flexibility of the labour market allows for an accelerated short-run adjustment towards a better long-run equilibrium. On the contrary, countries with bizarre characteristics in domestic labour markets like gender bias, higher inactivity, lower participation rates, and intense educational and skill discrepancies, suffer from high levels of unemployment and low potential growth. This is suggestive of the fact that immigration could have positive effects⁽⁴⁾ on unemployment in the long-run since, international workers fill deficiencies in native labour forces, but adjustment in the short-run might temporarily generate unemployment. Nevertheless, definitive conclusions cannot be established resorting to theoretical literature due to the heterogeneity of the features in immigrations, varying specificity of the host countries, migration policies and several other unobservable effects.

For instance, geographical factors can also play a role in affecting the outcomes (geographically smaller areas are likely to be more affected by mobility and spatial interactions). Few empirical works on the causal link between host economic activity and immigration found no evidence of immigration causing unemployment and growth, but surprisingly, the causation running in the opposite direction was concluded (Islam, 2007; Marr and Siklos, 1994; Pope and Withers, 1985). On the other hand, Esposito et al. (2020) found positive impacts of immigration on unemployment in the short-run in all the 15 EU

countries and certain countries in the long-run. However, Chamunorwa and Mlambo (2014) for South Africa, and Angrist and Kugler (2003) in their study containing a panel of 18 European countries for the period 1983-1999, concluded that immigration increased unemployment to a certain degree in the native labour market.

The disparity in the theory and various empirical findings on the subject matter calls for further investigation using sophisticated techniques, different and larger dataset, in order to check the consistency of the previous findings. This paper follows a purely macroeconomic approach in line with Esposito et al. (2020), Latif (2015), and Damette and Fromentin (2013) with an aim to estimate the short and long-run impacts of immigration on unemployment on a sample of 33 OECD countries with the most number of immigrants. A Panel Error Correction Model (PECM) is estimated on the sample over the period between 1990 and 2017. The long-run specification, which relates unemployment to GDP, is based on the Okun's Law (Huang and Yeh, 2013).

This relationship is extended with the net inflow of international migrants and is estimated using the traditional FMOLS and panel DOLS alongside the Common Correlated Effects (CCE), and augmented to the case of endogenous regressors (CCE-GMM). The use of CCE estimator allows to control for cross correlation between the countries by adding cross sectional averages of all variables as additional regressors (Kapetanios et al., 2011).

We contribute to the literature by using the greatest number of OECD countries and a broader time period in the dataset. Estimations obtained from a bigger dataset provided a clearer insight and bolstered the previous findings. Subsequently, we employ a fixed effects model with a unique combination of variables for static analysis of the research question as a mean to check the robustness of the main findings. The study also has a compilation of an extensive literature review to shed light on a broad array of findings over the years.

Rest of the paper is structured as follows: Section 2 reviews the existing literature; Section 3 provides the econometric framework which presents the model specifications, estimation results and robustness check of the empirical model and Section 4 draws the conclusion of the study.

2. Literature review

The immigration-unemployment relationship is not clear-cut, rather the inconsistency between the theoretical literature and empirical findings has always put forth a conundrum. Economic literature has examined the impacts of migration on unemployment (employment) from the outset of seminal articles of Todaro (1969), and of Harris and Todaro (1970). The popular theoretical viewpoint suggests that influx of migrants can have both positive and negative impacts on unemployment depending on the degree of substitution (or, complementarity) between migrant and native workers (Borjas, 1987; Greenwood and Hunt, 1995; Johnson, 1980; Schmidt et al., 1994) and the degree of labour market flexibility.

In a standard Solow-Swan framework, if native and migrant workers are perfect substitutes, there would only be an ephemeral negative impact on unemployment and wages due to the inclination of the capital-labour ratio to go back to the steady state level. But with inflexible labour markets and no full employment, the short-term negative effects on unemployment could be highly resolute, also affecting the long-run evolution of the variable (Brücker and Jahn, 2011). If the labour supply of immigrants and residents are imperfect substitutes, then assuming wage adjustments to clear labour market, an influx of immigrants will reduce wages, resulting in an increase of total employment due to the complementarity. Part of adjustment would take place if labour force participation rates are sensitive to real wage rates. Hence, immigration may cause certain degrees of unemployment among natives who are not willing to work at reduced wages.

Borjas (2009) predicted a decrease of wages in short-run as an outcome of the arrival of immigrants, in line with the neoclassical theory of factor demand. However, if the international and host-country workers are complements in production, the addition of the new international workforce might increase resident productivity, which in turn, raises their wages and their opportunities of employment.

For instance, Berry and Soligo (1969) noted that residents' income increase with increasing immigration; Wooton (1985), in a dynamic general equilibrium model showed that especially in the long-run, labour migration may be mutually favourable for both the aspects of immigration and emigration; Borjas (1995) claimed that an 'immigration surplus' leads to welfare for the host country population, assuming the existence of perfect labour markets, and Ortega (2000) in his paper, introduced immigration in a theoretical model with two countries and concluded that firms, immigrants and natives gain from migration.

On the other hand, Harris and Todaro (1970) asserted that migrants influx should negatively influence the overall level of employment; Greenwood and McDowell (1986) elucidated the adverse effects of immigration on employment and wages for natives and immigrants already present. In a recent research, Lozej (2019) modelled migration as an endogenous decision in a 'search and matching' framework and the results showed that unemployment increases immediately after the immigration shock, but falls subsequently.

There exists diverse empirical literature as well including studies that have summed up the other empirical findings over the years (Kerr and Kerr, 2008; Okkerse, 2008). The popular empirical studies on the subject matter, have presented with assorted conclusions. Ottaviano and Peri (2008) found out that immigration exerts small negative effects on unemployment and wages in the short term on national workers with no high school degrees. However, in the long-run, the effects are positive. Similarly, Gross (2002) carried out an empirical investigation in the immigrant workers flow into the French labour market from the mid-1970s and mid-1990s, and suggested that though the admittance of immigrants led to a minor increase in unemployment in the short-run, the long-run immigration decreased unemployment level.

In another study also based in France, cointegration and Error Correction Model techniques were applied to analyse the relationship between immigration, the labour market and economic development, it was found out that immigration reduced unemployment in both the short and the long-run (Fromentin, 2013).

Jean and Jimenez (2011) made a study on 18 OECD countries for the period of 1984-2003. They found short-run negative effects of immigration on unemployment for a period of five to ten years and no significant effects in the long-run. Their study presented the conclusions that anticompetitive product market regulations increase both the persistence and magnitude of this impact, while more stringent employment protection legislation intensifies its persistence and an increased average replacement rate of unemployment benefits increases its magnitude.

Latif (2015) applied a panel cointegration approach with provincial-level data from Canada and maintained that immigration had negative impact on unemployment in the short-run, but in the long-run, this effect is insignificant.

Also, Gross (2004) in a study involving data from the province of British Columbia in Canada, implied that immigration increased unemployment in short-run and in the long-run, unemployment was lowered permanently by the influx of migrants.

Peri and Sparber (2009) found evidence that due to the disparities in the task specialization of migrant and native workers, there is no significant negative employment effect of immigration.

Peri (2012) claimed that the main employment effect of migration in the US is operational through total factor productivity, validating the theory of immigration increasing the variety of skills available for production.

Martins et al. (2018) used matched employer-employee longitudinal data in their study based on Portugal and discovered that there is a strong positive association of immigrants on native workers hiring. Similarly, Villosio and Venturini (2006) put forth evidence of a complementary effect between natives and immigrants in Italy.

Ortega and Peri (2009) confirmed the positive effect of immigration on the growth of employment after the research on the impact of immigration on productivity, production factors and factors per worker for a sample of 14 OECD countries.

Ghatak and Moore (2007) found out that immigration had a significant positive effect on the unemployment rate in the destination countries after using Granger causality techniques on a panel data from 13 of the original EU countries.

On the contrary, Dustmann et al. (2005) for the UK, Carrasco et al. (2008) for Spain, Winter-Ebmer and Zimmermann (1999) and D'Amuri et al. (2010) for Germany, Strielkowski and Troshchenkov (2013) from the cross-sectional data of 99 municipalities of Denmark, Simon et al. (1993) for the US, and Pischke and Velling (1997) do not find a significant effect of immigration on the (un) employment conditions in the native labour force.

Boubtane et al. (2013) for 22 OECD countries in the period of 1980-2005, and Shan et al. (1999) for Australia and New Zealand, bolstered the findings by providing evidence that immigration does not Granger cause unemployment in any countries. This conclusion is corroborated by the studies based on natural experiments, i.e., immigration caused by political rather than economic factors (Card, 1990 for the Mariel Boatlift⁽⁵⁾ and Hunt, 1992 for the “pieds-noirs” return to France after the independence of Algeria).

Few recent studies provide detailed insights. Grossmann and Stadelman (2013) used a purely gravity approach to analyse the effects of migration flows by skill group on Total Factor Productivity, relative GDP per capita, and wages of the home and host countries. They declared a significant positive impact of skilled labour migration on relative TFP differences, consistent with the complementarity effect of skilled labour immigration in advanced economies⁽⁶⁾.

Damette and Fromentin (2013) used a panel VECM model to assess the connection between migration, wages and unemployment in OECD countries and addressed the endogeneity problems among the three variables. Their results showed that in the short-run, immigration positively affects unemployment in the continental European countries but it negatively affects unemployment in the Anglo-Saxon countries. D’Amuri and Peri (2014) collected aggregate individual level data from the European LFS to construct a dataset including task intensities and skill of foreign employed and native population in 15 Western European countries. The discovered evidence of complementarity between foreign and native workers due to specialization in different tasks, which stimulates higher job complexity and job creations.

To shed light on the impacts of immigration on economic prosperity, few theoretical works (Barro and Sala-i-Martin, 1995; Dolado et al., 1994) employ a Solow growth model extended by human capital to examine the effects of immigrants on growth. They conclude that the impacts of migration on economic growth depend on the composition of skills of the incoming migrants. The more migrants are educated and skilled, the more is the complementarity effect, possibly resulting in enhanced positive effects of immigration on economic growth and subsequently, on employment in the host country. Feridun (2005), using data from Norway, found out that immigration had a positive impact on GDP per capita while it had no effect on unemployment. Quite a few works investigated the fiscal impacts of immigration to evaluate whether receiving country’s social welfare system is burdened by the immigration more than is compensated by the taxes paid by the immigrants (Auerbach and Oreopoulos, 1999; Borjas, 1995, 2001). These studies generally point out that the total economic impact on the host country is relatively small.

In a related study, Beine et al. (2014) investigated whether immigration could alleviate the Dutch disease effects associated with booms in natural resource sectors. The study used a panel data for the 10 Canadian provinces and discovered that workers’ immigration into the booming provinces exerted a mitigating impact on the Dutch disease. The mitigation effect was more intense with inter-provincial migration flows immigration flows connected with temporary foreign workers program. However, any evidence of such mitigation effect

for permanent international immigration was not found. In another study, Gross and Schmitt (2012) used panel data from the 10 Canadian provinces and found that availability of ephemeral international labours contributed to the persistence of regional discrepancies in the rate of unemployment.

The diversified empirical conclusions in the immigration-unemployment relationship literature pool, provide the rationale for further empirical investigations to be carried out in the following sections.

3. Empirical analysis

This section intends to present the overall empirical findings and sheds further light on the immigration-unemployment debate. The entire framework has been constructed with reference to Esposito et al. (2020).

3.1. Model specifications and methodologies

Following Latif (2015), Esposito et al. (2020), and Boubtane et al. (2013), we initiate by modelling unemployment rate as a function of domestic GDP and immigrant inflows (check Appendix III for variable descriptions). Mathematically,

$$U_{it} = f(IM_{it}, GDP_{it})$$

where U represents the unemployment rate; IM is the immigrants inflow; GDP is the gross domestic product of a nation, and the subscripts i ($i = 1, \dots, N$) and t ($t = 1, \dots, T$) indicate the individual country and time period, respectively.

The relationship between unemployment and GDP is established with respect to the long-run version of the Okun's Law (Huang and Yeh, 2013). Taking into account the ample of empirical and theoretical evidences provided in the literature review section, the long-run effect of immigration on unemployment is expected to be positive by the virtue of the complementarity/substitutability effect. In the short-run, the degree of complementarity or substitutability will play a more crucial role in determining the ultimate immigration effects. Though, in a broader perspective, a higher degree of substitutability is expected increase unemployment due to immigration, but the outcome might also vary depending on certain other factors like the flexibility of labour markets and other prevailing economic conditions. The GDP variable is anticipated to have a negative coefficient since, economic growth creates job opportunities and reduces unemployment.

The long and short-run relations between immigration and unemployment will be estimated using a Panel Error Correction Model (PECM) of the form as follows:

$$unem_{i,t} = \beta_0 + \beta_1 limm_{i,t} + \beta_2 lgdp_{i,t} + \varepsilon_{i,t} \quad (i)$$

$$\begin{aligned} \Delta unem_{i,t} = & \alpha_0 + \alpha_1 \Delta limm_{i,t} + \alpha_2 \Delta lgdp_{i,t} - \rho (unem_{i,t-1} - \beta_0 - \beta_1 limm_{i,t-1} - \beta_2 lgdp_{i,t-1}) + \\ & + \sum_{i=1}^N \lambda_i + \sum_{t=1}^T \gamma_t + v_{i,t} \end{aligned} \quad (ii)$$

where $unem$ is the unemployment rate variable, $lgdp$ is the log of GDP at constant 2010 USD and $limm$ represents the log of inflow of immigrants. Equation (i) denotes the long-

run equation whereas equation (ii) is used for estimating the short-run deviations the equilibrium relation as well as the adjustment speed toward the long run equilibrium (ρ). Higher adjustment speed implies lower persistence of short-run disturbances. λ_i symbolises country specific fixed effects and γ_t represents time fixed effects and they are employed in order to take into account the unobserved heterogeneity and Cross Sectional Dependence (CSD).

The long-run relationship estimation implies that there exists a cointegrating relationship between the variables and that the series are non-stationarity. It is also to be taken into account that in longer panels, individual time series are probably affected by the same common factors, resulting in the presence of CSD. Hence, a couple of testing procedures are to be carried out preliminarily. We begin by testing for the presence of CSD following Pesaran (2004) and subsequently, test for the presence of unit roots using two different methods.

The first step involves the application of Maddala and Wu (1999) test, which is a panel unit root test of the first generation and is not robust when CSD is existent. In the second step, the CIPS test developed by Pesaran (2007) is used. The CIPS test belongs to the second-generation panel unit root tests and is robust in presence of CSD. In the end, the presence of a cointegration relation is examined by utilising the procedure constructed by Persyn and Westerlund (2008), which is robust in presence of CSD when standard errors are bootstrapped.

The cointegration relation of equation (i) is estimated using three different estimators. The first two estimators are the group-mean Panel Dynamic OLS (PDOLS) and the Fully Modified OLS (FMOLS) developed by Pedroni (2001). By adding lags and leads of the variables in equation (i), these two estimators control for potential endogeneity. The PDOLS does not control for other sources of endogeneity apart from the simultaneity bias. Both the estimators do not control for the CSD issues, and therefore, the Common Correlated Effects Mean Group estimator (Chudik and Pesaran, 2015; Pesaran, 2006) is introduced.

The advantages of this estimator are enhanced performance in presence of a small panel and it takes into account the CSD issue. By introducing cross sectional averages of all the variables as well as additional common factors, the CCE estimator controls for CSD. In this case, the additional factor is a year dummy equal to 1 to control for the time shocks of the European sovereign debt crisis and the Global Financial Crisis. A GMM version of this estimator (CCE-GMM) was developed by Neal (2015), which permits to take into account the endogeneity issues. The first two lags of the endogenous variables are used as the instruments. The paper estimates the PECM specification of equation (ii) by using a standard fixed effects estimator alongside a GMM approach, where the first and second lags of the endogenous regressors are used as the instruments. Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors are estimated to control for general forms of correlation among residuals.

Since the Okun's Law entails a simple correlation rather than a causal relationship, endogeneity problems in the long-run relation affect both GDP and immigration. Additionally, omitted variables, particularly with regards to technological developments, can aggravate the situation. As far as immigration is concerned, the unemployment in the host country could be a potential pull factor since job-searching migrants are more likely to choose countries with lower unemployment to increase the probability of landing into a job. All these endogeneity issues are attenuated in the short-run since unemployment conditions are mainly determined by the economic cycle and migrant inflows respond more to the long-run economic features of the destination country. We will use VECM-based Granger Causality test to determine the endogenous regressor(s) in this study.

3.2. Data type and source

We use a panel data of 33 OECD countries with the time frame 1990-2017. The dataset has been compiled by collecting data from the World Bank World Development Indicators (February 2019), OECD database, IMF database and FRED database.

3.3. Estimation and analysis

At first, the reports of Pesaran (2004) test for CSD is interpreted for all the variables. From the first panel of Table 2, the outputs show that all the three series display significant CSD. The remaining two panels of Table 2 provide the outcomes of the unit root tests for the lag specifications of zero and one.

Table 1. CSD and Unit Root Tests

Pesaran (2004) Test for Cross Sectional Dependence			
	<i>unem</i>	<i>limm</i>	<i>lgdp</i>
	11.99***	48.33***	114.66***
lags	Maddala and Wu (1999) Panel Unit Root Test		
	<i>unem</i>	<i>limm</i>	<i>lgdp</i>
0	97.31***	71.75	48.39
1	147.89***	125.348***	54.31
	Pesaran (2007) Panel Unit Root Test (CIPS)		
	<i>unem</i>	<i>limm</i>	<i>lgdp</i>
0	2.34	-0.84	1.29
1	-0.3	-1.53	1.86

Note: ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

The Maddala and Wu (1999) test shows that *limm* and *lgdp* have a unit-root whereas *unem* is a stationary series. However, due to the existence of CSD in the data, the Pesaran (2007) test results are more dependable and the results indicate that the assumption of I(1) process for all the series is accepted.

The outcomes of the Persyn and Westerlund (2008) cointegration tests with bootstrapped standard errors are displayed in Table 2. Skimming through the bivariate relations between each of the regressors and unemployment, we can confirm from the results that there exists a cointegration relation.

Table 2. Westerlund Cointegration Tests

	<i>limm</i>	<i>lgdp</i>	<i>limm, lgdp</i>
Gt	-2.65**	-3.2***	-3.35***
Ga	-10.69	-13.78*	-13.79*
Pt	-15.46***	-10.09	-14.62***
Pa	-13.74***	-6.69	-11.9***

Note: ***, ** and * represent significance at 1%, 5% and 10% levels respectively. Ga and Gt are tests for heterogenous panels (cointegration for at least 1 panel); Pa and Pt are pooled tests for homogenous panels (cointegration for all panels). H_0 : series are not cointegrated. Standard errors are bootstrapped using 100 replications.

For *limm*, three out of four tests are highly significant; two out of four tests are significant for *lgdp*. While both the regressors are tested, all the four tests for cointegration are significant. Henceforth, the existence of a cointegration relationship for equation (i) can be confirmed.

Table 3. VECM based Granger Causality Tests

$\Delta unem_{i,t}$ is not Granger caused by:			
	$\Delta limm_{i,t}$	$\Delta lgdp_{i,t}$	All
1 lag	0.001	17.8***	18.09***
2 lags	10.91***	36.68***	51.25***
$\Delta limm_{i,t}$ is not Granger caused by:			
	$\Delta unem_{i,t}$	$\Delta lgdp_{i,t}$	All
1 lag	15.2***	7.61***	50.59***
2 lags	14.58***	7.13**	44.3***
$\Delta lgdp_{i,t}$ is not Granger caused by:			
	$\Delta unem_{i,t}$	$\Delta limm_{i,t}$	All
1 lag	0.29	0.1	0.36
2 lags	0.62	0.99	1.43

Note: ***, ** and * represent significance at 1%, 5% and 10% levels respectively.

Lastly in Table 3, we show the results of the Granger causality test using alternatively one or two lags of the differenced variables. We find that *lgdp* Granger causes *unem* whereas evidences of bidirectional causality between *limm* and *unem* has been found. As per the results, *limm* is treated as the endogenous regressor in the PECM specification.

Estimation outcomes for equation (i) are shown in Table 4. The FMOLS model estimates a negative coefficient for *lgdp* as expected and for *limm* as well. The results show that both *lgdp* and *limm* are significant at 1% and 5% level, respectively. In the PDOLS model, the lags and leads are chosen as per Schwartz criterion. The model predicts negative coefficients for both *limm* and *lgdp*.

However, we find that *limm* is insignificant in this model. For both the estimators, the outputs can be potentially biased due to the possible presence of CSD.

Table 4. Unemployment Determinants: The Long-Run Relationship

	FMOLS	PDOLS	CCE-GMM
<i>limm</i>	-0.492** [0.25]	-0.445 [0.371]	-1.611* [0.881]
<i>lgdp</i>	-22.864*** [1.652]	-24.097*** [2.261]	-26.419*** [5.52]
Resid UR	-1.70**	-2.8***	-12.85***
N	791	758	759

Note: ***, ** and * represent significance at 1%, 5% and 10% levels respectively. Standard Errors are shown in []. Resid UR = unit root test of estimation residuals.

The CCE-GMM estimator, on the other hand, takes the cross correlation into account. $lgdp$ is still found to be negative and significant. The immigration impact is found to be changed substantially and is significant at 10% level. It can be concluded that the native workers have been complemented by the international workers during the last 27 years and thus, maintaining the unemployment at a lower level.

In Table 5, the estimation results of equation (ii) are shown. The results of a Fixed Effects (FE) model with HAC standard errors, and a GMM model with immigration treated as the endogenous regressor, are plotted.

Table 5. Unemployment Determinants: PECM

	FE	GMM
ρ	-0.272*** [0.029]	-0.38*** [0.037]
$\Delta limm$	-0.399*** [0.127]	-0.96*** [0.356]
$\Delta lgdp$	-25.979*** [1.596]	-25.776*** [1.828]
R ²	0.552	0.551
Hansen J		6.795
N	784	759

Note: ***, ** and * represent significance at 1%, 5% and 10% levels respectively. Standard Errors are shown in []. Hansen J = Hansen overidentification test.

From the results of both the estimators, we can interpret that immigration significantly reduces unemployment in the short-run. $lgdp$ has significant negative coefficients. The significantly negative values of ρ (-0.27 and -0.38) indicate that the short-run disturbances are persistent and that there is long-run convergence towards the equilibrium.

3.4. Robustness check

To check the soundness of the results obtained, a series of steps has been followed. First of all, to come up with further evidence on the cross-sectional diversities in the short-run impacts of immigration, an augmented version of equation (ii) is estimated where the log changes in immigration is interacted with both the OECD Employment Protection Index (epi) and the labour force participation rate (lfp). epi is used as employment protection is a crucial determinant of the adjustments of labour market after an immigration shock, and lfp controls for labour market flexibility (Esposito et al., 2020). The new equation is as follows:

$$\Delta unem_{i,t} = \alpha_0 + \alpha_1 \Delta limm_{i,t} + \alpha_2 \Delta lgdp_{i,t} + \alpha_3 (lfp_{i,t} \Delta limm_{i,t}) + \alpha_4 (epi_{i,t} \Delta limm_{i,t}) - \rho (unem_{i,t-1} - \beta_0 - \beta_1 limm_{i,t-1} - \beta_2 lgdp_{i,t-1}) + \sum_{i=1}^N \lambda_i + \sum_{t=1}^T \gamma_t + v_{i,t}$$

Both lfp and epi variables are non-stationary. However, the interactions with the immigration variable are stationary. Hence, the non-linear terms are included and the non-interacted variables are left out. The estimation results of negative coefficient of immigration from the main analysis does not alter.

In the next step, we carry out a static estimation of the immigration-unemployment relationship using a fixed effects model. Two new variables, secondary school enrolment ratio (sse) and inflation (inf) are introduced as control variables along with the pre-existing variables. The reason for choosing these variables are the established relationship between

them and unemployment. The *sse* variable controls for the human skill-set and increased education likely reduces unemployment. As for as inflation is concerned, the Philips Curve popularised the inflation-unemployment trade-off theory. The resulting equation is:

$$unem_{i,t} = \alpha + \beta_1 limm_{i,t} + \beta_2 lgdp_{i,t} + \beta_3 lfp_{i,t} + \beta_4 epi_{i,t} + \beta_5 inf_{i,t} + \beta_6 sse_{i,t} + \sum_{i=1}^N \lambda_i + \sum_{t=1}^T \gamma_t + \delta_{i,t}$$

Initially, the main regressors, *limm* and *lgdp* are introduced and then, one by one, the other control variables are used. The results display that the coefficient of immigration is negative throughout and is significant at 1% level.

Hence, the results of the empirical investigation that influx of international workers reduced unemployment rate in the OECD nation, stands.

4. Conclusion

The upward trend in economic growth observed across the last decade in the majority of the OECD member countries has fuelled the debate on immigration, the primary focus of which remains the flow control, to the contributions that immigration might play in decreasing sectoral labour shortages, and dampening the effects of population ageing. Nevertheless, events like the Brexit campaign fuelled by the anti-immigration arguments, prove that the scepticism related to allowing foreign population in the native country, persists. In light of these, the paper empirically analyses the unemployment impacts of immigration. The results suggest that immigration reduces unemployment in both the short and the long-run in the economically developed OECD countries in line with Ortega and Peri (2009), and (Esposito et al. (2020)). The explanation for this is that the migrant workers are complementing the national workers, and that they mitigate the negative impacts of skill mismatches and the aging population. Damette and Fromentin (2013) link the result obtained to the high-speed adaptation of migrant workers and the labour market's absorptive capacity, and mentions the rationale for this result that migration creates jobs as well as fill them. Thus, it is a bit unfair to condemn the migrant workers on grounds of taking away employment opportunities from the natives.

However, this paper suffers from the limitation of lack of data availability. More data points would provide clearer insights on the topic of discussion. Provided the fact that immigration is a matter of concern in many other nations apart from the OECD, recommendations would be to collect sufficient data for those countries inclusive, so that answers could be sought not limited to the OECD countries.

Notes

- (1) Australia, Canada, New Zealand, USA.
- (2) Western Europe.
- (3) During the recession, a debate ensued in Europe on whether immigrants were stealing jobs from the native workers (Rohac, 2014).

- (4) Throughout the paper, the study defines positive (negative) effect of immigration on unemployment as decrease (increase) of unemployment rate. However, empirically, a positive (negative) means a negative (positive) coefficient in the estimations provided later on.
- (5) In 1980, Fidel Castro granted free access to depart from the Mariel port, to any persons who wished to leave Cuba. Approximately, 125,000 Cubans, comprising of mostly unskilled workers, migrated to Miami, increasing Miami's labour force by 7 percent.
- (6) In evaluating the labour market effect of immigration in the host economy, the discouraging effect on internal labour mobility has to be taken in account (Brücker et al., 2011).

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Appendix I. List of countries

Australia	Czech Republic	Greece	Italy	Netherlands	Slovak Republic	Turkey
Austria	Denmark	Hungary	Japan	New Zealand	Slovenia	UK
Belgium	Finland	Iceland	Korea	Norway	Spain	USA
Canada	France	Ireland	Luxembourg	Poland	Sweden	
Chile	Germany	Israel	Mexico	Portugal	Switzerland	

Appendix II. Variable statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
<i>unem</i>	910	7.586	4.063	0.7	27.466
<i>limm</i>	825	11.045	1.451	7.21	14.517
<i>lgdp</i>	921	26.763	1.473	22.792	30.485
<i>lfp</i>	917	60.407	6.637	45.09	83.847
<i>epi</i>	836	2.205	0.872	0.093	4.833
<i>inf</i>	911	5.016	12.372	-5.214	208.178
<i>sse</i>	656	89.537	8.764	44.260	105.699

Appendix III. Variable descriptions

Variables	Descriptions	Source
<i>unem</i>	<i>Unemployment, total (% of total labour force)</i> . The share of the labour force that is without work but available for and seeking employment.	The World Bank
<i>limm</i>	<i>Log of total inflows of foreign population by nationality</i> . OECD countries seldom have tools specifically designed to measure the inflows and outflows of the foreign population, and national estimates are generally based either on population registers or residence permit data.	OECD
<i>lgdp</i>	<i>Log of Gross Domestic Product (constant 2010 US\$)</i> . Sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	The World Bank
<i>lfp</i>	<i>Labour force participation rate, total (% of total population ages 15+)</i> . Labour force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period.	The World Bank
<i>epi</i>	<i>Strictness of employment protection</i> . The OECD indicators of employment protection are synthetic indicators of the strictness of regulation on dismissals and the use of temporary contracts. They are compiled from 21 items covering three different aspects of employment protection regulations: (i) protection of regular workers against individual dismissals; (ii) regulation of temporary forms of employment; (iii) additional, specific requirements for collective dismissal	OECD
<i>inf</i>	<i>Inflation, GDP Deflator (annual %)</i> . It shows the rate of price change in the economy as a whole	The World Bank
<i>sse</i>	<i>School enrolment, secondary (% gross)</i> . Ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.	The World Bank

Influences and spatial effects on subjective well-being

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Abstract. *In this paper we explain the influence of some economic-social and psychological factors on a higher life satisfaction, as an expression of the subjective state of well-being, on a sample of 32 European countries. In the analysis, we used results of surveys on quality of life conducted during 2011-2012 and 2016 by Eurofound. We opted for estimating spatial models to highlight influences on well-being due to the existence of spatial autocorrelation between variables. The findings reveal that there is consistent positive relationship between life satisfaction and satisfaction in the fields and a significant negative relationships were found in relation to negative emotions, perception of a high degree of corruption in society or, even more importantly, unequal income distribution.*

Keywords: subjective well-being, life satisfaction, positive and negative affect.

JEL Classification: I31, C33, D31.

1. Introduction

As an essential human right, well-being, is defined as a prolonged state of contentment, of harmony of an individual, due to a good physical and mental health, personal and economical safety or of the feeling of social affiliation. It assumes satisfying the basic needs, the fact that individuals have a purpose in life and the objectives that they feel they can achieve. Also, it is strengthened by elements as personal relationships, membership in strong communities, freedom to make key life decisions, a good job, a reliable environment and a clean climate. Well-being can be considered a combination of what a person has, what he can do, and how satisfied he is with what he can do.

Well-being excludes depression, suffering, feelings of pressure and frustration, but it is more than that. So, the term of subjective well-being (SWB) is a comprehensive construct, that refers to how people experience and evaluate their lives in a positive way (Tov, 2018) and which includes several dimensions: mental, physical, emotional, psychological, societal, related to the job, personal development or individual values.

In the last decades, an important development in the field consists of recognition and acceptance of the fact that well-being embodies several aspects and can not be represented only by one measure. To describe and evaluate the well-being, objective considerations are used, economic or related to the individual's own characteristics (age, gender, marital status, etc.), his personality, the integration on the labor market. Also, subjective considerations are taken into account, regarding the way in which individuals perceive and evaluate their own life, mood, feelings and emotions, in general, psychic and mental factors (Diener, 1984; Diener et al., 2000; Diener et al., 2002; Seligman, 2018).

Components used in the assessment of subjective well-being are distinctively treated in literature, from a double perspective. The cognitive dimension (*cognitive well-being* – CWB), the extent to which individuals are satisfied in achieving their aspirations and based on beliefs, attitudes towards life satisfaction, both in global terms and in specific domains (job satisfaction, family life satisfaction, education, health, living standard, institutional trust) (Diener et al., 1999). For a person with a high CWB objectives, desires and standards are largely met by the current conditions of his life (Diener, 1984; Tov, 2018). *The affective component of subjective well-being* (*affective well-being* – AWB) refers to the individual's emotions and experiences, reflecting the amount of pleasant and unpleasant feelings, positive and negative affect that people are experiencing in their daily lives (e.g. happiness, joy, contentment, sadness, anger, concern, etc.) (Diener et al., 2002, p. 63).

From the economical point of view, well-being is analyzed in terms of income and/or its distribution. From the psychological and behavioral sciences' point of view, subjective factors must also be taken into account, as well-being transcends the economic dimension, focusing on social, cultural, political, environmental values, etc. That is why it is important that these dimensions are treated in their interdependence with each other.

Usually, achieving objectives leads to a pleasant feeling, while lack of fulfillment can have an unpleasant effect. Human well-being means taking into account what people say, their opinions and perceptions. Thus, emotional experiences provide information about how well one's life is going, and can be judged in terms of *life satisfaction (LS)*. This is the degree

to which a person positively assesses the overall quality of his or her life, i.e. how much a person likes his or her life (Veenhoven, 1996, 2005). Life satisfaction is how people show their emotions, feelings and how they feel about their directions and options for the future.

Thus, life satisfaction is a measure of well-being regarding mood, satisfaction with social and family relationships, the achieved objectives, ability to cope with everyday life. Life satisfaction is a key component of well-being "... it is the subjective appreciation of our life as a whole" (Veenhoven, 2015, p. 207).

2. Literature review

Literature in the fields of sociology, psychology, health, socio-economic and even political sciences comprises a very rich theoretical and empirical perspective on well-being or life satisfaction. The importance of different life circumstances in shaping the overall life satisfaction is a topic for various studies and researches, with a growing interest of economic approaches. Šoltés, Nováková and Szabo (2018, p. 60) cites specialists who have focused on the role of income, as a gain of individual satisfaction with life. Observing time series data in countries with different levels of development confirmed that between short-term fluctuations in people's happiness levels and their incomes there is a positive association, but without them being linked in long-term trends. The failure to confirm a relationship between GDP per capita and happiness has been widely analyzed in the literature, becoming a reference principle called the Easterlin paradox, after the name of Easterlin (1974) which highlighted it. As Clark, Frijters and Shields (2008) affirmed, the Easterlin paradox is not specific to the US. Developed countries have seen obvious increases in per capita income in the recent decades, but without the level of happiness of the population to increase. The authors captured data from Japan and from five European countries (Italy, Germany, France, Holland and Great Britain), where despite the increase in income, there was no evidence of an increase in life satisfaction.

In an analysis of happiness in the US and Great Britain in the last quarter of twentieth century, Blanchflower and Oswald (2004), using primary data from General Society Surveys (GSS) in the US, made a number of observations: if in the early 1970s, the percentage of those who declared themselves very happy was 34%, and the proportion of women with the highest score of happiness was slightly higher, 36%, by the end of the 1990s, the overall percentage dropped to 30% and only 29% of women still fell into this category. In relation with different demographic characteristics, white population seems to be less happy, and depending on the age, the configuration of the evolution of the level of happiness takes the form of a U-shape curve. For Great Britain, the association between income and life satisfaction was a flat one.

Stevenson and Wolfers (2013) mention different authors according to whom a high level of subjective well-being is not successive to a high income, once a basic level of satisfaction is met. To support this idea we find authors of reference for defining and assessing well-being, such as Diener and Seligman (2004), who see only a small improvement if it, if the essential needs of people are met. In another study, Diener and Biswas-Diener (2002) report a small effect of money on happiness in developed countries. For Layard (2003), the

threshold of independence for improving the level of happiness intervenes only for an income higher than 15.000 dollars per capita. Di Tella and MacCulloch (2008) or Clark, Frijters and Shields (2008) reached the same conclusions.

One of the findings drawn from the literature is that the higher the level of economic development and wealth of a country, the weaker the impact on the reported satisfaction. (Frey and Stutzer, 2002; Veenhoven, 2005, 2015). The fact that we are witnessing a general decrease in well-being in parallel with the increase in income, wealth in general has been explained by the fact that people are increasingly dependent on lucrative activity, at the expense of leisure time or consumer goods, which would certainly have an impact on their level of satisfaction, and their quality of life in general (Eaton and Eswaran, 2009).

However, these are not the only results and observations, other studies contest the Easterlin paradox. Blanchflower and Oswald (2004), following econometric estimates, concluded that there was a positive association between high income and a high levels of happiness. Using a scale that measures one's broad vision or assessment of their life, the valuation constantly increases with income. Kahneman and Deaton (2010) also identify an effect of increasing income in the direction of a better evaluation of life satisfaction, but not an emotional well-being. On a scale that measures wide vision or the assessment of one's own life, assessment increases together with income. Kahneman and Deaton (2010) identify the effect of income growth upon a better assessment of life satisfaction, without referring to emotional well-being.

Stevenson and Wolfers (2013) note, however the absence of a relationship between income and life satisfaction, appreciating that the relationship between well-being and income is a logarithmic one that does not indicate reductions when income increases. Layard, Clark and Senik (2012, p. 5) also highlight the importance given to logarithmic income transformation in the subsequent assessment of life satisfaction, the result being a linear variation of the absolute level of satisfaction with income logarithm.

Another research in this area identifies that people in richer countries are more satisfied with material conditions or life as a whole and this life satisfaction is significantly affected by other objective conditions in poor countries (Schyns, 2002). According to Zagórski, Kelley and Evans (2010), for rich countries, an increase in household income as well as an increase in higher education in a country with a high average educational level do not affect the happiness of individuals in the same way, but there is a strong beneficial impact of a country's level of development on their well-being, an aspect highlighted especially for poorer countries. Wiese (2014) tested the impact and importance of PIB on the well-being of citizens in European countries. He identified important differences in life satisfaction and the deviation from increased trends among certain countries (Spain, Italy, Portugal and Greece) and confirmed that some characteristics of their welfare state could determine their citizens to be more dependent on certain economic variables, such as income growth.

In a recent study on the importance of material living conditions, Šoltés, Nováková and Szabo (2018) concluded that both the richer population and the population of richer countries are more satisfied with life. These results are obtained by separate econometric estimates on three territorial areas, UE-15, countries from the Visegrad group (V4, Czech

Republic, Slovakia, Poland and Hungary) and Romania, using data from European Quality Life Survey (EQLS). Nevertheless, in the opinion of the authors, life satisfaction is not the most appropriate indicator for measuring well-being, omitting the objective dimension of quality of life.

3. Empirical evidence

Through this study, we set out to be able to identify a number of causalities with a strong impact on the subjective state of well-being, on a sample of 32 European countries, which would explain what socio-economic, demographic, political or cultural characteristics have a significant role for a better life. For this purpose, we used primary data regarding life quality obtained through annual or multiannual thematic surveys conducted by Eurofound and Gallup World Poll. Questions about life satisfaction (and happiness) are presented as separate aspects in such surveys, with certain distinctive elements more or less emphasized in some languages and cultures. All surveys provide a summary indicator of the extent to which the expectations and needs of the individual are met, at the level of coverage considered.

European Quality Life Survey, EQLS (Eurofound, 2018) comprises a unique set of subjective well-being indicators (26 indicators in the 2016 survey), to capture subjective general well-being including two global measures: life satisfaction, which allows people to provide an overall assessment of their lives, and overall happiness, which allows people to provide a more emotional assessment of how they feel. The conceptual framework used in EQLS is generally in line with OECD guidelines, the subjective well-being approach being focused through three groups of indicators:

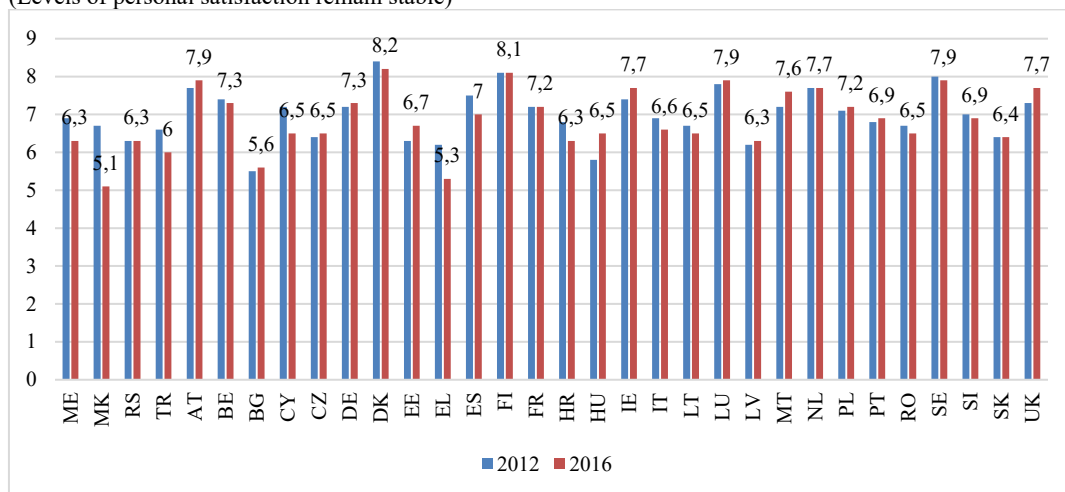
- evaluative well-being – life satisfaction and satisfaction with domains of life;
- positive and negative affect – happiness, vitality, feeling of calm, feeling of joy, feeling of depression;
- eudaimonic well-being – optimism, autonomy, sense of purpose, having time to enjoy life and endurance.

The EQLS results indicate that the ones who are content, the most satisfied with their lives and happiest have a purpose to pursue, are optimistic about their future and the freedom to live their lives autonomously (deciding for themselves). Physical and mental health is another key determinant for well-being. In the last survey (2016), two elements measuring resistance were added to capture the perceived ability to solve problems and the time it takes to return. Perceived resistance correlates positively with mental well-being variables.

On a scale of 1 to 10, the average score recorded in the European Union of personal satisfaction is, according to EQLS 2016, 7.0-7.1. At national level, the best located are the northwestern countries: Finland, Denmark, Luxembourg, whose performance slightly exceeds 8.0 points, followed by Sweden, the Netherlands, the United Kingdom, Ireland (7.8), Austria (7.9). Values above the EU average are in Germany, France, Belgium, Poland, Portugal, Croatia (7.4-7.5). The lowest scores were recorded in EU countries such as Bulgaria (6.4) and Greece (6.0; down from 2012 when the score was 6.5 due to a prolonged crisis), but also in some candidate countries (Macedonia – 6.1; Turkey – 6.2).

Relatively low levels are also found in Italy or the Czech Republic (6.8). Very close to the score of 7 are many states: Romania, Hungary; Lithuania; Latvia, Serbia (7.0), Slovakia, Cyprus (7.1), Estonia, Slovenia (7.2), Spain, Montenegro (7.3).

Figure 1. Personal satisfaction (with life in general, average scores), 2012 and 2016
(Levels of personal satisfaction remain stable)



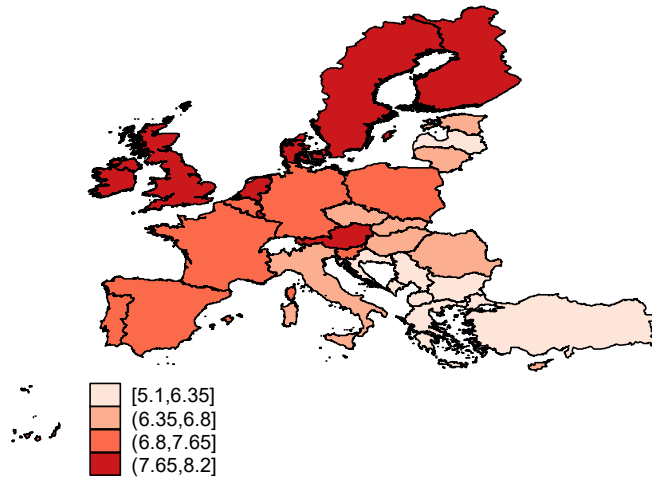
Source: Eurofound, EQLS, 2018.

Compared to the previous estimate (2011-2012), the indicator did not register any spectacular evolution in 2016, the data remaining relatively constant on the whole community space. More significant changes can be seen at the country level. Thus, between 2003 and 2007, life satisfaction and happiness increased in several Eastern European countries, so that in the period 2007-2011, against the background of the economic crisis, there were reductions in the perception scores on life satisfaction, and this especially in countries affected by the recession and where severe austerity measures have been taken. Lower values resulted in Croatia, Cyprus, Greece, Italy, Spain, and happiness in the Czech Republic. An increase in life satisfaction is observed in Austria, Estonia, Malta, Great Britain, Hungary and Ireland. Only Greece, Macedonia and Turkey are the countries where personal satisfaction has experienced a significant decline (even about 10%).

The largest differences between countries are directly observable in the analysis by age groups of the population. In the vast majority of countries, there is a tendency for the indicator score to decrease with age, as well as a significantly higher average score than the total average for the 18-24 age group. The largest gaps in personal satisfaction are in Eastern and Central European, EU and candidate countries, but also in some former EU member states. Thus, in Greece the average score of personal satisfaction among the population over 50-65 years is about 11% lower than the average for the total population, while the same score for the young population (18-24 years) exceeds by 26% general average. Equally high discrepancies are in Croatia (-9.5% for the elderly and + 22% for young people), Lithuania (-16.9%; + 18.5%), Romania (-12%; + 13.8%), Slovakia (-11%; + 17%), Slovenia (-8.7%; + 15.9%), Estonia (-11%; + 13%) etc. In only a few countries, the average score among the elderly is relatively close to the general average ($\pm 1-3\%$), and

even for young people the score is not much higher than it (Austria, Finland, Belgium). A special case is that of Sweden where, paradoxically, the personal satisfaction of people aged 50-64 is 5% higher than the national average, while for young people aged 18-24, the average score is lower by more than 11%.

Figure 2. National differences in well-being, 2016, average score of life satisfaction



Source: Stata processing.

4. General model and research hypothesis

Life satisfaction is a wide used indicator for measuring well-being, incorporating both the affective dimension of subjective well-being (the sense of satisfaction) as well as the cognitive dimension (the assessment of life as a whole). In the estimated econometric models we aimed to evaluate the influence of socio-economic, social, psychological factors on the subjective state of well-being, measured by life satisfaction or life ladder (as alternatives to the dependent variable), using spatial estimation techniques and procedures. To evaluate the role of these determinants we considered a sample of 32 European countries (EU-27, Great Britain, Montenegro, Northern Macedonia, Serbia and Turkey), and the period considered is summarized in two years, 2011-2012 and 2016. Factorial dimensions (independent variables) were grouped into several categories: i) influences of specific areas of life satisfaction; ii) social foundations of personal satisfaction with life (the role of social support, freedom to make choices in life, generosity, absence of corruption); iii) the impact of economic performance and unequal income distribution; iv) influences of some characteristics of the society in which people live. As econometric techniques and procedures, we used spatial econometrics models that take into account the existence of spatial interdependencies at the level of the national units considered. Such spatial models estimated in our paper are Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), Spatial Durbin Model (SDM) and Spatial Autoregressive Confuse (SAC).

The most extensive model includes, along with the explanatory variables of interest, expressing objective and subjective factorial dimensions of SWB influence, and the spatial gap of all embedded variables, having the following specification:

$$\log y = \alpha + \rho \log Y x W + \theta \log X x W + \beta \log X + \lambda x W \mu + \varepsilon, \quad (1)$$

where, the dependent variable, Y (well-being), is expressed by measuring life satisfaction (life_satisf) and life_ladder , the last more associated with happiness.

The independent variables used (vector X of the specification) concern satisfaction in different areas of life, self-optimism and the future of children, freedom to choose decisions, absence of corruption, participation in democratic life, trust in institutions, emotional well-being (positive emotions or negative), material living conditions, health status, education and possibilities for integration into work, profession, etc. Correlations between life satisfaction and some of these indicators showed fairly strong, or at least moderate, associations with large differences between countries.

The proposed hypothesis for testing are:

- I₁: Areas specific to life satisfaction, such as health, work, education, family, housing, standard of living (areas) have a positive influence on subjective well-being.
- I₂: Positive/negative emotional experiences provide information about how well someone's life is going and thus can be a factor in an assessment of well-being.
- I₃: A number of economic elements support the sustainability of well-being: economic performance, a more equal income distribution.
- I₄: Subjective determinants (the freedom to make key decisions in life, generosity) or related to the quality of society (absence of corruption) positively influence the well-being.
- I₅: There are direct and indirect effects of predictors on life satisfaction.

5. Results and discussions of spatial analysis

5.1. Construction of the neighbourhood matrix and testing autocorrelation

Spatial analysis involves, on the one hand, the estimation of the existence of spatial self-correlation, i.e. the random scattering (spread) of phenomena in space, starting from the construction of a neighbourhood matrix, the testing of spatial autocorrelation using the Moran test and then the inclusion in the regression analysis of the weighted neighbourhood and space matrices, respectively, in the estimation of the econometric models. Since the territorial units of analysis have different surfaces and locations in the continental plan, we opted for an inverse matrix of distances and, given the large distances between capitals and not to exclude any country from the sample, the countries in the vicinity of others will be those between whose capitals have a distance of about 1.000 km (the limit chosen not to remove any of the observations (countries) from the analysis).

The I^* Moran Global Index simultaneously measures spatial autocorrelation based on both characteristic locations (32 countries in Europe) and the values of the characteristics considered (life satisfaction). It evaluates whether the expressed pattern is grouped (as a

cluster), scattered, or random. In addition to the *I* Moran index, the value of a *z-score* and *p-value* are also calculated to assess the significance of this index. The *I* Moran test involves the interpretation of the results in the context of the null hypothesis. Table 1 summarizes the results. Since *p-value* is statistically significant and *z-score* is positive, we reject the null hypothesis, the spatial distribution of high and/or low values in the data set is more spatially grouped than would be expected if the underlying spatial processes were random.

Table 1. Measuring spatial global autocorrelation between well-being variables, 2016

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Type: Distance-based (binary)
Distance band: c1.c2 < d <= c3.c4
Row-standardized: Yes
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Moran's I
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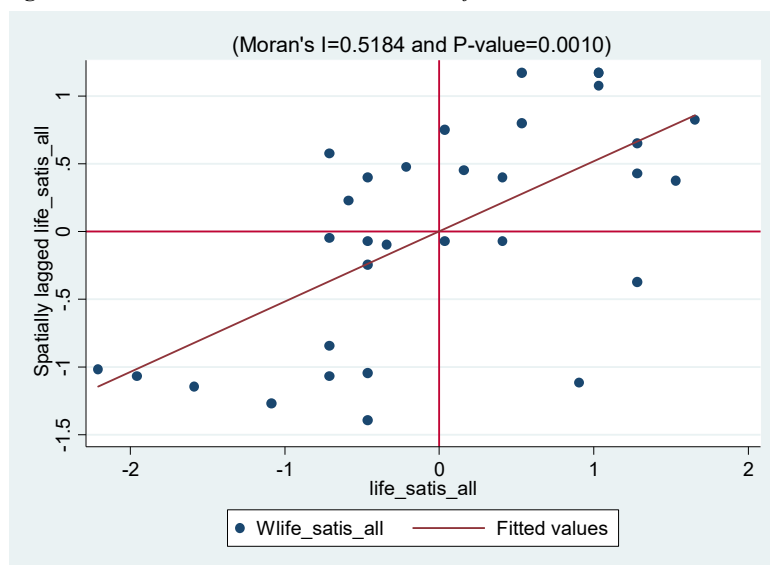
Variables	I	sd(I)	z	p-value
life_satis_all	0.518	0.090	6.094	0.000
life_satis_employed	0.459	0.090	5.456	0.000
life_satis_female	0.502	0.090	5.910	0.000
life_satis_male	0.524	0.090	6.156	0.000
happy_all	0.446	0.090	5.327	0.000
happy_employed	0.391	0.089	4.776	0.000
happy_female	0.421	0.090	5.023	0.000
happy_male	0.426	0.090	5.099	0.000
satisf_edu_all	0.170	0.089	2.273	0.023
satif_job_employed	0.404	0.090	4.859	0.000
satif_job_all	0.404	0.090	4.859	0.000
satis_stdviata_all	0.528	0.091	6.186	0.000
satisf_accomodall	0.189	0.091	2.439	0.015
satisf_family_all	0.091	0.091	1.349	0.177
optimism_own_all	0.277	0.088	3.506	0.000

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Figure 3. Moran charts in relation with lie satisfaction, 2016



Source: Stata processing.

This indicates a relatively high spatial autocorrelation in the satisfaction distribution among the analysed territorial units.

5.2. Main results

Estimation of the spatial models (Table 2) can be achieved through various methods, which are different depending on the used estimators, namely GMM and Quasi-Maximum Likelihood (QML). The first four models have life satisfaction as a dependent variable, while in the last four models we used, as a proxy of satisfaction, the Gallup measure – *cantrill life ladder*. The accent is put on the highlighting of the specific feels of satisfaction, combined with indicators of material conditions, social support, economic performance and inequality in income distribution among households, healthy life expectancy (healthy).

On the estimated models, the coefficients obtained have relatively similar values, which makes it difficult to choose a single model. A defining element in the choice of the optimal spatial model is the log-likelihood function, the selection of the model in relation to it assuming the choice of the model having the highest value of the function. Thus, the highest log likelihood value being confirmed also in the spatial Durbin Model – SDM. Other validation tests that indicated the preference for estimation by The Spatial Durbin Model (the model with the highest log-likelihood function value) are the Akaike Information Criterion (AIC) test and the Schwarz Criterion (BIC) test, whose minimum values confirm the preference for the SDM model. As such, in view of the selection of this estimate, I will interpret only the coefficients obtained and the direct and indirect effects of the SDM assessment (Models 3, 7 and 11) and which result to have statistical significance.

Table 2. *Spatial influences on subjective well-being*

<i>Var depend.</i>	SAR(1)	SEM(2) <i>life_satisfaction</i>	SDM(3)	SAC(4)	SAR(5)	SEM(6) <i>life_ladder</i>	SDM(7)	SAC(8)
<i>Main</i>								
satisf_education	0.0142 (0.10)	0.0161 (0.11)	0.503*** (3.81)	-0.000322 (-0.00)	-0.0961 (-0.85)	-0.0533 (-0.44)	-0.229 (-1.77)	-0.0929 (-0.81)
satif_job	0.336 (1.59)	0.348 (1.62)	-1.701*** (-6.50)	0.299 (1.29)	-0.680*** (-3.89)	-0.680*** (-3.32)	-0.724*** (-3.83)	-0.709*** (-3.81)
satis_standard	0.512*** (3.44)	0.463** (2.66)	-0.379* (-2.45)	0.554*** (3.43)	0.0357 (0.28)	0.0320 (0.24)	0.00666 (0.05)	0.0324 (0.26)
satisf_accomodat	0.285 (1.76)	0.321 (1.78)	1.231*** (6.30)	0.228 (1.13)	0.671*** (4.94)	0.765*** (5.35)	1.133*** (5.75)	0.699*** (4.84)
satisf_family	-0.0504 (-0.30)	-0.0689 (-0.41)	1.402*** (6.63)	0.0140 (0.06)	0.383** (3.26)	0.264* (2.16)	0.0664 (0.52)	0.355** (2.83)
health_expect	-0.00322 (-0.35)	-0.00449 (-0.42)	-0.0741*** (-5.09)	-0.000686 (-0.06)	-0.0248** (-3.26)	-0.0346*** (-4.55)	-0.0285*** (-4.24)	-0.0265** (-3.22)
log_gdp_pc	-1.301** (-2.59)	-1.155* (-2.21)	1.395** (2.82)	-1.375** (-2.74)	1.617*** (4.18)	1.782*** (4.22)	1.299** (3.05)	1.746*** (4.01)
positive_affect	0.00737 (0.01)	-0.0152 (-0.03)	-2.207*** (-4.20)	0.0130 (0.03)				
negative_affect	1.191 (1.40)	1.125 (1.32)	3.299*** (4.62)	1.264 (1.47)				
gini_housing	-1.327** (-2.62)	-1.346* (-2.57)	-3.803*** (-6.04)	-1.286* (-2.57)				
freedom_choices					1.989*** (4.88)	1.786*** (3.68)	2.651*** (5.74)	1.901*** (4.31)
generosity					-0.825* (-2.41)	-0.737* (-2.05)	-0.602 (-1.27)	-0.792* (-2.29)

<i>Var depend.</i>	SAR(1)	SEM(2) <i>life_satisfaction</i>	SDM(3)	SAC(4)	SAR(5)	SEM(6) <i>life_ladder</i>	SDM(7)	SAC(8)
corruption perception					0.135 (0.45)	0.326 (1.06)	0.286 (1.00)	0.168 (0.55)
<i>Spatial</i>								
rho	-0.232 (-0.71)		-1.216* (-1.99)	-0.471 (-0.72)	-0.856* (-2.25)		-2.498*** (-4.66)	-0.775* (-2.00)
lambda		-0.426 (-0.55)		0.497 (0.51)		-0.883 (-0.99)		-0.458 (-0.57)
Variance sigma2_e	0.014*** (5.65)	0.0144*** (5.60)	0.0055*** (5.44)	0.0283*** (10.40)	0.00955*** (5.61)	0.0101*** (5.40)	0.00414*** (5.00)	0.0189*** (11.17)
R ²	0.7135	0.7100	0.8697	0.7144	0.7345	0.7199	0.8028	0.7299
Log-likelihood	44.6850	44.5805	73.9957	44.7384	57.1726	55.2781	77.9675	57.3631
AIC	-65.3699	-65.16105	-103.9913	-63.47688	-90.34526	-86.55626	-111.935	-88.7262
BIC	-39.4633	-39.25446	-56.4959	-35.4114	-64.43866	-60.64966	-64.4395	-60.6607
N	64	64	64	64	64	64	64	64

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001.

Source: Stata processing.

Positive impact. Analyzing the obtained results, the main positive influences on the general satisfaction of life and the variable *life_ladder* are those exerted by the satisfaction in education, in the possibilities of living and regarding the family. Thus, an increase in the educational satisfaction score would contribute to an increase in the overall satisfaction score of 0.503 (Model 3). Living conditions also prove important for individual well-being (+1,231 in Model 3 and +1,133 in Model 11, respectively). A key place is also thanks to family fulfillment, with satisfaction increasing by 1,402 (Model 3) or 0.066 (Model 11). Economic performance has the expected, positive effect of a 1% increase in GDP per capita indicating an increase in the satisfaction score of 1.3 points (Models 3 and 11). In the equation having satisfaction (*life_ladder*) as a measure of subjective well-being (SWB), we introduced as a variable of influence and the measure of freedom in decisions, which turns out to be directly related to the outcome variable (SWB).

Negative influences. Estimates also show a number of negative influences on job satisfaction or standard of living. Nor is the measure of health likely to contribute beneficially to better well-being. Relevant and expected is the negative impact of income distribution and the perception of corruption. A high Gini coefficient or a significant perception of corruption clearly reduces the overall satisfaction of life.

However, we cannot say in a general way that these influences are favorable in all situations. Using the measure of life satisfaction as a dependent variable, they have a positive relationship with work and family satisfaction, education or economic performance failing to support a higher degree of well-being. However, even in this case, corruption negatively influences life satisfaction, which could refer to the importance of actions towards reducing it for an adequate (experienced) hedonic well-being.

Spatial effects

The parameters ρ (rho) in Table 1, Models 3 and 7 (all of SDM type), have the minus sign and statistical significance at 99% or 95%, indicating a pure negative spatial effect of the dependent variable, thus revealing the influence of the dependent variable from -a country on the same dependent variable from neighboring countries. The λ (lambda) parameters, related to the error terms, also record negative values, but are statistically insignificant, raising a question mark related to the presence of a spatial effect of the residues.

In order to assess the magnitude and impact resulting from changes in explanatory variables, the interpretation of the coefficients resulting from the estimates is not always correct, it being necessary to consider direct and indirect spatial effects. A number of empirical studies use estimates of the coefficients rho (ρ), theta (θ) and lambda (λ) to draw conclusions about whether or not spillovers have spatial effects. However, this is considered inappropriate (LeSage and Pace, 2009), requiring the interpretation of the impact of regressor changes in models. In this way, LeSage and Pace (2009) explain the possibility that a change of an independent variable in a given country has implications not only on the dependent variable in their own region – in which case we are talking about a direct effect, but also on the same variable. Dependent on other regions – when the estimated effect is indirect. In Table 3 we find these effects, for the models described above.

Direct effect estimates measure the impact of changing an independent variable on the dependent variable of a space unit. The direct effect includes the feedback effect that arises as a result of influences passing through neighboring countries and then returning to the country where the change is being investigated. Therefore, there are differences between the direct effects (Table 3) and the estimated coefficients of the explanatory variables (Table 2) for the SAR, SAC, SDM models (Elhorst, 2014, p. 16). According to LeSage and Pace (2011, p. 7), the global effects of spillovers include these feedback effects (the impact passing through neighboring regions, for example from region i to a region k , and back to the region where the change originates – region i), unlike the local effects of spillover region where the change has its origin- *region i*), in contrast to local spillover effects).

Table 3. Direct, indirect and total effects on subjective well-being

<i>Var depend</i>	Sar (1)	SDM (3)	SAC(4)	SAR (5)	SDM (7)	SAC (8)
	<i>life_satisfaction</i>			<i>life_ladder</i>		
<i>LR_Direct</i>						
Satisf_educat	0.0195 (0.14)	0.341* (2.35)	0.00512 (0.03)	-0.0950 (-0.79)	-0.393* (-2.57)	-0.0912 (-0.75)
Satif_job	0.327 (1.57)	-1.134*** (-3.38)	0.297 (1.23)	-0.711*** (-3.93)	-0.245 (-0.88)	-0.738*** (-3.89)
satis_standard	0.531*** (3.69)	-0.195 (-1.22)	0.588*** (3.47)	0.0517 (0.40)	-0.201 (-1.12)	0.0477 (0.38)
satisf_accomod	0.282 (1.81)	0.851*** (3.76)	0.224 (1.11)	0.684*** (5.26)	0.999*** (6.49)	0.710*** (5.20)
satisf_family	-0.0494 (-0.31)	1.230*** (6.08)	0.0202 (0.08)	0.396*** (3.36)	0.296 (1.77)	0.366** (2.89)
health_expect	-0.00301 (-0.33)	-0.0595*** (-4.11)	-0.000168 (-0.01)	-0.0254*** (-3.38)	-0.0285*** (-3.89)	-0.0270*** (-3.35)
log_gdp_pc	-1.352** (-2.70)	1.255* (2.55)	-1.455** (-2.76)	1.636*** (4.01)	1.642* (2.54)	1.760*** (3.95)

<i>Var depend</i>	Sar (1)	SDM (3) <i>life_satisfaction</i>	SAC(4)	SAR (5)	SDM (7) <i>life_ladder</i>	SAC (8)
positiv_affect	-0.0107 (-0.02)	-2.307*** (-4.69)	-0.000707 (-0.00)			
negative_affect	1.237 (1.43)	2.750*** (3.74)	1.338 (1.51)			
gini_hou-g	-1.298* (-2.57)	-3.444*** (-6.04)	-1.281* (-2.44)			
Freedom_choices				2.030*** (5.25)	2.109*** (4.42)	1.933*** (4.59)
generosity				-0.826* (-2.42)	-1.473* (-2.52)	-0.791* (-2.28)
percepti-n				0.141 (0.45)	0.795 (1.77)	0.173 (0.55)
LR_Indirect						
satisf_educat	-0.00345 (-0.15)	1.403** (2.86)	0.0171 (0.08)	0.0277 (0.74)	0.490 (1.60)	0.0248 (0.69)
satif_job	-0.0272 (-0.50)	-5.019** (-2.76)	0.0311 (0.04)	0.202* (2.12)	-1.508** (-2.91)	0.191* (1.96)
satis_standard	-0.0434 (-0.57)	-1.509* (-2.52)	-0.0476 (-0.06)	-0.0145 (-0.38)	0.669* (2.53)	-0.0123 (-0.34)
satisf_accomod	-0.0278 (-0.62)	3.177** (3.14)	0.0298 (0.04)	-0.189* (-2.57)	0.409- (1.22)	0.179* (-2.29)
satisf_family	0.00566 (0.22)	1.696 (1.87)	-0.0756 (-0.11)	-0.113* (-2.00)	-0.664** (-2.71)	-0.0985 (-1.68)
health_expect	0.000467 (0.32)	-0.127* (-2.49)	-0.00240 (-0.10)	0.00674* (2.43)	-0.000323 (-0.02)	0.00651* (2.16)
log_gdp_pc	0.123 (0.61)	1.033 (0.49)	0.0967 (0.05)	-0.460* (-2.22)	-1.220 (-1.24)	-0.451* (-2.05)
positive_affect	0.00677 (0.08)	0.555 (0.35)	-0.0178 (-0.03)			
negativ_affect	-0.113 (-0.52)	4.669 (1.63)	-0.183 (-0.22)			
gini_hou-g	0.113 (0.59)	-2.733 (-1.96)	0.0372 (0.02)			
Freedom_choices				-0.570* (-2.39)	1.636 (1.31)	-0.506* (-2.00)
generosity				0.232 (1.77)	2.595 (1.79)	0.206 (1.57)
percepti-n				-0.0355 (-0.39)	-1.491** (-2.80)	-0.0386 (-0.44)
LR_Total						
satisf_educat	0.0160 (0.12)	1.744** (2.98)	0.0222 (0.08)	-0.067 (-0.79)	30.0970 (0.34)	-0.0664 (-0.74)
satif_job	0.300 (1.50)	-6.154** (-2.92)	0.328 (0.33)	-0.509*** (-3.90)	-1.752*** (-3.62)	-0.547*** (-3.63)
satis_standard	0.487** (3.05)	-1.704** (-2.59)	0.540 (0.69)	0.0372 (0.40)	0.468* (2.14)	0.0355 (0.38)
satisf_accomod	0.254 (1.80)	4.028*** (3.37)	0.254 (0.32)	0.495*** (4.14)	1.408*** (3.69)	0.531*** (3.87)
satisf_family	-0.0437 (-0.29)	2.927** (2.85)	-0.0553 (-0.07)	0.283*** (3.37)	-0.368 (-1.80)	0.267** (3.04)
health_expect	-0.00254 (-0.30)	-0.186** (-3.02)	-0.00257 (-0.09)	-0.0186** (-2.69)	-0.0288* (-2.19)	-0.0204** (-2.60)
log_gdp_pc	-1.229* (-2.53)	2.288 (1.10)	-1.358 (-0.67)	1.176*** (3.79)	0.422 (0.62)	1.309*** (3.47)

<i>Var depend</i>	Sar (1)	SDM (3)	SAC(4)	SAR (5)	SDM (7)	SAC (8)
	<i>life_satisfaction</i>			<i>life_ladder</i>		
positiv_affect	-0.00397 (-0.01)	-1.752 (-1.02)	-0.0185 (-0.02)			
negative_affect	1.124 (1.40)	7.420* (2.51)	1.155 (1.10)			
gini_hou-g	-1.185* (-2.40)	-6.176*** (-3.49)	-1.244 (-0.58)			
Freedom_choices				1.460*** (4.64)	3.745** (3.22)	1.427*** (4.36)
generosity				-0.595* (-2.31)	1.122 (0.85)	-0.585* (-2.22)
percepti-n				0.105 (0.46)	-0.696 (-1.89)	0.135 (0.56)

Source: Stata processing.

in the spatial context, indirect effects (known as spillovers) imply that changes occurring in one region exert effects on other regions. Indirect effects estimates measure the impact of changing an independent variable in a particular unit on the dependent variable in the other units of analysis. By construction, SEM estimation does not differentiate between direct and indirect effects, because perturbations (the unspecified set of causes of the effect variable) are not used when considering the partial derivative of the dependent variable in terms of changes in explanatory variables (Elhorst, 2014, p. 22).

In SAR, SDM and SAC models, the direct effects may be different, due to the influence of spatially shifted endogenous variables (dependent variable * correlation matrix, WY), respectively any change in well-being in a region (country) will affect the state well in all regions. This is the logical consequence of models of simultaneous spatial dependence that take into account the dependent variables of other regions, and these (dependent variables) are determined by the characteristics of those regions (LeSage, 2008, p. 33).

All these influences combined make differences in the impact of changes in explanatory variables. Elhorst (2014, p. 31) describes these interactions as feedback effects, in that influences on well-being in a given region pass through neighboring regions and then back to the original region, causing a progressive change. The size of this feedback effect will depend on: (1) the position of the region in space; (2) the degree of interdependence between regions, according to the reference spatial matrix; (3) the size of the other estimated coefficients (β and θ), including the strength of the dependence spatial data given by the coefficient ρ .

We can see that there are differences between the coefficients in Table 2 and the direct effects in Table 3, due to the endogenous interaction effects between the neighborhood matrix and the dependent variable (WY). These interaction effects cause feedback effects, i.e. an impact that affects the well-being in certain neighboring countries/regions that pass into the surrounding regions and back to the initial region, which causes the change.

As Elhorst (2014, p. 9) shows, many empirical studies use point estimates of one or more spatial regression models to test the hypothesis of the existence or spatial spillovers. However, LeSage and Pace (2009, p. 74) point out that this may lead to erroneous

conclusions and that a partial interpretation derived from the impact of changes on variables of different model specifications is a more valid basis for testing this hypothesis.

According to Elhorst (2014, p. 15) the reason why the direct effects of the explanatory variables are different from the estimates (coefficients of elasticity) is due to the so-called direct effects of the dependent variable and the independent variables, respectively the feedback effects that occur/concern as a result of influences passing through neighboring states and then returning to the states from which they originated. These feedback effects are due in part to the coefficient of the spatially shifted dependent variable ($W * \text{life_satisfact}$) which proves to be statistically significant but negative ($\rho = -1.216$ in model 3) and in part to the coefficients of the spatially shifted explanatory variables. Thus, these coefficients are statistically significant, positive for the variables: $W * \text{satisfaction in education}$ (4.784), $W * \text{satisfaction in accommodation}$ (10.97), $W * \text{family satisfaction}$ (6.676) and negative for $W * \text{satisf_job}$ (-16.97), respectively, $W * \text{standard satisfaction}$ (-4.908), $W * \text{Gini}$ (-12.87).

In the following table we have summarized the direct, indirect effects and the estimated coefficients of the variables of influence of the subjective state of well-being (measured by life satisfaction). Thus, the direct effect of satisfaction in education in Model 3 (Durbin spatial type, Table 3) is 0.341, and the estimated coefficient of the variable (Table 5.3a, column 3) amounts to 0.503. As such, the feedback effect will be equal to $0.341 - 0.503 = -0.162$, which corresponds to -32.21% of the estimated coefficient. For job satisfaction the feedback effect is 0.567 (-33.33%), the standard of living satisfaction +0.184 [-0.195 - (-0.379)], representing -48.55% of the coefficient of elasticity; the feedback effect of the variable home satisfaction is -0.380 (-30.87%), the feedback for family satisfaction is -0.172 (-12.27%), for health +0.0146 (+19, 70%), for the economic performance measured by GDP/capita of -0.140 (-10.04%) and the one induced by the inequality in income distribution of -0.359 (-9.44%).

Table 4. *Proportion of the feedback and indirect effects of the explanatory variables upon well-being*

	Direct effect	Indirect effect	Elasticity coefficient	Feedback effect = direct effect – estimated coefficient	% from the estimated coefficient	% of the feedback effect in the direct effect	% indirect effect in the direct effect	Proportion of the WB modification in a country that leads to a modification in the explicative variable in surrounding countries
satis edu	0.341	0.0171	0.503	-0.162	-32.20	-47.51	5.01	19.94
satis job	-1.134	0.0311	-1.701	0.567	-33.33	-50	-2.74	-36.46
satis standard	-0.195	-0.048	-0.379	0.184	-48.55	-94.36	24.41	4.09
satis accomod	0.851	0.0298	1.231	-0.38	-30.87	-44.65	3.50	28.56
satis family	1.23	-0.076	1.402	-0.172	-12.27	-13.98	-6.14	-16.27
healthy_expect	-0.0595	-0.002	-0.074	0.0146	-19.70	-24.54	4.03	24.79
gdp	1.255	0.0967	1.395	-0.14	-10.03	-11.15	7.70	12.98
positive affect	-2.307	-0.018	-2.207	-0.1	4.53	4.33	0.77	129.61
negative affect	2.75	-0.183	3.299	-0.549	-16.64	-19.96	-6.65	-15.03
gini	-3.444	0.0372	-3.803	0.359	-9.44	-10.42	-1.08	-92.58

Source: calculated on the basis of the results of the estimated models.

In parallel, we also calculated how much the feedback effect and the indirect effect represent from the direct effect. Estimates would show, for example, that for the variable satisfaction in education, the feedback effect (-0.162) represents -47.51% of the direct effect, and the indirect effect of the change in the explanatory variable appears to be 5.01% of the same direct effect. This means the change in neighboring countries when the change in a particular country is in the proportion of about 1 to 19.9 in the case of job satisfaction, from 1 to -36.5 if job satisfaction changes.

Increasing satisfaction in education in a country will increase WB not only in that country (0.341) but, to some extent, in neighboring countries (0.0171); the same for home satisfaction. However, the decrease in job satisfaction in one country does not indicate a decrease in WB in neighboring countries.

6. Conclusion

The subjective state of well-being is a multidimensional concept that reflects the way in which an individual evaluates his own life in relation to the conditions in which he lives, with the possibilities of adapting to the environment and the society to which he belongs. In evaluating the subjective state of well-being, life satisfaction and/or cantril life ladder are mainly used as alternative measures, obtained following surveys regarding the quality of life, satisfaction in life or happiness. The study is conducted on a sample of 32 European countries (EU-27, Great Britain, Montenegro, Northern Macedonia, Serbia and Turkey), using spatio-temporal observations obtained under EQLS, and the period considered is summarized in two years, 2011 -2012 and 2016. As econometric techniques and procedures, the spatial regressions allowed to take into account in the estimates the spatial interdependencies at the level of national units, and which could be tested. Moran's I statistics showed a relatively high spatial autocorrelation in the distribution of life satisfaction among the countries in the sample. On this basis, we continued the estimation by spatial models, in which the dependent variable was alternatively life satisfaction or life ladder.

The factorial dimensions (independent variables) are grouped on several categories: i) influences of specific domains of life; ii) social basic elements of personal life satisfaction (the role of social support, freedom of choice, generosity, absence of corruption); iii) the impact of economical performance and of unequal income distribution; iv) influences of some society characteristics where individuals live.

The main conclusions regarding the effects registered in supporting life satisfaction can be expressed as follows:

1. The H1 hypothesis is confirmed regarding the favorable effects induced by satisfaction in different fields, especially related to education, family life, accommodation satisfaction, standard life, in relation to the general satisfaction of life.
2. Material well-being can be a supporting factor of SWB, but not absolutely, in the sense that in relation to the life satisfaction measure, the effect is not conclusive, unlike the life ladder measure, which is more attributed the sense of state of happiness. However,

what is unequivocal is the unequal distribution of income, the greater the inequalities, the lower the degree of satisfaction with life.

3. It is also particularly relevant and robust the role of social connections, the feeling of freedom to live according to their own choices and decisions, but also the hedonic side of SWB, respectively positive affect seem to have the same beneficial contribution in the perception of a better life satisfying. Thus, the research hypotheses are verified, SWB being strongly affected (negatively) by the feelings of frustration, which individuals experience throughout their lives. The total negative effect of the influence of positive emotions is obvious, in combination with variables related to the perception of corruption.
4. There are spatial effects, mainly direct, which can lead to a better perception of one's life, with particular reference to satisfaction in the educational field or with family life. On the other hand, a better general satisfaction of life in one country is not reflected in other countries, with the mention that the effect is clearer in terms of the level of happiness.

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Pre- and post- analysis of Bank of Japan's policy implementation of negative interest rates

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Abstract. *This paper analyzes the effect of Bank of Japan's implementation of negative interest rate policy on various macroeconomic indicators – the Nikkei Stock, unemployment rate, foreign exchange rate, gross domestic product (GDP), and inflation rate – in a pre-and-post analysis. The implementation of negative interest rates was in response to conventional monetary policy having little to no effect after the financial crisis of 2008. The Bank of Japan was not the first central bank to implement negative interest rates; however, it is only one of six central banks to do so. For this reason, literature in unconventional monetary policy, specifically negative interest rates, is limited. In this paper, we find evidence that movements in the Nikkei 225 Stock, the exchange rate, unemployment, and GDP coincide with movements expected under conventional monetary policy. We also find evidence of statistically significant impact on GDP and unemployment. However, we could not find evidence it had an effect on the inflation rate. Overall, this paper finds that the unconventional monetary policy of negative interest rates followed similar movements as that of conventional monetary policy.*

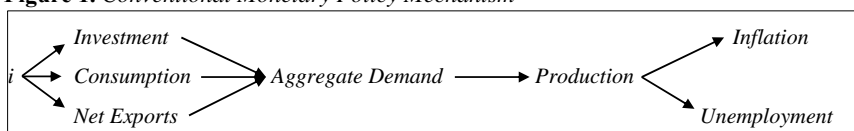
Keywords: GDP, monetary policy, unemployment, inflation rate, 2008 financial crisis, exchange rate, policy analysis.

JEL Classification: E520, E580, E200.

Introduction

Under conventional monetary policy, central banks make decisions regarding interest rate policy in an attempt to accomplish specific goals intended to stimulate economic growth through a variety of channels. There are two common goals central banks worldwide tend to focus heavily on: a targeted inflation rate (i.e., price stability) and full employment (Piffer, 2011; IMF, 2017). The mechanism in which setting interest rate policy results in achieving a central bank's goals, and ultimately the desired outcome of positively influencing economic activity, is illustrated below in Figure 1 where i represents the interest rate policy.

Figure 1. Conventional Monetary Policy Mechanism



As seen from Figure 1, adjusting the interest rate results in influencing investment, consumption, and net exports, and these in turn provide further change within an economy until eventually affecting the goals set by the central banks (e.g. targeted inflation rate and full employment) (Claus et al., 2018). The impact adjusting interest rate policy has on the progression illustrated in Figure 1 is that it has an inverse effect on investment, consumption, net export, aggregate demand, production, and inflation while it has a positive effect on unemployment. For example, if an arbitrary country's economy (e.g. country A) is contracting, policy makers would decide to lower interest rates as one approach to boost the economy. In doing so, theoretically, reducing interest rates would lower borrowing costs thereby increasing the amount of borrowing allowing investments to increase. With consumption, lowered interest rates would prompt an increase in spending today rather than saving for the future thereby increasing consumption. Regarding net exports, lowered interest rates trigger a country A's currency to depreciate, upon which outside countries begin to view country A's goods as cheaper thereby country A would increase its exports and decrease its imports, resulting in an increase in net exports. In turn, the increases experienced would lead to an increase in aggregate demand on the basis that investment, consumption, and net exports are its primary components (Kira, 2013). As a result, there would be an increase in a country's production which would theoretically lead to increasing inflation and decreasing unemployment (Dell'Ariccia et al., 2018). On the contrary, if a central bank determines its economy is expanding too quickly such that there is a threat of hyperinflation, raising interest rates would be the course of action to counterbalance the impending threat of hyperinflation. In this case, theoretically, the opposite progression of lowering interest rate ensues.

When the 2008 global financial crisis occurred, however, countries worldwide struggled to boost their economies despite conducting conventional monetary policy. The desired results of growth in investment, consumption, and net exports did not occur even though central banks lowered interest rates to near-zero (Claus et al., 2018); a result contradicting what conventional monetary policy theory states. There are various explanations why

lowering interest rates to near-zero did not produce the desired results: the decline in global growth in the midst of the crisis increased savings rather than increasing investment or consumption, populations were pessimistic about the future thereby also increasing savings, aging and declining population growth increased savings (and thus decreased investments and consumption), and distribution of income provoked those with high income to save more and spend less whereas those with low income could not invest properly (Jurkšas, 2017). Overall, lowering interest rates to near-zero failed to encourage growth in investments, consumption, and net exports resulting in ineffectiveness from the conventional monetary policy mechanism.

To address this issue, various central banks began implementing unconventional monetary policy through utilizing a strategy known as quantitative easing (QE). QE policies implemented in conjunction with near-zero interest rates utilized by major central banks were unconventional means to stimulate economic growth, and a resolution to the global financial crisis (Aizenman et al., 2016). Central banks that implemented QE include the United States' Federal Reserve, the Bank of England, the European Central Bank, and the Bank of Japan (BOJ) (Cecchetti and Schoenholtz, 2015; Fawley and Neely, 2013). Generally, QE is the process of central banks buying back securities (e.g. government bonds) to improve economic growth by injecting money into the economy in hopes of encouraging investment and consumption, an objective lowering interest rates to near-zero could not achieve (Dell'Araccia et al., 2018). Conceptually, the securities purchased by central banks expand reserves held by commercial banks upon which can then be immediately accessed and lent out, thus potentially stimulating investment and consumption (Cecchetti and Schoenholtz, 2015). However, QE struggled to increase investment and consumption despite the large volumes of securities purchased by central banks due to commercial banks withholding increased excess reserves rather than lending (Fawley and Neely, 2013).

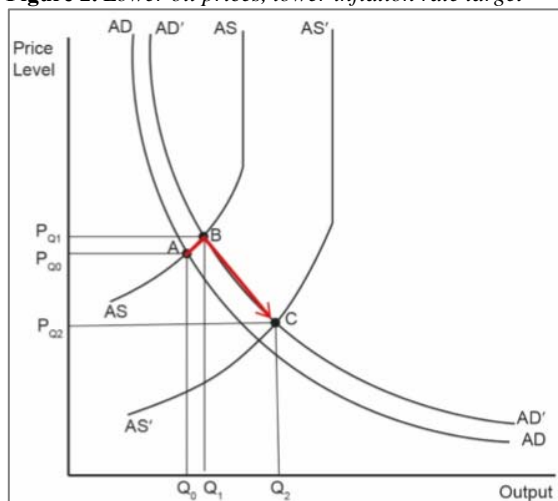
In addition to near-zero interest rate policy and QE, negative interest rate policy (NIRP) was another unconventional monetary policy tool six central banks imposed to further stimulate economic growth. The six central banks were the European Central Bank in June 2014, the Swiss National Bank in December 2014, the Swedish Riskbank in February 2015, the Danmarks Nationalbank in July 2012, the BOJ in January 2016, and the Central Bank of Hungary in March 2016 (Arteta et al., 2016; Aizenman et al., 2016; Jurkšas, 2017). Specific objectives NIRP implementation were expected to accomplish that were set by central banks includes price stability (i.e., European Central Bank, Swedish Riskbank, Swiss National Bank, BOJ, and Central Bank of Hungary) and exchange rate stability (i.e., Danmarks Nationalbank, Swiss National Bank, and the Central Bank of Hungary); completing these objectives in turn would aid in stimulating the country's economy (Angrick and Nemoto, 2017). The underlying general concept of NIRP is that commercial banks will pay interest on their deposits of excess reserves to the central bank instead of the central bank paying interest to commercial banks. Arteta et al. (2016) refers to NIRP as "taxing" commercial banks for excess reserves held requiring them to pay interest which is contrary to the norm. Central banks introduced NIRP with aspiration that it would

achieve their goals in a similar theoretical manner to conventional monetary policy (Jurkšas, 2017). NIRP is unknown territory central banks have not ventured into prior to Denmark's Nationalbank's implementation in 2012, therefore research is limited regarding its long-term impact on central banks' objectives and various economic indicators. This paper will primarily focus on the BOJ's NIRP implementation, where there is a lack of research due to only having three years of data available to study.

Japan

As mentioned earlier, the implementation of negative interest rates was not the first unconventional monetary policy the BOJ utilized. In 2013, the BOJ implemented quantitative and qualitative monetary easing (QQE) as a way to achieve an inflation target rate of 2% set intentionally to overcome deflation and sluggish economic growth resulting from the 2008 financial crisis that magnified existent problems dating back to the 1990's (Dell'Ariccia et al., 2018). Under QQE, the BOJ purchased trillions of yen in long term Japanese government bonds which resulted in a short-term increase in inflation; however, sustained inflation growth failed due to a decrease in oil prices the following year in 2014. The decline in oil prices had a negative impact on inflation due to oil products being substantial components of Japanese imports. Yoshino et al. (2017) provided the following figure to illustrate the impact of oil prices on Japan's inflation rate.

Figure 2. Lower oil prices, lower inflation rate target



AD = aggregate demand; AS = aggregate supply.

Source: Yoshino et al. (2017).

From Figure 2, it can be observed aggregate supply (AS) increases when oil prices drop because oil is often used as an input, thus lower oil prices signifies cheaper inputs. Moreover, fundamental economics states input costs is one determinant of supply: the lower an input cost, then the cheaper it is to utilize the input thereby increasing the supply. In Figure 2, this is evident by the rightward shift from AS to AS' and from point B to point C. Additionally, aggregate demand (AD) increases from reduced oil prices because it is

now cheaper to consume oil and oil products; hence, the rightward shift from AD to AD' in Figure 2. The movements from the two curves results in the price level decreasing from P_{Q1} to P_{Q2} . Amid declining oil prices, the BOJ kept the target inflation rate at 2%, and introduced a second round of QQE by purchasing more securities in late 2014. However, despite two rounds of QQE, Japan continued to experience persistently low inflation thus adopting NIRP in January of 2016 in conjunction with continued utilization of QQE (Dell'Aricecia et al., 2018; Arteta et al., 2017; Angrick and Nemoto, 2017; Yoshino et al., 2017).

The BOJ implemented NIRP as a three-tier system: current accounts at the BOJ (i.e., commercial bank reserves) were divided into three strata each with an assigned specific interest rate (Angrick and Nemoto, 2017; Jurkšas, 2017; Arteta et al., 2017; Yoshino et al., 2017). The first-tier is designated the "positive" rate upon which an interest rate of 0.1% was assigned. The second-tier was subjected to an interest rate of 0% designated as the "Macro Add-On" rate. Tier three, the "Policy-Rate", was designated the negative interest rate at -0.1% (Angrick and Nemoto, 2017; Wall Street Journal (Online), 2016). According to a transcript of an interview between the Wall Street Journal and BOJ Governor Haruhiko Kuroda (2016), Mr. Kuroda stated the third-tier accounts for less than 10% of total reserves suggesting NIRP's overall impact might be marginal. The initial amounts each tier's specific interest rate was applied to, as stated by the announcement BOJ delivered in 2016, were 210 trillion yen in the first tier, 40 trillion yen in the second tier, and 10 trillion yen in the third tier. Configuration of the initial amounts within each tier was based on a series of mathematical equations. First, the BOJ subtracted the required reserves amount (i.e., the amount financial institutions are required to hold in reserves) from the average outstanding balance of current accounts at the BOJ to produce the amount for the first tier. To calculate the second tier, the BOJ added the required reserve amount together with the BOJ total amount of credit supplied from various programs. The third-tier amount was configured from subtracting the first and second tier amount from total current accounts. Furthermore, the amounts within each tier would steadily increase at the discretion of the BOJ based on the pace of increase observed in total current accounts (Key Points of Today's Policy Decisions, 2016). Based on the configuration of the three-tier system in addition to Mr. Kuroda's statement, there is an early indication NIRP's impact might be marginal.

When the BOJ began QQE and included NIRP in its unconventional monetary policy, their objective was to achieve the 2% inflation target rate in addition to stimulating economic growth after the global financial crisis of 2008. Due to NIRP's recent implementation (i.e., 2016) there is a lack of research regarding its effectiveness, specifically on various economic indicators. Therefore, the purpose of this research is to analyze how the NIRP has affected Japan's economy drawing comparisons before and after its implementation. This research will analyze its effect on important factors of economic growth that are generally affected when central banks make decisions regarding changes in interest rate policy: Nikkei Stock, unemployment rate, foreign exchange rate, gross domestic product (GDP), and inflation rate.

Data set

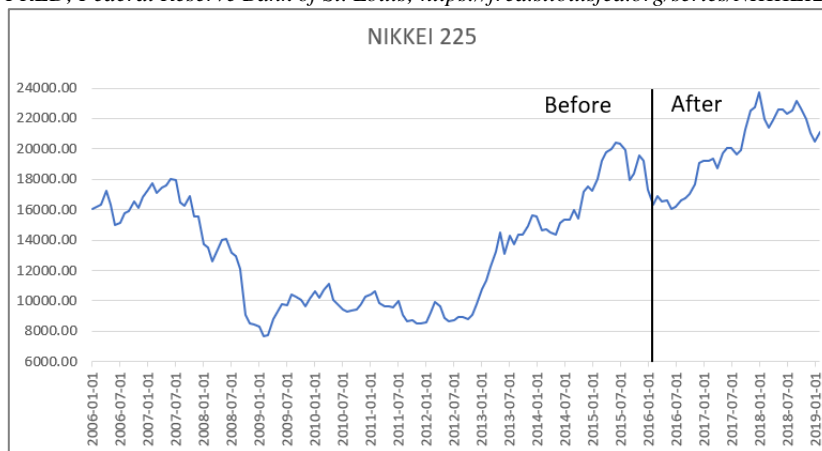
The data obtained for the Nikkei Stock, unemployment rate, foreign exchange rate, GDP, and inflation rate begins from January 2006 and concludes with the most recent data available. The data set was utilized in two ways to conduct the analysis of NIRP. First, graphical representations are used to observe any significant variations. Each variable's graph was obtained from the Federal Reserve Bank of St. Louis website (FRED). Additionally, Nikkei Stock, unemployment rate, foreign exchange rate, and inflation rate data were measured monthly; GDP was measured quarterly. Second, regression analysis was conducted on specific variables (i.e., inflation rate, unemployment rate, and GDP) to further determine if NIRP had a statistically significant impact.

To conduct regression analysis, additional variables needed to be obtained, specifically consumption, investment, and net exports, as these are components of GDP (Wolla, 2013). In theory, monetary policy affects consumption, investment, and net exports (see Figure 1) whereas fiscal policy affects government expenditure. Based on this, GDP was broken down into its components to better capture the effect NIRP has on GDP, and data on these variables were obtained from the FRED. Consumption was broken down into real consumption of households and final private consumption. Investment was divided into real private residential investment and real private non-residential investment. Net export data includes real net exports of goods and services. Furthermore, the variables of interest were converted to percent change from a year ago, and data was collected quarterly to provide a common unit of measure. Additionally, a dummy variable was created representing interest rate policy that takes on a value of 1 if the interest rate is negative and 0 otherwise.

Results

Nikkei 225 Stock Average

Figure 3. Nikkei Industry Research Institute, Nikkei Stock Average, Nikkei 225 [NIKKEI225], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/NIKKEI225>



Prior to the financial crisis of 2008, the Nikkei Stock fluctuated between about 16,000 and 18,000, even reaching an index as high as about 18,000. Once the financial crisis occurred, the stock plummeted to just below 8,000 yen, and never fully recovered close to what it was prior the financial crisis (about 16,000 yen). The recovery phase did not take place until about five years later in 2013 when it reached close to 16,000 yen. The steep increase observed from Figure 3 in 2013 and 2014 could be attributed to the two rounds of QQE the BOJ implemented, which coincides with the findings of Dell'Ariccia et al. (2018).

In Figure 3, when NIRP is implemented (as evident by the split in the graph), there is an increase in stock prices coinciding with the theory that stock prices increase when interest rates decrease. However, the increase is minimal at the onset of the unconventional monetary policy, an observation corresponding with Jurkšas (2017) who found slight increases in stock indices across four countries with NIRP including Japan. The immediate slight increase could be attributed to the markets' uncertainty of using negative interest rates. Additionally, there may not have been a drastic change in stock price due to markets adjusting prior to its implementation. In theory, markets typically adjust to policy changes prior to their implementation based on news and discussions presented beforehand.

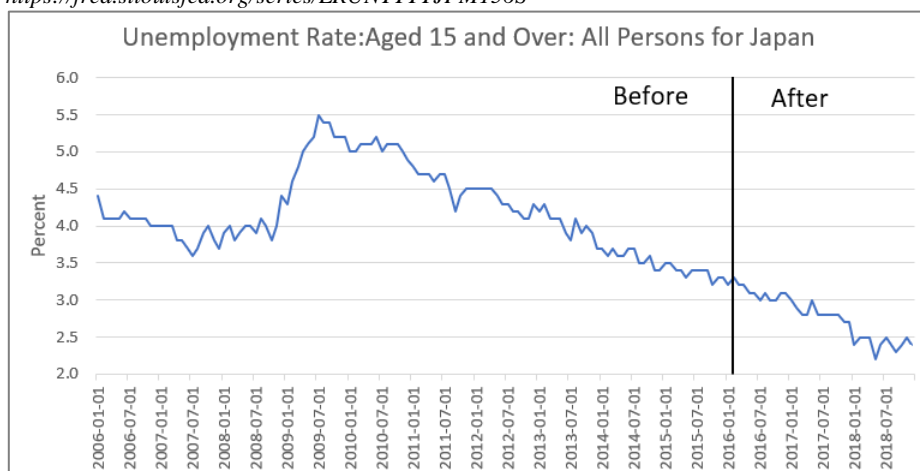
The idea of NIRP had been discussed by the BOJ prior to its official announcement, and as the likelihood of its implementation increased, the markets began to make adjustments. This could be a reason why there is a decline right before its implementation.

Outside of the immediate minimal increase observed from Figure 3 after NIRP implementation, the stock price has been rising with some fluctuation overtime. The Nikkei 225 index increased from just above 16,000 at the onset of NIRP to about 21,000 as of January 2019, with a high of close to an index of 24,000 yen in 2018. This rise could be due to external factors in addition to markets becoming more comfortable to NIRP.

Overall, ten years prior NIRP, the Nikkei 225 didn't surpass an index of 18,000 until 2015; in the three years since NIRP, the Nikkei 225 surpassed 18,000 in 2017. This could be indicative of how impactful NIRP was compared to earlier implementations of unconventional monetary policy (i.e. QQE). However, further statistical analysis is warranted to accurately compare the two unconventional monetary policies' level of impact on the Nikkei 225 Stock. Nevertheless, as mentioned earlier, the increase observed post NIRP is consistent with conventional monetary policy theory that stock prices increase as interest rates decrease.

Unemployment rate:

Figure 4. Organization for Economic Co-operation and Development, *Unemployment Rate: Aged 15 and Over: All Persons for Japan [LRUNTTTJPM156S]*, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/LRUNTTTJPM156S>



From Figure 4 above, Japan’s unemployment rate can be observed decreasing from the beginning of 2006 until about mid-2007 when it begins to fluctuate, between about 3.5% and just above 4%, to late-2008 when it drastically increases, reaching a peak of 5.5% around mid-2009: this sharp increase in unemployment rate has often been attributed to the global financial crisis, and has since been observed in other countries (“The Recession of 2007-2009”, 2012; Restrepo-Echavarria, 2017). Since the peak in mid-2009, and when central banks began to adapt unconventional monetary policy, the level has seen almost a constant decreasing trend. During this time, the BOJ began to lower its interest rate policy from its peak of 0.5% in 2008 to 0.3% in late 2008, and then to 0.1% in the beginning of 2009, followed by another decrease to 0% in late-2010; changes that, according to conventional monetary policy mechanism, played an important factor in unemployment rates observed decrease. The unemployment rate not only returned to levels previously seen before the crisis but has steadily decreased further to its current position to just below 2.5%. When the NIRP was implemented in 2016, unemployment for January was 3.2%. After the NIRP, the unemployment rate has only increased or decreased by 0.1 percentage points, except in May 2017 when it increased by 0.2 percentage points (due to new participants in the labor force), and January 2018 when it decreased 0.3 percentage points from December 2017.

As shown in Figure 4, since the NIRP implementation in 2016, the unemployment rate appears to have consistently decreased at about the same rate as before its implementation. However, unemployment is not affected instantaneously when a new interest rate policy is put into effect; rather, it takes time for movements in unemployment to be reflective of a change in the interest rate. Furthermore, two rounds of QQE were implemented during this time that could have aided in unemployment’s decline. Therefore, it is difficult to conclude NIRP is having a significant effect on unemployment rate based solely on Figure 4 as it

shows a steady decrease seven years before its implementation. Furthermore, NIRP may only be aiding the driving force behind the decrease in unemployment rate. Thus, regression analysis was conducted to further examine its impact.

Regression analysis: The independent variables included in the regression were net exports (netexp), real private residential investment (realresinv), real private non-residential investment (nonresinv), real consumption of households (hhcon), private final consumption (pfcon), 3-month LIBOR rate (libor) based on the yen, and the interest rate dummy variable (irdummy). The results from the regression are shown in Table 1. Additionally, Table 2 contains the results from a joint significant test on the determinants of GDP (netexp, realresinv, nonresinv, hhcon, and pfcon) to determine if they are jointly statistically significant. The determinants of GDP were tested for joint statistical significance based on GDP's (i.e., aggregate demand) influence on the unemployment rate (see Fig. 1). As stated previously, quarterly data was utilized from January 2006 to the most recent date.

Table 1. Unemployment Regression

VARIABLES	unemp
pfcon	0.0806 (1.335)
hhcon	0.685 (0.509)
nonresinv	-1.680*** (0.180)
realresinv	-0.0818 (0.0962)
netexp	-0.000385 (0.000910)
libor	-0.00389 (0.00448)
irdummy	-7.829** (3.007)
Constant	-1.642* (0.920)
Observations	45
R-squared	0.815
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	
pfcon = private consumption, hhcon = household consumption, nonresinv = real private non-residential investment, realresinv = real private residential investment, netexp = net exports, libor = 3-month LIBOR rate, irdummy = interest rate dummy variable that takes a value of 1 if the interest rate is negative and 0 otherwise	

Table 2

Joint Significant Test
Variables
pfcon = 0
hhcon = 0
nonresinv = 0
realresinv = 0
netexp = 0
F(5, 37) = 29.88
Prob > F = 0.0000
H ₀ : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$
H _A : at least one $\beta \neq 0$

Observing Table 1, the coefficient estimate on irdummy is negative and statistically significant at the 5% level or greater indicating negative interest rate has a decreasing influence on the unemployment rate. The 3-month LIBOR rate did not show to have a significant impact on unemployment rate over the time period. Similarly, the rest of the variables, apart from nonresinv, were found not to be individually statistically significant, implying they do not influence unemployment rate. However, a joint significance test was

conducted for selected variables (see Table 2) which produced an F-statistic of 29.88 with a p-value of 0.0000. With this result, it is concluded that we reject the null hypothesis suggesting the determinants of GDP are jointly statistically different from zero. Thus, the declining trend in unemployment rate is jointly influenced by the pfcon, hhcon, nonresinv, realresinv, and netexp, in addition to the NIRP statistically individually assisting in this movement.

It should be noted, however, that despite the regression indicating NIRP has a statistically significant impact on unemployment rate, the magnitude of its impact is unclear. Combining the regression results with the findings from Figure 4, it is inconclusive to state the effectiveness of negative interest rates on unemployment rate. As mentioned when discussing Figure 4, the regression results in Table 1 might be indicating NIRP as supporting the already established decline in unemployment rate. Prior to its implementation, the BOJ engaged in two rounds of QQE in addition to lowering interest rates numerous times. These actions could have initiated and sustained unemployment rate's reduction, with NIRP helping to sustain that decline. Further research would benefit from isolating each actions' impact on unemployment rate. Overall though, based on the regression results displayed in Table 1, the unconventional monetary policy of negative interest rates produced the same results on unemployment that conventional monetary policy does: that is, as interest rates are lowered, the unemployment rate decreases.

Foreign exchange rate

Figure 5. Board of Governors of the Federal Reserve System (US), Japan/US Foreign Exchange Rate [DEXJPUS], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/DEXJPUS>

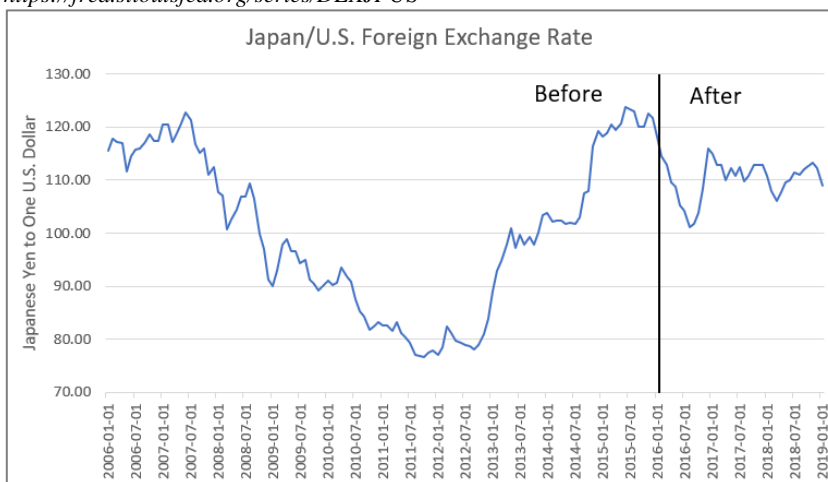


Figure 5 displays the exchange rate fluctuated between values of about 110 and 120 Yen/1 USD from 2006 until the financial crisis occurred. When the global financial crisis occurred, the currency began to depreciate (with periods of appreciation although there is an overall slight declining trend) until it reached an overall low of 76.64 Yen/1 USD about October 2011. The yen then began to recover and appreciate, with slight decreases in various years, to reach a high of 123.72 Yen/1 USD in June 2015 following the introduction

of QQE in 2013 and its expansion in 2014. In conventional monetary policy theory, a significant increase in money supply, which the two QQE policies sought to achieve, should influence a country's currency to depreciate. However, this was not the case.

Further observations from Figure 5 after NIRP in 2016 indicates the yen maintained its depreciation it began in November 2015 until it reached a value of 101.24 Yen/1 USD in August 2016 where it began to appreciate once more. The depreciation it began to experience in November 2015 could be attributed to the foreign exchange market making adjustments to news regarding NIRP. Once the policy went into effect, the currency's depreciation was maintained. Then in December 2017, the yen depreciated to a value of 106.5 Yen/1 USD (with minor fluctuations in-between), followed by it appreciating towards the end of 2018 upon which it has begun to depreciate once more to its current value of 108 Yen/1 USD (as of January 2019). Although NIRP is unconventional, Figure 5 displays some evidence the exchange rate followed its theoretical conventional monetary policy movement: a decrease in interest rate depreciates a country's currency. While there is this evidence NIRP had an effect on the exchange rate, previous research has found NIRP's effect on the exchange rate to be inconclusive (Aizenman et al., 2016, p. 4; Hameed and Rose, 2017, p. 41).

GDP

Figure 6. Cabinet Office, Gross Domestic Product for Japan [JPNGDP], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/JPNGDP>



Figure 6 displays Japan's GDP maintained levels between ¥520,000 billion and ¥540,000 billion from the 1st Quarter of 2006 until the financial crisis in 2008 when it decreased steeply to low levels it has not experienced before at ¥486,125.5 billion in the 1st Quarter of 2009. Japan GDP then experienced an increase until the 3rd Quarter of 2010 when it decreased again to about ¥485,000 billion in the 2nd quarter of 2011. From that point until the 4th Quarter of 2012, GDP experienced slight increases and decreases. As it can be observed from Figure 6, when QQE was implemented in 2013 and renewed in 2014, GDP's growth became stable and began to trend upward with less fluctuations than prior QQE.

After the NIRP was implemented, GDP did experience a slight dip from Quarter 2 to Quarter 3 in 2016, however GDP has continued its growth despite that minor dip. In fact, GDP is now at levels above what Japan had experienced prior to the financial crisis reaching a value as high of about ¥550,000 billion in the 4th Quarter of 2017. Overall, it would appear from Figure 6 the unconventional monetary policy of negative interest rates produced the same results as conventional monetary policy: Japan's GDP grew from about ¥53,800 billion at the onset of NIRP to a value of about ¥54,700 billion (as of July 2018), hence lowering the interest rate into negative territory did increase GDP as it would have under conventional monetary policy. Although GDP's growth trend was maintained after putting into effect NIRP, Figure 6 is unable to provide conclusive evidence to determine exactly if NIRP's impact is significant. Therefore, additional analysis was conducted using a regression model.

Regression analysis: Table 3 reports the results from regressing Japan's GDP on pfcon, hhcon, nonresinv, realresinv, netexp, and the interest rate dummy variable. From the output, the only variables to have an effect on Japan's GDP are hhcon, nonresinv, and realresinv as they are individually statistically significant. Accordingly, a joint significance test was conducted on pfcon, hhcon, nonresinv, realresinv, and netexp similar to the joint significant test conducted for unemployment rate. From Table 4, it was found that these variables are jointly statistically significant as the p-value is 0.0000 thereby indicating they jointly influence Japan's GDP. The coefficient on the variable of interest, irdummy, is positive thereby indicating GDP increases as the interest rate takes on a negative value. This is suggestive of lowering interest rates into negative territory proceeding in a similar manner as conventional monetary policy. However, the interest rate dummy variable is not statistically significant indicating there is no evidence of an impact on Japan's GDP. It should be noted the level of statistical significance could be affected based on the limited number of observations present. To investigate this, an additional regression of GDP was conducted converting quarterly data into monthly data. Yearly data was averaged, and then used to fill in missing monthly data. Table 5 reports the results, and Table 6 reports the results from a joint significant test conducted on the same variables as Table 4.

As a result from converting the data from quarterly to monthly, the coefficient on the interest rate dummy variable maintained its positive effect as before suggesting a negative interest rate positively influences GDP. However, contrary to the previous results in Table 3, the interest rate dummy variable using monthly data is now statistically significant at less than the 0.1% level or greater. This is indicating that there is evidence NIRP has an impact on GDP monthly rather than quarterly. Three other variables also experienced increases in statistical significance – hhcon (from 5% to less than 0.1% or greater), realresinv (from 1% to less than 0.1% level or greater), and netexp (from not statistically significant to less than 0.1% level or greater). Each variable maintained its positive/negative effect on Japan's GDP. Additionally, the joint significance test results in Table 6 mirror the results in Table 4 indicating there is evidence the variables – pfcon, hhcon, nonresinv, realresinv, and netexp – are jointly statistically significant, and jointly influence GDP utilizing monthly data.

Table 3

GDP Regression	
VARIABLES	gdp
pfcon	0.203 (0.434)
hhcon	0.361** (0.165)
nonresinv	0.375*** (0.0578)
realresinv	-0.0598* (0.0312)
netexp	0.000257 (0.000295)
irdummy	1.530 (0.945)
Constant	-0.325 (0.292)
Observations	45
R-squared	0.672
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Table 4

Joint Significance Test	
Variables	
pfcon = 0	
hhcon = 0	
nonresinv = 0	
realresinv = 0	
netexp = 0	
F(5,38) = 15.48	
Prob > F = 0.0000	
H ₀ : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$	
H _A : at least one $\neq 0$	

Table 5

GDP Monthly Regression	
VARIABLES	gdp
pfcon	0.125 (0.326)
hhcon	0.465*** (0.0923)
nonresinv	0.390*** (0.0300)
realresinv	-0.0657*** (0.0203)
netexp	0.000608*** (0.000216)
irdummy	1.150*** (0.337)
Constant	-0.345** (0.167)
Observations	144
R-squared	0.708
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

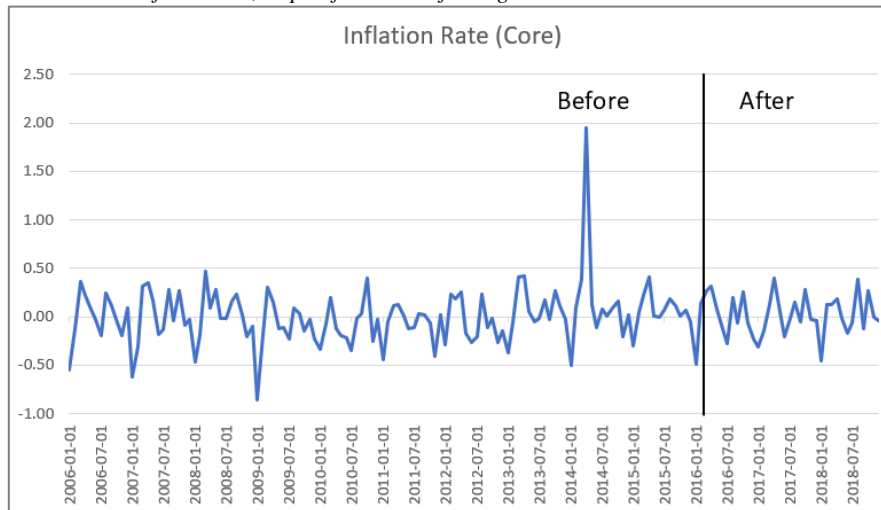
Table 6

Joint Significance Test: GDP Monthly Regression	
Variables	
pfcon = 0	
hhcon = 0	
nonresinv = 0	
realresinv = 0	
netexp = 0	
F(5, 137) = 63.88	
Prob > F = 0.0000	
H ₀ : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$	
H _A : at least one $\neq 0$	

Overall, Figure 6 did not display a significant fluctuation that could have been utilized to signify NIRP's effect, however there is some evidence of negative interest rate's impact displayed by the continued growth GDP has been experiencing since its implementation. Furthermore, the regression output provided deeper analysis indicating NIRP has a positive effect on GDP growth after 2016, however it was not statistically significant when utilizing quarterly data. Upon converting the data from quarterly to monthly, NIRP was found to have a statistically significant impact on GDP. Despite these findings, it is difficult to accurately conclude NIRP as the sole factor in GDP's growth since 2016 due to the two rounds of QQE that were implemented in 2013 and 2014 in addition to the lowering of interest rates beforehand. GDP growth was already experiencing an upward trend when QQE was introduced in 2013, and again in 2014. Altogether, NIRP appears to have maintained the steady growth GDP was already experiencing prior to its implementation, thereby acting in a manner similar to conventional monetary policy when interest rates are lowered (i.e., GDP increases).

Inflation rate:

Figure 7. Organization for Economic Co-operation and Development, Consumer Price Index: OECD Groups: All Items Non-Food and Non-Energy for Japan [CPGRLE01JPM357N], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/CPGRLE01JPM357N>



Before NIRP and the financial crisis, the inflation rate fluctuated between a rate of -0.5% and 0.5% (see Figure 7). When the financial crisis occurred, inflation rate reached a low of close to -1% around the beginning of 2009. Inflation rate recovered to return within the range of -0.5% and 0.5% by mid-2009 and continued to fluctuate. To overcome the fluctuation and low inflation, the BOJ's targeted inflation rate was set at 2% in 2013 (Yoshino et al., 2017; Dell'Ariccia et al., 2018). To achieve this goal, the first round of QQE was implemented in the beginning of 2013 where there is a noticeable increase in inflation rate. However, this increase was minimal as the inflation rate did not exceed 0.5% at that time and resumed the fluctuation it had been accustomed to experience. In 2014, inflation did reach the 2% target rate (as seen in Figure 7) when there was an expansion of QQE in addition to prices of oil and energy increasing. Despite reaching its goal, the inflation rate sharply decreased again below 0.5% within the same year once oil prices began to significantly decline (Yoshino et al., 2017).

Since the sharp decline from 2% inflation rate in 2014, the BOJ has been unable to reach its 2% target inflation rate, let alone climb outside 0.5% with it fluctuating between -0.5% and 0.5% once again. Even after NIRP implementation, Figure 7 shows that inflation rate has yet to increase above 0.5%. Theoretically, under conventional monetary policy, the inflation rate should increase as a result of interest rates decreasing: Figure 7 shows the expected response has not yet been produced. This observation is in conjunction with findings from Aizenman et al. (2016) and Arteta et al. (2016) who both presented results which stated NIRP did not influence inflation. However, it should be noted there is a length of time before inflation rate begins to show signs of it being affected by changes in interest rate policy. Therefore, we cannot conclude NIRP will not affect inflation in the future.

Based on the inconclusiveness from the Figure 7, regression analysis was conducted to further analyze the impact of NIRP on inflation rate.

Regression analysis: Table 7 contains the results from regressing inflation on net exports, real private residential investment, real private non-residential investment, real consumption of households, private final consumption, 3-month LIBOR rate based on the yen, and the interest rate dummy variable. Based on the results, all the independent variables are not individually statistically significant, indicating there is no evidence they individually influence inflation rate. Table 8 reports the results from a joint significant test on consumption, investment and net exports that produced a p-value of 0.6862 indicating these variables are not jointly statistically significant. In addition to the variable of interest – irdummy – not being statistically significant, its coefficient estimate would indicate NIRP has the opposite effect on inflation rate contrary to conventional monetary policy. That is, rather than increasing inflation rate as a result of lowering interest rates, inflation rate decreases when interest rates were lowered into negative territory. However, taking into account the effect converting quarterly data into monthly data had on GDP, the process was repeated for inflation rate.

Table 7

Inflation Regression	
VARIABLES	inflation
pfcon	7.504 (91.20)
hhcon	-32.00 (34.77)
nonresinv	-10.88 (12.27)
realresinv	0.299 (6.572)
netexp	-0.000159 (0.0622)
libor	0.219 (0.306)
irdummy	-32.49 (205.4)
Constant	-53.70 (62.86)
Observations	45
R-squared	0.084
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

Table 8

Joint Significance Test on Inflation Regression
Variables
pfcon = 0
hhcon = 0
nonresinv = 0
realresinv = 0
netexp = 0
F(5, 37) = 0.62
Prob > F = 0.6862
H ₀ : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$
H _A : at least one $\neq 0$

Table 9

Inflation Regression – Monthly	
VARIABLES	inflation
pfcon	-34.64 (265.9)
hhcon	3.900 (76.39)
nonresinv	-15.06 (26.12)
realresinv	4.034 (17.65)
netexp	0.0493 (0.175)
libor	0.0142 (0.545)
irdummy	1,219*** (396.9)
Constant	-33.42 (137.2)
Observations	133
R-squared	0.108
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

After converting the data from quarterly to monthly, irdummy is now considered statistically significant at less than 0.1% level or greater (see Table 9). This suggests there is evidence NIRP influences the inflation rate at the monthly level. Furthermore, the coefficient on irdummy is positive thereby indicating interest rates in negative territory increase inflation rate: a finding opposite the results in Table 7 and in conjunction with conventional monetary policy.

The lack of consistency regarding the statistical significance of irdummy results between quarterly and monthly regressions is not surprising, as inflation has continued to fluctuate

within the same range of -0.5% to 0.5% as before the NIRP went into effect, and even before the two rounds of QQE were implemented. The inconclusive findings and uncertainty regarding NIRP's impact presented in this paper also coincide with previous research on inflation rate and negative interest rates. Jurkšas (2017) stated inflation expectations hadn't recovered in the euro area, and there is uncertainty in the impact on short-term and long-term inflation based on negative interest rates complex transmission mechanism. Dell'Ariccia et al. (2018) determined the two rounds of QQE did not sustain inflation growth, and negative interest rates' impact on inflation was difficult to identify. In a study conducted on multiple countries that implemented NIRP, Arteta et al. (2017) discovered inflation expectations decreased in most of these countries. Yoshino et al. (2017) additionally found failure in achieving the 2% inflation target rate. Overall, the BOJ implemented QQE and negative interest rates to reach the targeted inflation rate of 2% but have yet to have significant impact on inflation rate outside of a short spike in 2014.

Conclusion

NIRP falls into the category of unconventional monetary policy, with QE (or QQE utilized by Japan), as only six central banks have implemented this policy as a means to promote price stability and economic growth after the 2008 global financial crisis. There has been limited research regarding this unconventional mechanism based on the fact it has not been implemented before: the first central bank established NIRP in 2014. Central banks were hesitant in implementing the policy due to the uncertainty surrounding whether lowering interest rates into negative territory would produce similar results as that of conventional monetary policy. This paper focused on Japan's implementation of NIRP, and whether the unconventional mechanism replicated what conventional monetary policy theory states should occur when interest rates are lowered.

Based on observations derived from each figure, and from the output's produced by the regression analysis, there is evidence NIRP has followed conventional monetary policy to an extent. Movements in the Nikkei 225 Stock and the exchange rate coincide with movements expected under conventional monetary policy: that is, when interest rates were lowered, the stock exchange increased, and the exchange rate depreciated as it would under conventional monetary policy. Economic growth has occurred post-NIRP implementation as indicated by sustained decrease in unemployment rate and continued growth in GDP. Furthermore, lowering interest rates into negative territory was found to have a statistically significant impact on GDP and unemployment, in addition to decreasing unemployment and increasing GDP as would have occurred under conventional monetary policy. However, NIRP has yet to increase the inflation rate as would be expected under conventional monetary policy being that the rate is still well below the target rate of 2%.

Overall, it would appear the unconventional monetary policy of lowering interest rates into negative territory produced similar results as that of conventional monetary policy regarding GDP, unemployment, stock market, and the foreign exchange rate: inflation rate has yet to be affected in the same manner. Additional research is warranted to provide conclusive findings on NIRP's impact on inflation rate. Furthermore, additional research

should isolate NIRP's effect from other unconventional monetary policies implemented (such as quantitative easing) to further clarify the magnitude of NIRP's effect. Based on potential results produced from future negative interest rate research, central banks may be less apprehensive to solely implement negative interest rates rather than in conjunction with other unconventional monetary policy tools in the event of another financial crisis whether it occurs globally (e.g. the 2008 financial crisis) or domestically.

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Using of KPIs and Dashboard in the analysis of Nike company's performance management

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Abstract. *The purpose of management control is to increase the motivation of managers and to create a greater convergence of objectives within an organization. It is a well-established management principle that what cannot be measured cannot be managed. However, it is equally true that what cannot be monitored cannot be well managed. This is where business dashboards come in. Living in an age of digitalization in which the world is changing and adapting to the complex systems of society, businesses must always be prepared with the tools necessary for adaptation. This article describes some important concepts in enterprise performance measurement management exemplified by Nike. In addition, a dashboard will be designed and the importance of monitoring key performance indicators will be highlighted.*

Keywords: enterprise performance management, Dashboard, KPI, business analysis.

JEL Classification: A10, G12, G17, L25, M2.

1. Introduction

Business analysis is a set of activities that coordinate change in an organizational context by defining needs and proposing solutions that bring value to the business. This value is determined by achieving benefits, reducing costs and identifying new opportunities within the organization.

Business analysis: According to BABOK® (A Guide to the Business Analysis Body of Knowledge – Babok Guide, 3rd edition), is the *practice* of enabling *change* in an enterprise/organization by *defining needs* and *recommending solutions* that *provide value* to stakeholders.

Business analysis is a relatively new economic discipline that promises to provide great benefits to organizations, ensuring that business requirements are aligned with the business change solutions implemented. Many of these solutions will include new or improved IT systems, and others may have a broader purpose, incorporating changes in areas such as business processes and employee roles.

Living in an age of digitalization in which the world is changing and adapting to the complex systems of society, businesses must always be prepared with the tools necessary for adaptation.

The vision of modern companies is to easily manage the wide range of products and services they offer that are supported by multiple processes, organized in several points of the business network, which must be carried out as efficiently as possible through various communication channels.

It is well known that enterprise is an important point in a country's economy, being the most eloquent example of a complex adaptive system. Like a fitness landscape represented by speed, intelligence and endurance, the business sector must be able to maintain intense and varied connections.

The need to identify useful tools that would help improve or increase performance is current and of great interest to all businesses. Experiencing a world in which we are surrounded by a multitude of data, the need to maintain the strategic direction set by a company, to reduce the uncertainty of making the right decisions, exists.

This research aims to analyze how key performance indicators (KPIs) are used in order to monitor the performance of the Nike company but also how to design an effective dashboard for this purpose.

2. Theoretical concepts on Key Performance Indicators (KPIs)

Often, the information found in dashboards is dashed by both the customer and the managers. These elements are called KPIs.

In Wayne W. Eckerson's view, a KPI is a way of measuring the performance of a company or an individual, the organizational or strategic activity that is crucial for the current or future development of a company.

KPIs are high-level snapshots that look at a project evolving from predefined targets. KPIs measured with current achievements will influence future ones. KPIs are essential elements of added value to a company.

Terms such as “cost variation”, “time”, “performance”, “cost”, “implementation time”, “collection period” are considered KPIs if used correctly, even if they do not always appear under this name. The need for KPIs is simple: What can be measured, can be achieved!

If the purpose of a performance measurement system is to improve efficiency and effectiveness, then the KPIs used must reflect measurable elements. It does not make sense to measure an action if users are unable to change the result.

For more than four decades, the only KPIs have been their time, cost, and derivatives. Today, it is well known that true results cannot be measured in terms of time and cost alone. That is why there is an increased need to use other KPIs. It has been shown that many KPIs can be contained in a single KPI. For example, the customer satisfaction KPI can be a mix of time, cost, quality and efficient communication in the customer relationship. KPIs are derived from formulas that help us combine other elements of measurement into a single KPI, which is also specific for the benefit of a company.

What is or is not a KPI is defined by each company. Project managers need to explain to management the difference between metrics and KPIs, why certain KPIs are presented in a dashboard. For example, metrics focus on completing projects, reaching intermediate stages, and meeting performance goals. KPIs focus on future outcomes and this is the information needed by stakeholders (decision makers) to make decisions. Simply put, metrics risk getting stuck in the past. With the help of KPIs one can understand how to use this data for future decisions. Neither metrics nor KPIs can anticipate the success of a project, but KPIs can provide much more accurate information about the end result if the trend continues.

The fact that stakeholders are interested in metrics/KPIs and dashboards does not guarantee that they will understand what will be presented to them. It is imperative that stakeholders understand the information presented in the dashboard in order to draw the right conclusions. The risk is that stakeholders do not understand the indicators and then reach erroneous conclusions and lose confidence in the concept of measurement by indicators. Restoring confidence in the performance measurement process can take a long time and become expensive.

With all this in mind, it is necessary that in the first months of using the concept of performance measurement, the project manager periodically informs each stakeholder so as to ensure that they understand what they see and always reach the correct conclusion.

We have previously stated that what is measured is achieved and that by measurement the understanding of information is obtained. If the purpose of a measurement system is to achieve efficiency and effectiveness, then KPIs must reflect controllable indicators. There is no point in measuring an activity or a KPI if the user cannot change the result because the KPI will not be accepted by stakeholders.

Stakeholders: Each task includes a list of stakeholders who will participate in or be affected by it. A stakeholder is an individual with whom a business analyst will interact directly or indirectly during the ongoing task. Any stakeholder can be a source of requirements, assumptions or constraints.

Some of the stakeholders involved in a business initiative can be found in the following list, which is not exhaustive and can vary depending on requirements.

- Business analyst: Inherently a stakeholder in all activities specific to business analysis. According to BABOK, he is responsible and accountable for these activities.
- Customer: Uses products or services provided by the company and may have contractual or moral obligations that the company undertakes to fulfill.
- Expert in the field (business): Has detailed knowledge about a specific topic relevant to the business need or scope of the solution. Here you can find people such as managers or consultants.
- End user: Interacts directly with the solution. Here you can find all those who participate in a business process or use the proposed solution.
- Expert in the field (implementation): Has extensive knowledge regarding the implementation of one or more components of the solution. Some of the people who can fulfill this role are: developer, solution architect, database administrator, change manager.
- Operational support: Responsible for the regular maintenance of a system or solution. It can be provided by: operations analysts, technicians, launch managers.
- Project manager: It manages the activities necessary to deliver a solution that meets a specific business need and the achievement of project objectives, taking into account factors such as scope, budget, program, resources, quality and risk.
- Supervisory authority: Responsible for defining and imposing standards. Standards can be imposed on the solution through legislation, corporate governance methodologies or auditing. These include: the government, public regulators and auditors.
- Sponsor: Responsible for initiating the effort in defining a business need and developing a solution that meets that need. They authorize the efforts to be made and control the budget and the scope of the initiative.
- Supplier: Stakeholder who is outside the boundaries of a particular organization or business area. It provides the company with products or services in accordance with contractual or moral obligations to be fulfilled. These include: consultants, vendors, providers.
- Tester: Responsible both for verifying how the solution meets the requirements defined by the business analyst, and for directing the verification process. They also ensure that

the solution meets quality standards and that the risk of gaps is well determined and minimized. An alternative role is that of Quality Assurance analyst.

Collaboration between stakeholders involves frequent and two-way communication. Collaborative relationships help maintain the free flow of information when obstacles arise and promote a common effort to solve problems and achieve the desired results.

It is a real challenge to work with stakeholders. There are complex situations that need to be overcome, such as:

- Convincing stakeholders to accept KPIs can be difficult, even if they understand and have experience in project management.
- Before presenting the KPIs to stakeholders, it is necessary to check whether the KPIs are in the system or should be collected.
- The cost, complexity and duration of obtaining the information must be established.
- The risk of the IT system changing and losing its relevance in an asset change process may impact the collection of information needed by KPIs during a project.
- Some KPIs may not appear from the beginning, over time stakeholders will request the inclusion of additional KPIs in the system.

The ultimate goal of a KPI is to identify what is needed to improve performance and maintain strategic direction. If the measuring system is set for short periods of time, the team can react immediately to correct errors.

KPIs are pre-set quantifiable units of measurement that reflect the major success factors of an organization. They are units of measurement that measure the evolution of organizational objectives. It is a real waste of time to select and implement KPIs that cannot be controlled.

For example, a blood pressure monitoring device tells us the blood pressure, if it is too high or too low, but does not explain to the doctor what to do to bring it to normal parameters. KPIs aim to reduce uncertainty in order to make the right decisions. Qualitative measurements of indicators and KPIs can be used and should be used as levels of quantitative measurements. Eventually quantitative measurements become qualitative.

The literature often identifies the characteristics of KPIs using the SMART rule.

- **Specific:** The KPI is clear and focused on achieving the organization's goals and objectives.
- **Measurable:** KPI can be represented by quantitative units.
- **Achievable:** A KPI can be achieved with the available capacity and resources.
- **Relevant:** The KPI contributes to the intended impact of the organization.
- **Time bound:** The KPI is framed in a time interval.

Although the SMART rule is a valid model, its applicability to KPIs is debatable. Perhaps the most important attribute of a KPI is that it is ACTIVE. If the intermediate result is not favorable then users should identify what action can be implemented to correct the trend. Users must be able to control the result. This is a weakness of the SMART method.

Wayne Eckerson has developed a more sophisticated set of 12 features for KPIs. The features are more suitable for business KPIs.

1. *Strategic*: KPIs are adapted to the company's objectives.
2. *Simple*: KPIs must be straightforward and easy to understand, without containing complex indicators that are difficult for users to identify.
3. *Assume*: KPIs must be assumed by an individual or group within the organization, who can be held accountable for the outcome.
4. *Actionable*: KPIs are regularly monitored in order to be able to intervene when necessary.
5. *Frame time*: KPIs can be updated from time to time so that performance is improved if needed.
6. *Benchmarks*: Users can return to the original form of the KPI.
7. *Precise*: Performance Indicator data can be measured and reported with reasonable accuracy.
8. *Correlate*: The KPI can be used to achieve the expected result.
9. *Practices*: The use and analysis of KPIs have shown that the data must be realistic.
10. *Align*: KPIs must be aligned with the organization's strategy and objectives.
11. *Standardized*: KPIs are based on standardized definitions, rules and mathematical formulas so that they can be integrated into dashboards.
12. *Relevant*: KPIs lose their impact over time, so they need to be periodically reviewed and updated.

KPIs should be understood and used there and when they are needed and help complement the performance management framework, business dashboard, balanced dashboard or business intelligence strategy. To facilitate the design of dashboards and scoreboards, the KPIs introduced are grouped according to the key business perspectives they present and which are used by most organizations, regardless of the type or branch of activity: *Financial perspective; Customer perspective; Marketing and sales perspective; Employee perspective; The perspective of corporate social responsibility.*

3. Scorecard, Dashboards and Reports

There is a fine difference between scorecards, dashboards and reports. Each of these tools can combine elements that belong to the other tool, but in essence each addresses a distinct level of the organization's decision-making process.

Scorecard: Starting with the highest and strategic level of decision of the organization we find the scorecard. The scorecard is mainly used to help align the operational level of the business with the strategic one. The main purpose of a scorecard is to keep the business oriented towards a common strategic plan, by monitoring in real time the execution and reporting the results of that execution to a specific strategy. The basic indicator of a scorecard is the KPI. These KPIs are often a combination of several indicators that measure the organization's ability to implement a strategic plan. An example of a KPI scorecard is

“Profitable Sales Growth” which combines in a single Indicator the following units of measurement: enrollment of new customers, sales volume, operating profit.

Dashboards: At the next level after the scorecard, in the decision-making process of the organization, the dashboard is located, given the fact that it focuses more on the presentation of results, operational objectives. An operational objective can contribute to one or more strategic objectives. In a dashboard the focus is on how to achieve the operational objective itself, not on the strategy. The purpose of a dashboard is to provide users with specific business information in a format that is both intuitive and easy to understand. The information transposed in a dashboard is based on units of measurement and performance indicators.

Reports: Probably the most prevalent BI tools are reports. They can be very simple and static in nature, such as a list of sales over a period of time, or sophisticated report tables that contain groups of information, pivots, analysis of information. Reports are best when the user needs to analyze raw data in an easy-to-read format. When combined with scorecards and dashboards, the reports amazingly allow users to access raw information that is the basis for determining units of measure and KPIs.

An enterprise dashboard is a graphical visualization tool connected to different databases. These databases are generated by enterprise systems such as the core platform, CRM, credit processing system and other database systems.

A dashboard is used to track and present the KPI implemented at the institution level. They track company results such as customer trends, financial results, just about anything you want to track as long as there are databases. A dashboard helps you keep track of developments over time, historical and recent, such as customer and funding developments. At the same time, a dashboard also helps to generate future predictions using analysis systems.

At the base of a dashboard that provides correct information and for the understanding of decision-makers, or those directly interested in monitoring the activity are:

- Selection of KPIs.
- Database preparation.

Even if it seems incredible, the technology used to create a dashboard does not matter. All the tools used in creating a dashboard, Power BI, Tableau, Qlik, Datapine are the same at the end of the day. What is most important is the database used and the establishment of the KPIs needed to be analyzed, presented.

3.1. Using applied software to design Dashboards

For every organization in the digital age, the volume and value of data is constantly increasing. If you want to get more value out of the available data, then you can use the dashboard technique that serves as an essential tool for monitoring and control within an organization.

In one place, quickly and effortlessly, we can get a precise and deep understanding of business data through a simple graphical interface. To gain in-depth knowledge about this, let's continue to introduce Dashboard software, with a special note on free and open-source Dashboard software solutions.

Having laid the groundwork for an effective organizational dashboard, it is worth noting that the dashboard software must also meet the standards of any good software, which includes the following:

- Quick response. Users should not be too late in retrieving dashboards and associated reports.
- Intuitive. End-users should not be forced to go through a large learning curve or compulsory training.
- Web-based. Users should be able to access the dashboard via the web if they have adequate access rights. The web-based feature can also be called thin client.
- Secured. System administrators can easily manage security software to reduce and track improper access. The software must also provide data encryption to ensure the transmission of sensitive data over the Web.
- Scalable. A large number of users can access the software without the system crashing or slowing down below an acceptable level of performance. This quality requires a reasonable size of hardware and network.
- Compatible with industry. The software should integrate with the standard databases of different vendors and work with different server standards (e.g. Net, J2EE) and different operating systems (e.g. Unix, Windows, Linux).
- Open technology. Software should not have proprietary standards that make it difficult or impossible to extend it in a complex IT environment. It should work well with the predominant protocols for information exchange, such as XML, ODBC, JDBC, OLE DB, JMS and Web Services. Note, open technology does not mean open source, which mostly refers to free software with open access to the source code.
- Sustainable. It should be easy to manage a large deployment of existing IT staff with limited training in on-board software. In other words, the software should not be so complex as to require a long-term contract or hire another expert to support its deployment, assuming that the organization has reasonably qualified IT staff.

3.2. Some software used for dashboards design.

1. Seal Report⁽¹⁾: is a free open-source dashboard software that provides a framework for daily reporting. With minimal effort, dashboards can be created using any database as a source.

This software has limited business intelligence capabilities. The emphasis is on easy installation and quick report design. Once the software is set up, reports can be built and delivered in minutes.

Seal Report contains the Report Designer application that helps you create, edit, and run reports. The server manager in this software performs administrative activity. The end user

can edit and run dashboards using Web Report Server. The activity scheduler schedules the execution of the report.

2. Dashbuilder⁽²⁾: The non-technical user can visually create business dashboards by using this free dashboard tools. Data can be extracted from the dashboard from heterogeneous sources of information, such as regular text files. This complete web application is based on Uberfire.

The new version of this software is UF Dashbuilder which has many amazing features and user interface. For building dashboards and business reports, this software is an open-source platform. Target users of this tool can be managers or business people who act as consumers of dashboards and reports.

3. Grafana⁽³⁾: The Grafana serves as an open-source dashboard for excellent analysis and monitoring. With this free dashboard software, users can create dashboards with panels. Within a set time frame, this panel represents specific values.

For any specific project or business need, you can customize the dashboard because it is versatile. This open-source application for analysis and monitoring works as a powerful tool for computerized business decisions. It is a flexible software that supports multiple data sources.

This analysis platform allows you to query and view different KPIs. A data-driven culture can be promoted by creating, exploring and sharing dashboards with team members.

4. Datapine⁽⁴⁾: It is another software tool that helps companies turn valuable data into new perspectives and make real-time data-based decisions, with the help of which they can design an efficient dashboard.

Datapine has a user-friendly interface that allows it to be understood by non-technical users as well. It offers a variety of innovative BI 4.0 features, such as smart alerts, predictive analytics and interactive dashboard features.

5. Case study: Nike's performance management

Nike Company, Inc. was founded in 1964 by Bill Bowerman and Phil Knight, based in Beaverton, Oregon. At first, the company was known as “Blue Ribbon Sports”, then changed it to NIKE in 1971. Currently, the company's executive director is Mark Parker (since 2006).

The Nike story begins with a small sports shoe distribution point in the trunk of Phil Knight's car. From these seemingly unfavorable circumstances, Phil started the company that created a real culture and a lot of fashion trends. The company was born out of the need for Oregon athletics coach Bill Bowerman to find more durable running shoes and Phil Knight's desire to make a decent living, without giving up his passion for athletics. The first pair of shoes was designed with the help of a waffle maker. Watching his wife

prepare the waffles, Bill came up with the brilliant idea that such a model would be suitable on the running track, that's how the Nike Waffle Trainer was born.

Nike's core business is the worldwide design, development, manufacture and marketing of high-quality footwear, clothing, equipment and accessories. NIKE is the largest seller of sports shoes and clothing in the world. Nike is identified by a mix of independent distributors and subsidiaries in over 120 countries around the world. Almost all footwear and clothing are produced outside the United States, while sports equipment is produced both in the United States and abroad. Nike Inc. sells its products through its online stores, retail, direct sales, wholesalers and other third parties. The fiscal year of the enterprise consists of 52 or 53 weeks and ends on the last Saturday of September.

The suppliers of any organization are those economic agents that provide the entity with the resources it needs to carry out the activity, so with their help the production process is carried out. In general, companies have to choose their suppliers based on certain criteria such as: geographical location (for the supply and distribution chain), transport costs, economic power and market share, the price they offer for goods or services provided, the quality of resources and supply, but also the seriousness and compliance with the contract drawn up. Because labor is quite expensive in the United States, about 99% of footwear is produced abroad. In the case of Nike, most factories are located on the Asian continent, in countries such as China, Taiwan, India, Thailand, Vietnam, Pakistan, the Philippines and Malaysia. The reduced supply chain allows the company to save \$ 0.15 per piece compared to a classic distribution model. For the Nike company, which transports over 900 million pieces a year, these savings represent a real competitive advantage.

The efficiency of the Nike company increases from the low production costs. Instead of owning its own factories, the Nike footwear division requires the services of independent manufacturers located in 14 countries around the world. Most of the independent factories (96%) are located in Vietnam, China and Indonesia.

Beyond the production process, Nike also relies on independent companies to supply raw materials for footwear from the countries where they are produced. This allows Nike to reduce its intermediate costs by limiting the number of suppliers with whom it has to negotiate contracts. Once the shoes have been manufactured, the items are shipped to 57 distribution centers around the world. In the United States, the company operates five major distribution centers in Memphis, Tennessee.

Although sales to wholesalers continue to account for the vast majority of Nike's revenue, the company is making serious efforts to expand its presence in other distribution channels, especially DTC-direct to customer sales. In 2012, 83.3% of Nike's revenue came from wholesale sales, while 16.2% came from DTC sales; by 2013 these values decreased to 79.2%, respectively increased to 20.3%. DTC sales allow companies to interact directly with consumers, provide improved customer service, and become more aware of what customers really want.

Another potentially disruptive factor that Nike's production and distribution process will have to deal with is automation. The high cost of labor in the United States is the main factor pushing production abroad, but as robotic technology improves, companies like Nike have the opportunity to remove these unnecessary costs and resume many of their production operations.

According to Morgan Stanley forecasts, “Almost 20% of Nike and Adidas footwear production will move to more automated factories by 2023, due to a commercial environment” buy now, wear now “forced by the transition to e-commerce”.

If the automation goes as planned – a report by the International Robotics Federation claims that about 1.3 million new robots will be installed in factories in the next three years – companies like Nike could firmly consider restructuring their production strategies.

However, a company as expansive as Nike must continue to find ways to minimize production and distribution costs across all of its production channels. This will require great responsible logistics planning, as well as a firm commitment from Nike to be as innovative in its distribution operations as it has been for decades in product design.

5.1. SWOT Analysis

First of all, it should be reminded what a SWOT analysis is and what it is used for. Therefore, SWOT analysis is a method of analysis-diagnosis that is performed in a relatively short period and that does not look for detailed solutions, but rather global solutions. Diagnostic analysis or SWOT analysis (Strengths-Weaknesses-Opportunities-Threats) is, in short, the analysis of strengths, weaknesses, opportunities, but also the so-called “threats”. Thus, the four sections listed above for NIKE will be highlighted below.

Figure 1. SWOT Analysis



Source: The design is done by the authors.

5.2. Boston Consulting Group Matrix

The BCG matrix is a 2×2 matrix and uses the idea that economic performance is determined by two factors, namely the relative market share and the relative growth rate of the market.

The relative market share is the ratio between the market share of the company in question and the market share of the strongest competitor of the company. The relative market share expresses the level of market dominance by the firm. Market share also indicates the ability to generate income, with cash flow being the most important factor: the higher the level of market dominance, the greater the company's ability to generate liquidity.

The market growth rate is an important indicator for two reasons. In a fast-growing market, sales of a product may grow faster than in a slow-growing market. This increase in sales thus attracts a large amount of cash that can be used to grow the business.

Taking into account these two factors, the products are classified as follows:

- STARS (stars) – high market share/high market growth (cash neutral – does not generate cash).
- MILK COWS (high market share/low market growth (cash generators).
- Question Marks – low market share/high market growth (cash flow).
- Dogs – low market share/low market growth (cash neutral – does not generate cash).

In order to be able to build the BSG matrix, we selected 4 Nike brand products for which we found or estimated the relative market share and the relative growth rate of the market. The first product selected is part of the Nike equipment category and is a white “Utility Power” (Product 1) sports bag for men.

The second product chosen is part of Converse for Nike, namely “Converse Chuck Taylor All Stars Low Top” (Product 2).

In this category, Nike competes with brands such as New Balance, H&M, Zara, etc. for casual, sports shoes. Thus, a growth rate of 14% and a market share of 12% were estimated. The leader in this market is New Balance with a market share of 25%. Another product to analyze is part of the Nike Skateboarding category and is called “Nike SB Zoom Stefan Janoski Canvas RM” (Product 3).

A last selected product is part of the Men Apparel category and is represented by Nike “Trening B NSW TRK SUIT CORE BF” (Product 4).

To achieve the BCG matrix, we will need a series of data. We will use the data related to the 4 products above from NIKE's portfolio. The information of the indicators used are summarized in the table below.

Table 1. Data used for the construction of the BCG matrix

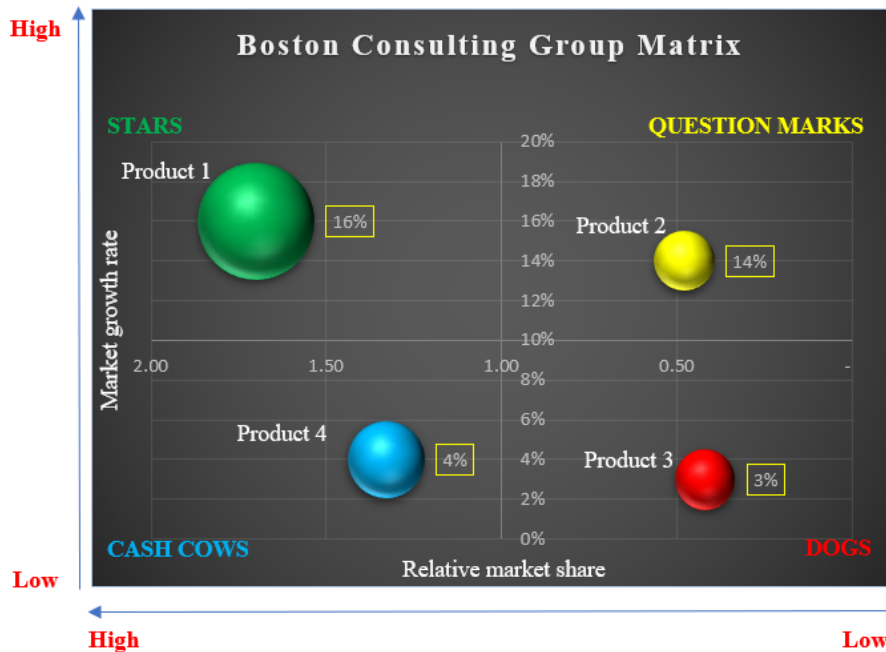
Products	Market growth	Market share	Market share of the largest competitor	Relative market share
Product 1	4%	20%	15%	1.33
Product 2	14%	12%	25%	0.48
Product 3	3%	12%	28%	0.42
Product 4	16%	46%	27%	1.70

Source: The calculations are performed by the authors.

It is necessary to know the notions of market growth, market share and relative market share). In order to obtain the relative market share, you must divide the market share of the analyzed product by the market share of the most important competitor.

Boston Consulting Group helps companies increase their efficiency in terms of successful business activities. To this end, the matrix plays an important role because it is a useful tool for strategic product performance planning at industry and company level. The matrix was introduced in 1970 by Bruce Doolin Henderson, president and CEO of Boston Consulting Group, and has since been used by many corporations to improve their ability to run their business efficiently and profitably. The BCG matrix needs a systematic classification rule, being an exploratory analysis tool based on interactions, so as to obtain the consensus between different managers and the analysis of the personalized classification scenario. The matrix provides recommendations for the development of strategic resource allocation and strategy development in the typical multi-business company. It is argued that relative competitive position and growth are the two fundamental parameters that must be taken into account when determining the strategy that an individual business must follow when viewed in the context of the company's overall business portfolio.

Figure 2. BCG Matrix for Nike's Portfolio



Source: The design is done by the authors.

From the BSG matrix above it can be seen that the equipment and accessories are Cash Cows for the Nike company. They generate cash to turn questioned products (dilemmas) into dairy cows. To support these products, Nike has hired a lot of celebrities for advertising and invested in an innovative design.

In the chapter Star you can find sportswear. Certainly, the leader of the Nike product portfolio are Nike shoes (Nike Air Max etc.), but they have not been analyzed because Nike is the leader in this market segment, holding the largest market share. It seems that due to the pandemic period, sportswear has become a star of the portfolio because there have been changes in the lifestyle of consumers. The stars bring in the highest income, but can easily be converted into dairy cows if growth strategies are not carefully managed.

The Nike Converse product category can be found in the Dilemmas or question marks category. If Nike adopts effective and specific strategies, this product can be converted into a Cash Cows. For such a product there is a higher market growth than market share. Converse almost came out of the top of consumer preferences, as many athletes stopped using or switched to similar models provided by competitors. In the Dogs dial we are dealing with product 3, i.e., the Nike Skateboarding category. These products do not consume too much cash, nor do they generate enough profit. Nike skateboarding looks like the company's dog because it is not the heart of skateboarding brands, so it does not receive enough support/feedback from people.

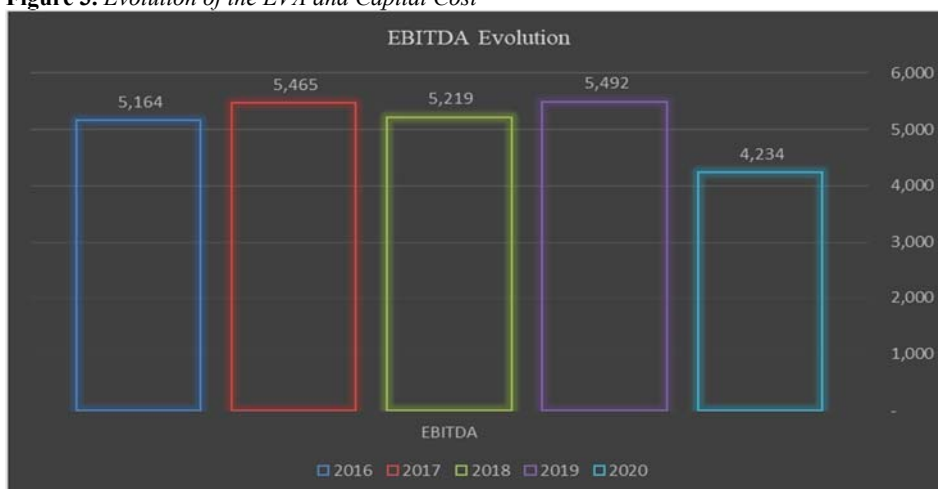
5.3. Analysis of key performance indicators

5.3.1. Financial perspective

A. EBITDA

This financial indicator allows us to better compare companies and their operating profitability without taking into account their capital structure. EBITDA is a measure of an enterprise's operating profitability over time that will eliminate the potentially distorted effects of changes in interest, taxes, depreciation and amortization. Therefore, this indicator is the sum of net profit, cost of interest, cost of taxes, cost of depreciation and amortization. To identify the profitability of Nike, we will analyze the historical values of this indicator for the last 5 years (2016-2020). Values are expressed in millions of dollars.

Figure 3. Evolution of the EVA and Capital Cost



Source: The design is done by the authors.

B. EVA (Economic Value Added)

We will use this indicator to receive confirmation of the profitability of Nike and its projects. EVA is calculated as net operating income after tax less costs to finance the company's capital. The formula is:

$$EVA = NOPAT - (WACC \times K)$$

where:

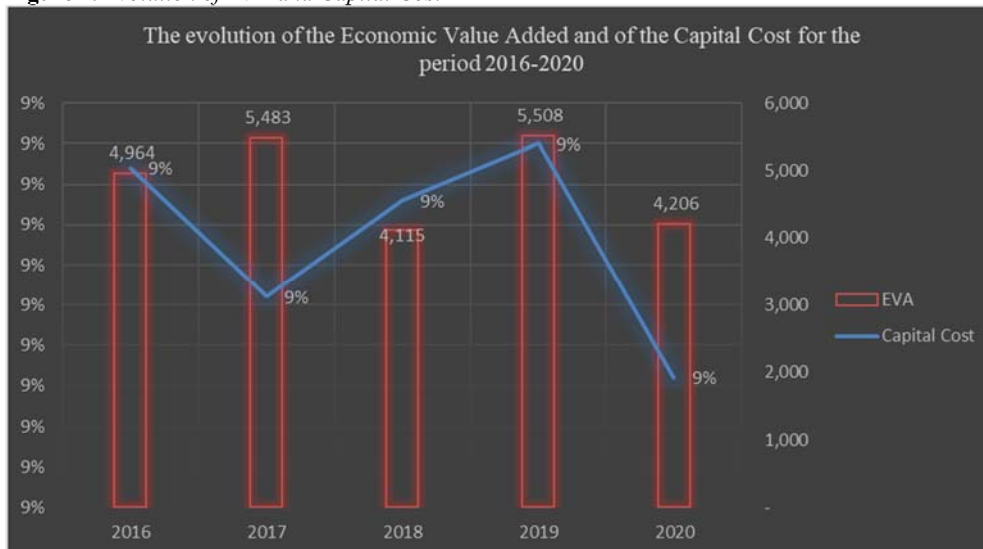
NOPAT – Net Operating Profit after Tax.

WACC – Weighted Average Cost of Capital.

K – Economic Capital used.

WACC is the rate that a company is expected to pay on average to all holders of securities to finance its assets; Like net income, the highest value for Nike is recorded in 2019 at a rate of 9.35% expected to be paid to holders of securities to finance their assets.

Figure 4. Evolution of EVA and Capital Cost



Source: The design is done by the authors.

If a company's EVA is negative, it means that the company does not generate value from the funds invested in the business. Instead, a positive EVA shows that a company produces value from the funds invested in it. Therefore, Nike is showing performance on this indicator, producing a maximum value of 5508 million dollars in 2019 from the invested funds.

5.3.2. The customer's perspective

A. Customer satisfaction index

To assess customer satisfaction, we will analyze these indicators to get an idea of the success of the Nike organization in providing products and services in the footwear market.

Nike has always invested in keeping its customers interested and loyal by offering superior quality of its products and efficient distribution chain and being aware that it is much more difficult to gain new customers, thus relying on customer retention and satisfaction already existing.

B. Net promoter Score

This indicator measures the customer experience and predicts business growth. This proven value has transformed the business world and now provides the basic measure for customer experience management programs around the world. Any score that is greater than 0 is considered good, as this indicates that Nike has more promoters than detractors and that Nike customers are loyal to the company. Also, scores above 20, as in our case, are considered to be favorable.

Figure 5. Evolution of Customers KPI



Source: The design is done by the authors.

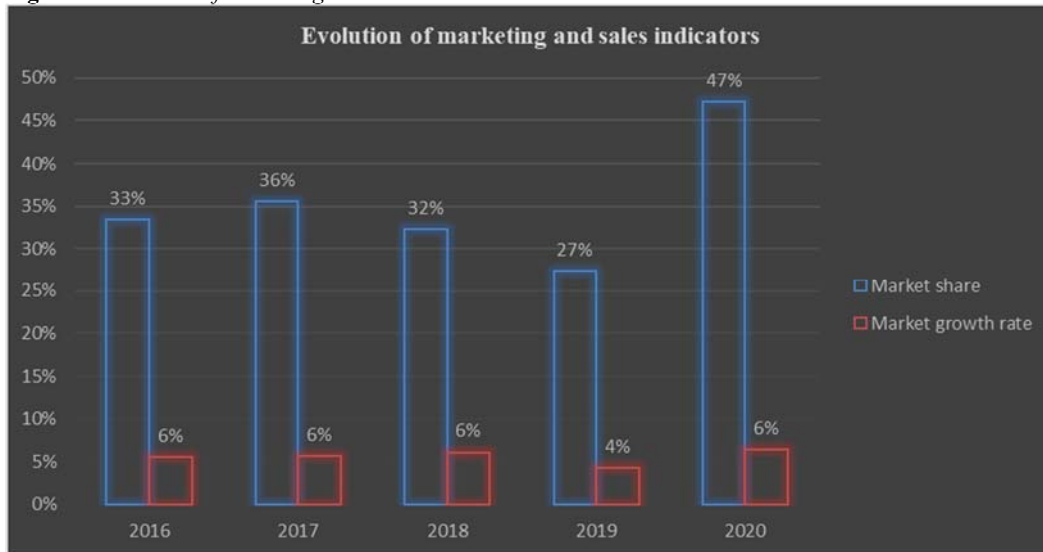
C. Customer retention rate

This indicator is calculated according to the number of customers at the end of a period, the number of new customers in that period and the number of customers at the beginning of that period. The customer retention rate indicates what percentage of all customers Nike has managed to keep over a period of time. Nike customers have always been loyal to the company and usually those who have bought a Nike item in the past have returned to buy a Nike product in the following years due to the innovation that Nike brings to the footwear market, due to product diversification and models, due to the prices that are affordable and these are just some of the reasons that explain the high retention rates of Nike customers in the chart above.

5.3.3. Marketing and sales perspective

Key sales performance indicators are measurements that tell you how your business is doing in terms of conversions and revenue. You can analyze the sales KPIs related to a certain channel, time period, team, employee, etc. to make the best business decisions.

Figure 6. Evolution of marketing and sales indicators



Source: The design is done by the authors.

A. Market share

We used this indicator to analyze Nike's competitive strength and market growth potential.

As market share is a key indicator of market competitiveness, it allows managers to assess the growth or overall decline of the market, to identify key trends in consumer behavior and to see their market potential and market opportunities. Therefore, this indicator measures real market power and identifies opportunities for improvement. Being a market leader, Nike has almost doubled its market share in the last year compared to the previous year, thus placing itself in a competitive advantage.

Therefore, the company can often receive better prices from suppliers, because their larger order volumes increase their purchasing power.

B. Market growth rate

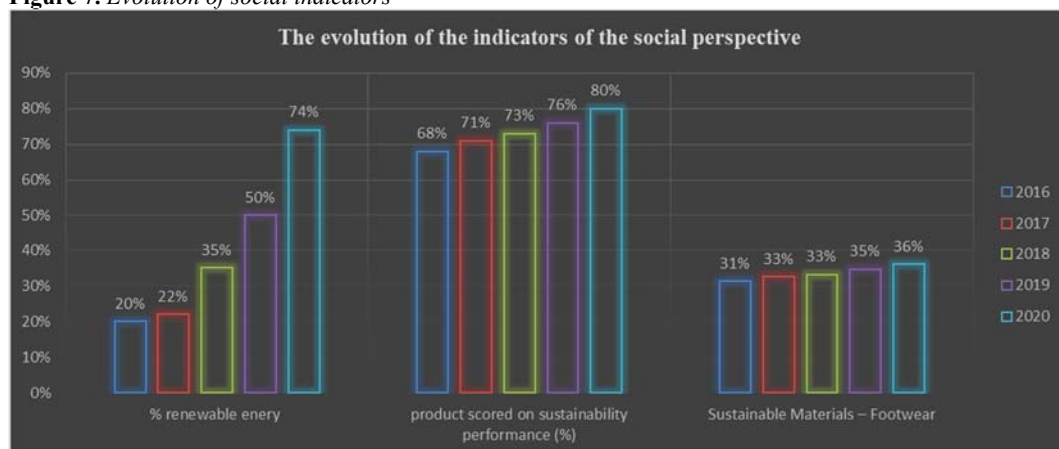
We studied the footwear market of the analyzed company, Nike, and we studied the main competitors and to better understand the size of the market and the rate at which this market decreases or increases, we evaluated this indicator for the potential for future revenue growth. The market growth rate is calculated as the total market sales for the current year analyzed divided by the total market sales for the year before the year under review. Therefore, in order to identify future growth opportunities in the footwear market and to increase the company's performance, we analyzed the historical values for the last 5 years.

In the current context, the footwear market is growing compared to the previous year but in the last 5 years the values have not deviated much from the average, which makes us think that in the coming years, the growth rate of the market will increase and will also be around the average.

5.3.4. The perspective of corporate social responsibility

Nike's goal in this regard is to reach 100% renewable energy by 2020. Values form an upward trend with a fairly accelerated growth which can be a positive sign in terms of achieving the Nike goal.

Figure 7. Evolution of social indicators



Source: The design is done by the authors.

5.3.5. The employee's perspective

To assess the likelihood that Nike will be financially successful in fulfilling its vision and mission of the organization, we analyzed this indicator of the level of employee involvement. Nike evaluates employee satisfaction through questionnaires delivered and completed in each quarter to take into account their wishes, but also their objections. Nike's performance in this field is very high, and employees are very satisfied with the place where they work.

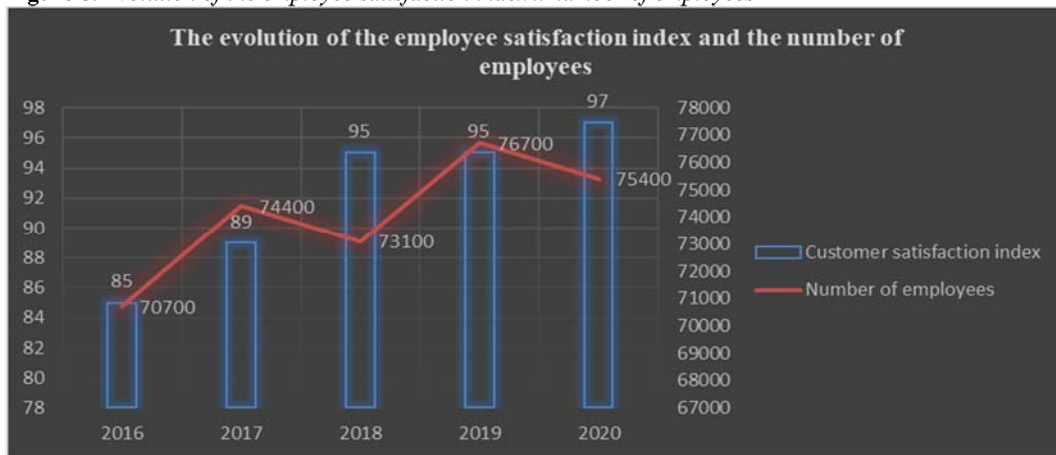
This is also seen online in the many appreciations of the CEO, the Nike representative.

From a customer perspective, although the NPS is a favorable indicator, Nike could invest more in retaining its loyal customers and attracting more customers so that the number of promoters is considerably higher than the number of detractors, and NPS to exceed 50. In this case, the company would be in the case of "Excellent".

Nike can solve this problem by offering its customers several special holiday offers/promotions, diversifying the product chain, investing in the mobile application, researching and evaluating customer opinions distributed on various social networks and understanding dissatisfaction.

From a marketing and sales perspective, Nike in the last 5-6 years, except for the current year, was at the same market share, the average being 30% and the average growth rate of about 6%. Nike can raise these numbers by getting to know its customers better, by providing excellent customer service, by looking for new opportunities, by being present on social networks, by hosting events, by volunteering.

Figure 8. Evolution of the employee satisfaction index x number of employees



Source: The design is done by the authors.

Also, the brand capital is on an upward trend in the last 3 years, but it does not show a rapid growth. To increase the value of the brand, Nike must differentiate itself from its main competitors, the company must be creative with video marketing, have a strong team and be consistent.

From the employees' perspective, the indicator of involvement/loyalty score is favorable but not excellent. Of a small sample, one-third of employees were dissatisfied with working with Nike. Thus, Nike can improve this indicator by organizing trainings/team building/events for employees or by evaluating employee satisfaction through monthly questionnaires to be up to date with their grievances.

At the same time, the wage competitiveness rate is an important indicator here. Given that for a similar position, Nike pays more than its main opponent, Adidas, but not by much difference, the company could do a little research in this area and increase employee salaries to keep the commitment high and not loses employees to the detriment of the competitor.

6. Dashboard design for Nike Company

In the following I designed the dashboard for the performance of the Nike company that was made in Datapine. This dashboard highlights KPIs for both customer perspective, employee perspective, financial, marketing and sales and social responsibility, as well as

general statistics such as Market Cap, number of stores, number of factories and target customer segment.

Various types of bar charts, line charts, speedometers, bar charts and line charts were used to create the dashboard to make the dashboard more interactive. Two colors were used, blue and orange and their derivatives because an unwritten rule is not to use more than four colors so that the dashboard is not too loaded, but also because these are the specific colors of Nike, and are found in most reports.

Figure 9. Nike Dashboard



Source: The design is done by the authors. The dashboard was design in Datapine.

In the dashboard we can observe how the customer's perspective was highlighted. For this perspective, a speedometer warning system for the Net Promoter Score indicator has been implemented, which suggests that when the needle is on the orange area, the company will have problems. Any score that is greater than 0 is considered good, as this indicates that Nike has more promoters than detractors and that those who purchase Nike products are loyal to the company. Also, scores above 20, as in our case, are considered to be favorable.

So, looking at the previous dashboard, it can be said that Nike is a very high-performing company and has no cause for concern in the near future, but it needs to invest and build strategies to keep its customers loyal (because switching costs are reduced, and customers could migrate to another competitor at any time), satisfied employees and try to raise satisfaction scores and Net Promoter Score, i.e. to have more promoters than detractors,

which can be achieved through innovative products with pleasant design, easy to wear, increase product quality, improve the supply chain so that customer demands are met in a timely manner, more attractive ads, more interactive mobile application and more effective marketing strategies materialized through promotions, vouchers, etc.

In terms of financial performance, Nike is constantly growing, recording revenues of \$ 39.1 billion in 2019, which means an increase of 7% compared to 2018, when the company's revenues amounted to \$ 36.4 billion. About 42% of total revenue was generated by North America, 26% by Europe, the Middle East and Africa. 17% from China and 14% from the rest of Asia and Latin America. A Nike stock has risen from \$ 1.17 in 2018 to \$ 2.49 in 2019.

Analyzing human performance, it was found that the organization has more employees' promoters than detractors, a higher rate of salary competitiveness compared to the main player, Adidas and a very high employee satisfaction index. Nike believes that a skilled and involved workforce is the key to growth and sustainability. In their view, the employees involved means that they are valued and want to contribute positively and actively to business objectives.

To lead to such employees, Nike must ensure a safe work environment both physically and emotionally, with the active involvement of management to achieve this safe work environment. In order to be aware of the opinions, thoughts, emotions of employees, Nike has created a survey which is distributed in turn called "Engagement and Wellbeing Survey". Nike has been declared one of the top 100 companies to work for. Nike offers employee benefits such as fitness rooms on campus and discounts of up to 50% on company products. Employees can also bring their children and drop them off at one of the children's centers on campus.

Moreover, Nike is one of the most diverse companies in the world, in terms of ethnicity, religion, age, gender, etc.

In terms of environmental and social responsibility, Nike is taking drastic measures. By 2025, Nike aims to use 100% renewable energy, by 2020, Nike wanted 100% of the cotton used to be produced as sustainably as possible, to use more and more sustainable raw materials for both clothing production, as well as for the production of footwear and reduce carbon dioxide emissions greatly.

Since 2010, Nike has collected over 7.5 billion plastic bottles from fields and rivers, which it later turned into recyclable polyester and used in making clothes and shoes. Today, approximately 76% of Nike products in the clothing and footwear category are made from recyclable materials.

Transportation routes to and from distribution centers have been optimized to reduce CO₂ emissions by 30%, emphasizing Nike's commitment to building the greenest and most sustainable supply chain possible. Nike wants to transport its products in a sustainable way, thus reducing costs at the same time. Nike decided to transport its products on cargo ships in exchange for air transport.

Thus, it saved 8 million dollars in one year. With this change in mode of transport, Nike aims to reduce its environmental footprint by reducing carbon dioxide emissions by 30% by 2020.

7. Conclusions

Performance analysis is one of the main concerns of a company's management, because only by analyzing the activity and identifying problems in the processes can maximize profit. Thus, it is necessary to select the most appropriate methods according to the company's objectives.

The main tools for information management and analysis of the indicators detailed in this paper are: Balanced Scorecard, which aligns the company's activities with its vision, Benchmarking, through which you can identify strengths and weaknesses, the performance pyramid, which is focuses on external effectiveness and internal efficiency and the dashboard, which presents an overview of the company's results. At the same time, it is necessary to determine trends and predict future market requirements, in this regard being addressed certain methods such as logistic regression and extrapolation.

An effective analysis of an enterprise starts from key performance indicators (KPIs), which are the basis for decision-making. They aim to align with the objectives and take over the best strategies and practices.

Nike Inc. is one of the main manufacturers of sportswear and footwear, with the largest market share. Over time, this company has managed to create an unmistakable brand, which enjoys great respect among consumers. They have always known what is the best way to market and implement a new product in a certain market, they have gone through crises and critical moments for the company's existence, in the end to make Nike a well-known and desired brand by everyone.

Based on the analysis of key performance indicators and through the creation of the dashboard, we can say that Nike company is successful in selling its products and has a high degree of customer satisfaction.

For better and better financial performance and greater market share, Nike should focus its strategy on market and product development, diversifying them to target more customer segments. For better human performance, Nike should hire capable, healthy, diverse people and provide them with a work environment conducive to daily work, as well as beneficial benefits. This can be achieved by highlighting the already existing program of inclusion and social diversity, by offering competitive benefits and wages, but also by understanding and moral support when they need it.

To actively participate in the proper functioning of the community, they could donate 2% of their income to improve the environment or society, for example they could implement a program to encourage children between the ages of 7 and 12 to play more, to practice sports, etc. Another solution to increase the performance of Nike is certainly to reduce the

environmental footprint and reduce carbon dioxide emissions by using recyclable materials, by collecting old shoes and recycling them, by using recyclable energy, by reducing water waste, etc.

Notes

- (1) The Sale Report is an open-source dashboard software and it can be accessed from the following available address: <https://sealreport.org/>
- (2) The Dashbuilder software can be accessed from the following available address: <http://dashbuilder.org/>
- (3) The Grafana program can be accessed from the following available address: <https://grafana.com/>
- (4) The Datapine software can be accessed from the following available address: <https://www.datapine.com/>
- (5) For recommendations, suggestions or observations, you can contact the authors Ionuț Nica (ionut.nica@csie.ase.ro) or Ștefan Ionescu (stefion09@gmail.com).

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Economic policy uncertainty and adaptability in international capital markets

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Abstract. *This article has analyzed the association of economic-political uncertainty with efficiency in international capital markets. As the Adaptive Markets Hypothesis (HMA) points out, market efficiency may be affected by changes in market conditions. We understand that periods of economic-political uncertainty represent changes in the economic environment of countries. The capital market's efficiency level was obtained through Hurst's exponent, calculated based on the average performance indicators of stock markets belonging to 21 different economies. We got the political-economic uncertainty through an index representing the frequency of information regarding uncertainty made available in the countries' media from 2003 to 2018. After calculating Hurst's exponent in four-time windows, the regression method with panel data was used, with the cultural dimensions, inflation, and growth of the economy as control variables. The results point to a negative and significant relationship of economic-political uncertainty with market inefficiency. These findings denote periods of more significant economic-political uncertainty and tend to present less informational inefficiency. However, the global financial crisis results point to a positive and significant relationship between political uncertainty and market inefficiency. These results show that uncertainty increased the level of inefficiency, specifically in periods of recession. However, this picture has reversed over the years, which may represent that the economies have begun to adapt to these environments of uncertainty, thus corroborating capital markets' adaptability.*

Keywords: market efficiency; adaptive market; political uncertainty; cultural dimensions.

JEL Classification: G14, G15, G41, M14.

Introduction

In an ideal market, the securities traded price provides precise signals for the agents' best decision on how and where to allocate their resources (Fama, 1970). The Efficient Market Hypothesis (HME) indicates that security prices reflect available information, and the capital market is efficient enough to incorporate this information into its security prices (Fama, 1991; Beaver, 1998). For Hiremath and Kumari (2014), the arrival of new information in an efficient capital market quickly impacts securities' prices, which tend to incorporate it.

However, HME's assumptions cannot be thoroughly tested, as the statement that security prices reflect all available information is not accurate, given the possibility of abnormal returns, limited rationality, trading costs, and other information (Fama, 1991). Furthermore, one may argue that fear and greed drive the markets since they are not rational (Lo, 2004). Before this, the Adaptive Market Hypothesis (HMA) approach emerges. Through this approach, markets have frictions that determine their evolution over time (Hiremath and Kumari, 2014). In an adaptive market, market efficiency may decrease in a specific time and return when environmental conditions make resource allocation strategies more propitious (Urquhart and Hudson, 2013).

Thus, market efficiency accompanies changes in the environment, including competitiveness, available profit opportunities, and adaptability of market participants (Lo, 2005). In this sense, Noda (2016) states that market efficiency may arise periodically due to changes in market conditions.

As the HMA relates to the periodic variation in market efficiency through changes in market conditions and institutional factors (Ghazani and Araghi, 2014), factors such as political uncertainty and the economic environment may generate variations in market efficiency levels. We understand Political uncertainty as a probability of economic changes affecting the functioning of the market for its economic agents (Baker et al., 2016). Therefore, it is essential to understand that political uncertainty is related to periods of instability that the economy presents in specific periods (Antonakakis et al., 2013). Bordo, Duca, and Koch (2016) also corroborates the idea that political and economic uncertainty affects the decisions of market agents. In this sense, this hesitation about the future has implications for economic agents' behavior, resulting in distinct market behavior due to these levels of uncertainty in economic policy (Brogaard et al., 2015).

In their studies, Antonakakis, Chatziantoniou, and Filis (2013), Arbatli et al. (2017), Arouri et al. (2016), Baker, Bloom, and Davis (2012), and Brogaard et al. (2015) investigated the impact of the levels of economic policy uncertainty in capital markets, more specifically on the return and volatility of securities. The results pointed to a negative impact on the return and positive impact on stocks' volatility, concluding that the level of uncertainty in these economies generated an impact on the securities pricing.

This article aims to verify the association of the index of economic-political uncertainty with the levels of efficiency in international capital markets. Additionally, the work aims

to verify the relationship between cultural and macroeconomic variables with the efficiency of these markets. Studies selected for this research focus on the impact of uncertainty on securities' return and volatility (Antonakakis et al., 2013; Arouri et al., 2016; Baker et al., 2012; Brogaard et al., 2015), as well as the impact of uncertainty on macroeconomic factors (Arbatli et al., 2017).

Analyzing the uncertainty regarding the level of informational efficiency of markets becomes relevant to understand the impacts that periods of instability generate on stock price predictability, helping users in their decisions about resource allocations.

This study was motivated by the opportunity to analyze variables aggregated across countries, using cross-sectional and temporal cutouts between variables at the country level. Analyzing the existing interactions between variables that represent the political and economic adaptability and uncertainty of markets, which help to explain the level of efficiency of markets, is essential.

Efficiency and adaptability of capital markets

Market efficiency is a central feature of capital markets where prices tend to reflect available information (Beaver, 1998). When new information arrives in a market, prices respond and incorporate the available information.

According to the Adaptive Market Approach (HMA), the laws of natural selection determine the evolution of markets and institutions in markets that have frictions (Hiremath and Kumari, 2014). In an adaptive market, investment strategies may decline for a given time and return to profitability when environmental conditions become more conducive to such strategies (Urquhart and Hudson, 2013).

The HMA helps explain why stock returns' predictability arises over time; thus, a consequence of the HMA related to this temporal variation in market efficiency, which in turn has a connection with the transformations resulting from market conditions and institutional factors (Ghazani and Araghi, 2014). In this direction, Lim and Brooks (2011) highlight some factors that can generate inefficiencies in the market, such as the characteristics of the market microstructure, the limits to arbitrage, psychological biases, noise trading and the existence of market imperfections and phenomena such as cycles, trends, bubbles, collisions, manias.

Thus, it becomes crucial to analyze the various factors associated with the levels of information efficiency of various capital markets.

Economic-political uncertainty

Studies that address the interactions of economic policy uncertainty in several countries have existed for more than three decades, focusing mainly on the effects of political uncertainty on macroeconomic variables such as economic growth levels, inflation, and investments (Antonakakis et al., 2013). Arouri et al. (2016) affirm that recent political-economic events have renewed interest in the economic impact of political uncertainty, contributing to an increase in research on the effect of political shocks on economic variables.

Levels of political and economic uncertainty affect the decisions of households, companies, policymakers, and financial intermediaries (Bordo et al., 2016). In the view of Brogaard et al. (2015), uncertainty about the future has real implications on the behavior of economic agents; for this reason, market behavior is expected to change, given the levels of political uncertainty in specific periods. Arbatli et al. (2017) comment that studies on political uncertainty have come to call more attention in recent decades due to concerns about the European immigration crisis, the failed coup in Turkey, the results of the elections in the United States, the tighter capital controls in China, the presidential removals in Brazil and South Korea, and the populist political forces that happen in several other countries. Baker et al. (2016) developed the Economic Policy Uncertainty (EPU), which reflects the frequency of these terms found in major newspapers; Davis (2016) expanded this method of analysis of economic-political uncertainty to other countries.

Arouri et al. (2016) have provided evidence that an increase in political uncertainty significantly reduces the return on shares in U.S. firms. The study of Brogaard et al. (2015) found a negative correlation between changes in the EPU index and stock returns. Antonakakis, Chatziantoniou, and Filis (2013) concluded that the dynamic correlations of political uncertainty and stock market returns of U.S. companies are consistently negative.

Regarding the volatility of securities, Antonakakis, Chatziantoniou, and Filis (2013) and Arouri et al. (2016) pointed out that an increase in volatility is related to periods of increased political uncertainty. Arbatli et al. (2017) maintain that the EPU index varies positively with the volatility of Japanese companies' stocks, as well as with exchange and interest rates; and that political and economic uncertainty, in addition to influencing stock returns and volatility, also positively influences macroeconomic factors such as exchange and interest rates, causing these periods of uncertainty to increase. Political uncertainty influences the increase in volatility at the level of individual firms and leads to an increase in volatility at the aggregate level (Baker, Bloom, and Davis 2012). Volatility in stock prices is generally associated with the risks that exist in a business. Amihud and Wohl (2004) points out in his study that the increased uncertainty in the market amplifies the volatility of your firm's shares.

Materials and methods

This section deals with aspects related to sample selection, the choice of data collection sources, the constitution and definition of research variables, the choice of statistical tests required, and the definition of econometric models adopted in this paper.

Sample selection and data collection

This research sample consists of the countries present in the calculation of Economic Policy Uncertainty (EPU). The study of Baker et al. (2016) provides the methodology for the constitution of this index. Table 1 presents the countries that are part of the sample and the representative index of each stock exchange used.

Table 1. Countries and indexes employed in the study

Country abbreviation	Country	Index	Index abbreviation
AUS	AUSTRALIA	All Ordinaries Index	AOR
BRA	BRAZIL	Bovespa Index	BVP
CAN	CANADA	TSX Comp. Index	TSX
CHN	CHINA	Shanghai Share Index	SHBS
CHL	CHILE	IPSA Index	IPSA
SPN	SPAIN	IBEX Index	IBEX
FRA	FRANCE	CAC40	CAC
GER	GERMANY	DAX Index	DAX
GRC	GREECE	ATHEX Comp. Index	ATH
HKG	HONG-KONG	Hang Seng Index	HSI
IND	INDIA	SENSEX 30 Index	SNX
ITA	ITALY	FTSE MIB Index	FMIB
JPN	JAPAN	Nikkei 225	NKX
KOR	SOUTH KOREA	KOSPI Index	KOSPI
MEX	MEXICO	Mexican Bolsa Index	IPC
HOL	HOLLAND	AEX Index	AEX
RUS	RUSSIA	MOEX Index	MOEX
SGP	SINGAPORE	Straits Times Index	STI
SWE	SWEDEN	OMX Stockholm 30 Index	OMXS
UKG	UNITED KINGDOM	FTSE 250	FTM
USA	UNITED STATES	DJIA	DJI

It became necessary to establish an initial time cut from 2003 onwards, as some countries only made EPU data available. This study comprises data that represent, on average, 4,007 daily observations of the market's informational efficiency and the monthly data necessary to calculate the average economic policy uncertainty. Both the variable representing market efficiency and the variable representing political uncertainty were obtained, in daily or monthly cuts, and we converted both into annual cuts.

Hurst exponent – a proxy for market efficiency

The Hurst Exponent is a measure initially created by the hydrologist Harold Edwin Hurst, who developed the formula called Rescale Range to calculate the predictability of floods in the River Nile in the 1950s (Santos 2018). Later, we used the Hurst Exponent to measure efficiency and predictability in the stock market (Tzouras et al., 2015). Couillard and Davison (2005) claim that the Hurst Exponent provides information on long-term correlations in a time series. The study of Tzouras, Anagnostopoulos, and McCoy (2015) presents the steps to obtain the exponent of Hurst.

As pointed out in the study of Mandelbrot and Wallis (1969), the Exponent of Hurst has variation between 0 and 1, where: values $0 < H < 0.5$ denote negative long-term dependence; values between $0.5 < H < 1$ denote long-term memory; and values of $H = 0.5$ represent random walk of the series. However, in this study, the variation between -0.5 and 0.5 was used, with 0 being the central measurement of the series. Thus, in the analysis of this research, it is assumed that the market is more efficient when the index is closer to zero, and the further away – positively or negatively – from zero, it is assumed that the market efficiency decreases (Santos, 2018).

Research variables

The dependent variable comprises the Hurst Exponent (EXH) of the international stock market indices. The independent variable of interest is the level of economic-political uncertainty of the countries analyzed, represented by the EPU.

The main models in this research use only these two variables. However, to control the dependent variable's variations, the six cultural dimensions foreseen in the study of Hofstede (1980) were used, as well as the variables representing the macroeconomic environment of the respective countries (Table 2).

Table 2. Definition of independent variables and dependent on the second research

Variable	Definition
Dependent Variable	
Hurst Exponent (EXH)	Measure of efficiency and predictability in the stock market and ranging from -0.5 to 0.5 [21].
Independent Variable	
Economic policy uncertainty (EPU)	Frequency of information available in the media regarding economic uncertainty related to policies [10].
Control Variables – Cultural Aspects	
Power distance (PD)	Degree of tolerance to inequality in wealth and power indicated by a degree to which centralization of power is permitted [25].
Individualism (IND)	The degree to which individuals are integrated into groups in each society [26].
Masculinity (MSC)	A measure in which society places emphasis on male values of performance and visible achievement [25].
Aversion to uncertainty (AVU)	A measure in which people present discomfort with ambiguous or uncertain situations [27].
Long-term Orientation (LTO)	It represents the focus in which people will employ their efforts; it leads to a conservative behavior, focusing on the future [26].
Indulgence (IDG)	It represents a society that allows relatively free gratification of basic and natural human desires related to enjoying life [26].
Control Variables – Macroeconomic Environment	
Inflation (INF)	It represents the average inflation of the country in the study periods [20].
Gross Domestic Product Growth (GDP)	It represents the average GDP growth of the country in the periods of the study [20].

Statistical models and tests used in the study

For each of the regression models, we performed panel diagnostic tests to highlight which effect is most appropriate. The first model aims to verify only the relationship between economic policy:

$$|EXH|_{it} = \alpha_0 + \beta_1 EPU_{it} + \mu_{it} \quad (1)$$

The second regression model aims to verify the association of political uncertainty and the macroeconomic environment with market efficiency:

$$|EXH|_{it} = \alpha_0 + \beta_1 EPU_{it} + \beta_2 INF_{it} + \beta_3 PIB_{it} + \mu_{it} \quad (2)$$

The third model aims to verify the association of political uncertainty, cultural dimensions, and the macroeconomic environment with market efficiency:

$$|EXH|_{it} = \alpha_0 + \beta_1 EPU_{it} + \beta_2 DP_i + \beta_3 IND_i + \beta_4 MSC_i + \beta_5 AVI_i + \beta_6 OLP_i + \beta_7 IDG_i + \beta_8 INF_{it} + \beta_9 PIB_{it} + \mu_{it} \quad (3)$$

We estimated six more models in this study, all with the same configurations of the Models presented previously. The differences between Models 4, 5, 6, 7, 8, and 9 consists only in their periods and the impact of the financial crisis (2007 to 2009).

Models 4, 5, and 6 refer to the period from 2003 to 2006/2010 to 2018. Models 7, 8, and 9 refer to the period from 2007 to 2009, which comprises the same configuration of the respective Models 1, 2, and 3.

Besides, results were generated for the immediate post-crisis period, comprising the same number of years of the crisis (2007 to 2009). Models 10, 11, and 12 represent the same configurations as Models 1, 2, and 3, however, for the specific period immediately after the crisis (2010 to 2012). We have used Stata® 11.0 statistical software to obtain the results of this paper.

Results and discussions

This section presents the detailed results, the results of the validation tests of the regression models, and, finally, the interactions between the variables through the regression tests.

Results of the descriptive statistics

Table 3 shows the values referring to the main descriptive statistics of the variables.

Table 3. *Descriptive statistics of the sample*

Variable	M	Mdn	Min	Max	SD	CV
EXH	0,0758	0,0701	0,0003	0,2377	0,0511	0,6739
EPU	124,29	112,35	27,00	460,47	59,21	0,4764
PD	57,62	60,00	31,00	93,00	17,70	0,3072
IND	52,76	48,00	18,00	91,00	25,28	0,4791
MSC	51,48	56,00	5,00	95,00	19,73	0,3833
AVU	62,33	65,00	8,00	112,00	27,21	0,4365
LTO	56,86	52,90	21,16	100,00	22,20	0,3904
IDG	50,59	47,77	16,96	97,32	21,37	0,4223
INF	2,78	2,21	-2,67	15,53	2,68	0,9630
GDP	2,76	2,55	-9,13	14,53	3,27	1,1851

On average, the dependent variable – EXH – has a relatively low value (0.0758), showing that countries are closer to information efficiency than to inefficiency. About the variable that represents the political uncertainty – the EPU – the average value is 124.29. The minimum and maximum values comprise the interval between 27.00 and 460.47. Regarding the dispersion measures, we can observe that the market efficiency presents standard deviation and coefficient of variation with values of 0.05 and 0.67, respectively. When comparing these data with the political uncertainty, one notices that these data are low.

Additionally, it becomes essential to verify if the independent variables used in this research present strong correlations among themselves. In Table 4 are presented the correlation results between the variables.

Table 4. Correlation matrix of the variables of the second research

EXH	EPU	PD	IND	MSC	AVU	LTO	IDG	INF	GDP	
1,00	-0.10*	0.21***	-0.24***	0.01	0.02	0.01	-0.12**	0.18***	0.03	EXH
	1,00	0.09*	-0.02	0.03	-0.00	0.17***	-0.20***	0.01	-0.13**	EPU
		1,00	-0.76***	0.08	0.20***	0.21***	-0.44***	0.50***	0.34**	PD
			1,00	-0.01	-0.16	-0.35**	0.40***	-0.22***	-0.33***	IND
				1,00	0.09*	0.03	-0.18***	-0.09*	-0.02	MSC
					1,00	0.03	-0.03	0.12**	-0.36***	AVU
						1,00	-0.69***	-0.05	0.13**	LTO
							1,00	-0.16***	-0.23***	IDG
								1,00	0.18***	INF
									1,00	GDP

Note: This table reports the results referring to the correlation tests of the independent variables of the study. Correlation coefficients, using all observations 1:01 – 21:16.5% critical value (bicaudal) = 0.1070 for n = 336. ***, ** and * correspond to the statistical significance at the levels of 1%, 5%, and 10% respectively.

Regarding the dependent variable, there is a significant association of low efficiency with political uncertainty, distance from power, individualism, indulgence, and inflation. We performed tests to verify if the errors present heteroscedasticity, normality, and autocorrelation. In all models, rejected the null hypothesis of the absence of heteroscedasticity. We corrected this problem with the regression model we have adopted.

Panel data regression

Table 5 provides results for Models 1, 2, and 3.

Table 5. Regressions of the dependent variable EXH for the total period (2003 to 2018)

Variable	Model 1	Model 2	Model 3
Constant	0.0891 (0.000)***	0.0964 (0.000)***	0.1783 (0.000)***
EPU	-0.0001 (0.013)**	-0.0001 (0.002)***	-0.0001 (0.019)**
PD			-0.0001 (0.525)
IND			-0.0006 (0.000)***
MSC			0.0001 (0.755)
AVU			-0.0001 (0.171)
LTO			-0.0003 (0.054)*
IDG			-0.0004 (0.050)**
INF		0.0037 (0.100)*	0.0028 (0.033)**
GDP		-0.0034 (0.001)***	-0.0021 (0.037)**
R ²	0.0178	0.0620	0.1131
N	336	336	336
Panel Effects	Random	Fixed	Grouped

Note: Constant values outside the brackets represent the regression coefficients, values within the brackets represent the p-value and ***, ** and * correspond to the statistical significance at the levels of 1%, 5%, and 10% respectively. We corrected all models using the vce(robust) Stata command.

The results presented in Table 5 show that, in all models, negatively related to the variable representing the economic-political uncertainty to the low efficiency of capital markets.

The EPU variable is negatively associated with the levels of 1% and 5% with the EXH variable showing that, in periods of high political uncertainty, the market tends to be more efficient, and that, in periods of low political uncertainty, the efficiency levels are lower. In general, we not expected the results since we expected that the uncertainty related to periods of political-economic instability was determinant of the low efficiency of capital markets. It is noticeable that the relationship is maintained even when others we inserted factors explaining market efficiency, such as the cultural and economic aspects of each economy.

These findings provide possible evidence of irrational exuberance of market participants since even if the environments present high political uncertainty, observed through the EPU variable, the participants of these markets react positively with reflexes in the observed efficiency. Shiller (2000) points out that the market can exaggerate concerning the financial assets traded, being optimistic at inappropriate moments. Thus, the individual may be presenting an irrational manner, an optimism that does not represent the real situation in which the economy was inserted.

It should be observed that, in markets and periods with higher inflation rates, there is less information efficiency, through the positive and significant relationship between the INF and EXH variables at the 5% level. We also observed that in economies with low GDP growth, there is less efficiency, while in economies with high GDP growth, there is greater efficiency. Both results regarding the macroeconomic environment are satisfactory, considering that periods of inflation generate uncertainty that influence the reduction of efficiency and that a low GDP represents a reduction in market efficiency.

The results regarding cultural aspects indicate that aspects such as Individualism (IND), Long Term Orientation (LTO), and Indulgence (IDG) are negatively related to the levels of 1%, 5%, and 10% with low market efficiency. We understand that these cultural and behavioral aspects of individuals belonging to these economies help explain the variation of efficiency in these capital markets, showing that:

- a) Markets where individuals are less integrated into groups, are more individualistic, there is greater informational efficiency.
- b) Markets with more conservative behaviors, focusing on the future, also have higher efficiency.
- c) Markets with more indulgent individuals, with fewer restrictions and regulations, efficiency is also increased.

These results help to understand that several factors related to political uncertainty, economic environment, and cultural aspects of individuals determine the levels of informational efficiency in capital markets.

To provide greater robustness to the results obtained, the same tests, now evidenced, were made in a time cut that comprises the years adopted in this research, except for the global financial crisis – 2007 to 2009. Thus, Models 4, 5, and 6 shown in Table 6 have the same configurations as Models 1, 2, and 3; however, this is analyzed from 2003 to 2006 and 2010 to 2018, excluding from the base the recession periods.

Table 6. Regressions of the EXH dependent variable for the period without crisis (2003 to 2006 and 2010 to 2018)

Variable	Model 4	Model 5	Model 6
Constant	0.0881 (0.000)***	0.0801 (0.000)***	0.1577 (0.000)***
EPU	-0.0001 (0.006)***	-0.0001 (0.009)***	-0.0001 (0.065)*
PD			-0.0003 (0.300)
IND			-0.0005 (0.003)***
MSC			0.0001 (0.963)
AVU			0.0001 (0.553)
LTO			-0.0004 (0.043)**
IDG			-0.0003 (0.130)
INF		0.0038 (0.225)	0.0022 (0.146)
GDP		0.0002 (0.855)	0.0010 (0.452)
R ²	0.0192	0.0480	0.1060
N	273	273	273
Panel Effects	Random	Fixed	Grouped

Note: Constant values outside the brackets represent the regression coefficients, values within the brackets represent the p-value and ***, ** and * correspond to the statistical significance at the levels of 1%, 5%, and 10% respectively. We corrected all models using the `vce(robust)` Stata command.

We may observe from the results shown in Table 6 that by excluding periods of the financial crisis, there is a similarity with the results presented above about the research total period. In general, in periods without crisis, the negative relationship between political uncertainty and low market efficiency is maintained. The results regarding the cultural aspects of individualism and a long-term orientation maintain a negative and significant relationship with low market efficiency. In this time cut, the variables related to the cultural aspect of indulgence and the macroeconomic aspects – inflation and GDP – have lost their significance.

The study presents results for three more models that comprise the same configurations of the previous models, but for a more specific time cut. Antonakakis, Chatziantoniou, and Filis (2014) comment that during the Great Recession – 2007 to 2009 – the repercussions of political uncertainty increased in the economies.

Benati (2013) also states that the macroeconomic impact of the political uncertainty on the financial crisis from 2007 to 2009 substantially delayed the recovery of several countries' economies. Therefore, the results presented in Table 7 have the same configurations as Models 1 to 3, but from 2007 to 2009.

Table 7. Regressions of the EXH dependent variable for the period of financial crisis (2007 to 2009)

Variable	Model 7	Model 8	Model 9
Constant	-0.0099 (0.580)	0.0289 (0.092)*	0.1586 (0.031)**
EPU	0.0010 (0.000)***	0.0007 (0.001)***	0.0005 (0.000)***
PD			0.0001 (0.940)
IND			-0.0008 (0.029)**
MSC			-0.0001 (0.947)
AVU			-0.0003 (0.061)*
LTO			-0.0004 (0.227)
IDG			-0.0006 (0.121)
INF		-0.0001 (0.958)	0.0022 (0.237)
GDP		-0.0064 (0.000)***	-0.0045 (0.001)***
R ²	0.4091	0.6322	0.4647
N	63	63	63
Panel Effects	Fixed	Fixed	Grouped

Note: Constant values outside the brackets represent the regression coefficients, values within the brackets represent the p-value and ***, ** and * correspond to the statistical significance at the levels of 1%, 5%, and 10% respectively. We corrected all models using the vce(robust) Stata command.

The findings now show a positive relationship between political uncertainty and low market efficiency. In the models, the variable that analyzes the relationship between political uncertainty and low market efficiency denotes a positive and significant relationship, thus contradicting the previous results, which provided evidence of negative relationships. Thus, we noted that the financial crisis period presents adverse results to those of periods without crisis.

The results of these models show that political uncertainty is associated with low efficiency through a positive and significant relationship. These results are following the study of Benati (2013), which points out that in the period of the Great Recession, political uncertainty was a factor that aggravated the recovery of the economies.

Thus, for the specific period of the global financial crisis – 2007 to 2009 – the results began to make greater sense, since in periods of high political uncertainty, the capital market tends to be less efficient due to the increase in short- and long-term dependence in the series, thus affecting market predictability, as the hypothesis of this research points out.

Additional testing of the post-world financial crisis period

Further analysis of the post-global financial crisis period is relevant: from 2007 to 2009. As this research suggests that markets are adaptive – and the findings evidenced in the previous subsection indicate that in total, non-crisis and post-crisis periods political uncertainty is associated differently, depending on the period that the country is following – it is essential to investigate whether the markets, in the first years after the crisis, are adaptable.

Table 8 shows the same immediate period after the financial crisis, comprising the years 2010 to 2012, containing the same number of observations of the previous regression (N = 63).

Table 8. *Regressions of the dependent variable EXH for the post-financial crisis period (2010 to 2012)*

Variable	Model 10	Model 11	Model 12
Constant	0.0575 (0.002)***	0.0393 (0.103)	0.1675 (0.003)***
EPU	-0.0001 (0.834)	-0.0001 (0.991)	0.0001 (0.443)
PD			-0.0006 (0.144)
IND			-0.0009 (0.005)***
MSC			-0.0001 (0.308)
AVU			0.0002 (0.270)
LTO			-0.0004 (0.138)
IDG			-0.0004 (0.203)
INF		0.0039 (0.036)	0.0023 (0.372)
GDP		0.0007 (0.731)**	0.0007 (0.714)
R ²	0.0053	0.0732	0.3339
N	63	63	63
Panel Effects	Random	Random	Grouped

Note: Constant values outside the brackets represent the regression coefficients, values within the brackets represent the p-value and ***, ** and * correspond to the statistical significance at the levels of 1%, 5%, and 10% respectively. We corrected all models using the `vce(robust)` Stata command.

The results for these three models show mainly that the independent variable of interest (EPU) loses statistical significance. The results also show that, in the period of the global financial crisis, political-economic uncertainty reduced the efficiency reported by the capital markets. After the period of crisis, the market adapted to a level at which the aspect of political uncertainty was no longer significantly influenced market efficiency.

We observed other relevant information regarding these two periods more descriptively. In the three years of the global financial crisis, from 2007 to 2009, the average reported by Exponente de Hurst, proxy, representing the low level of efficiency, was 0.0953. In the post-crisis period, which comprises the three years after the crisis, from 2010 to 2012, the capital markets showed an average Hurst Exponent of 0.0543, thus providing evidence that after the crisis, the international markets increased their reported levels of efficiency. These findings show that the market adapted to a different level after the financial crisis when uncertainty was no longer an essential factor associated with the level of efficiency in the markets, as well as the increase in the level of efficiency, which shows that these economies adapted and recovered to different levels after the global crisis.

Discussion of results

A possible explanation for the change in the signal of the interaction between the variables representing the political-economic uncertainty may represent possible adaptability of

capital markets to periods of political uncertainty and financial crisis. We observe that in the initial years was negatively affected by reducing efficiency in periods of uncertainty and started to present a positive relationship if considered the whole period, by increasing efficiency in periods of political uncertainty.

This result shows that markets adapt to changes that occur continuously, and the information starts to impact differently as markets get used to it, and that, in this case, is the political-economic uncertainty. The loss of significance in the relationship between uncertainty and efficiency soon after the crisis may indicate that markets have adapted at different levels, representing a degree of recoverability through increased efficiency and a lack of uncertainty on their degree of shareholder predictability.

Another explanation for these findings may also have support in the irrational exuberance of Shiller (2000), which points out that the optimistic outlook of market participants tends to end through actual events, not related to the irrational exuberance in the stock market and, as an example of events that end with the irrational exuberance of the markets, financial crises stand out. As in the period before and after the world financial crisis, the markets are efficient in periods of political uncertainty and only start to present low efficiency in the specific period of the world financial crisis, this result has some support in the irrational exuberance of Shiller (2000).

The results regarding the cultural aspects provide more evidence of the adaptability of capital markets, since, in periods of crisis, only the dimensions of Individualism (IND) and Aversion to Uncertainty (AVU) were significant with the efficiency of the markets, since the characteristics of the culture that relate to efficiency change from time to time, representing more evidence of the adaptability of capital markets.

The negative relationship between the aversion to uncertainty and the low efficiency of the markets shows that there is greater efficiency in economies where there is more significant discomfort with uncertain situations. This result may be related to the positive relationship between political uncertainty and low efficiency, as it is highly understandable that economies with an aversion to uncertainty, at times when the market presents high political uncertainty, individuals tend to react negatively to information, causing efficiency to decrease. Therefore, since it is significant only in the first years of the analysis, the aversion to uncertainty is related to the positive association of political uncertainty and low efficiency.

The agents that participate in these markets, when adapting to the new information and the constant moments of uncertainty, do not take into account the aversion to uncertainty in market interactions and this may be related to the negative reflection that political uncertainty starts to present in the level of efficiency, causing these periods instead of affecting, negatively, efficiency to affect, positively, through the increase in efficiency in the markets. This attitude indicates that individuals in the financial markets adapt to changes in the markets.

Finally, this study highlights that the conclusions regarding the unexpected results in the non-crisis period and the results obtained in the crisis period are valid only for the specific period analyzed, i.e., between 2003 and 2018.

The effects that political uncertainty presents to market efficiency – sometimes negative, positive, or absent – show that market participants adapt to the phenomena of political uncertainty according to the situation in which the market is experiencing. After all, the market reacts differently to the same phenomenon because of the adaptability of market participants.

Thus, it is understood that there is an association of the political uncertainty of countries with the levels of efficiency of their market indicators, which is supported by the idea that markets are adaptive and work cyclically, with levels of efficiency continually changing and being dynamically explained by several factors, as stated Lo (2004) and Lo (2005).

Therefore, the periods are essential in determining the association or not, between uncertainty and efficiency, and thus it is essential to reaffirm that these results are valid only for the research period in question.

Conclusions, limitations, and suggestions

According to HMA, given markets' frictions, efficiency levels can be affected as a result of factors that vary from time to time generating, for a period, the inefficiency of these markets that subsequently return to optimal efficiency, according to the adaptability characteristics of their users.

Therefore, market efficiency is affected by market changes. In this direction, this study used an index that measures the level of political uncertainty in capital markets, as it represents a factor present in recent years in the world economies and also represents an aspect that comprises a market change that can affect its efficiency. Therefore, this study aimed to verify the association of economic-political uncertainty with information efficiency in international capital markets.

Our result provides an important finding, which corroborates the idea that market participants adapt to changes in economic environments. Like Lo (2005) states, the level of market efficiency depends on the adaptability of market participants. Initially, when periods of uncertainty began to appear strongly, market participants were not prepared for these environments, and there was a reduction in the efficiency of these markets. However, market participants have adapted to these periods of uncertainty over the years, using the uncertainty of these environments favorably, with positive effects on efficiency.

These results are also related to particularities of individuals' culture, since the aspects related to their behavior are more present in specific periods, corroborating the HMA.

Another critical finding references the irrational exuberance that the capital markets present, and that is related to the market's exaggerated optimism regarding the perspectives of a specific society. The findings provide evidence that market indices tend to be more efficient in times of political and economic uncertainty, except in periods of the financial crisis, when this uncertainty is now associated with the observed efficiency reduction. These results are supported by the irrational exuberance of Shiller (2000), which states that there is an exaggerated optimism of market participants regarding the financial assets traded, and this optimism tends to end in moments of the financial crisis.

The results generally present evidence that Individualism (IND), Long Term Orientation (LTO), and Indulgence (IDG) are positively related to efficiency; more individualistic, more conservative, and less restricted societies tend to be those with more efficient capital markets.

Finally, countries with higher inflation rates (INF) tend to be less efficient, just as societies with lower GDP growth are less efficient. In general, this research presented a broader picture of aspects related to market efficiency, providing evidence that markets adapt both to changes in institutional and economic factors and factors in the behavior of market participants.

One limitation of the study was related to the use of a few control variables, mainly those related to macroeconomic factors. Another limitation of the study is that by using only annual clippings, given that the variable representing the political uncertainty is monthly.

For future research on the same subject, we suggest that factors such as taxes, regulatory strength, among others, that can explain the efficiency of the markets be used. We also suggest it used half-yearly or quarterly data to increase the number of observations in the sample.

Acknowledgements

We thank all those involved in the construction of this article, who provided some support for its growth. We especially thank Professors Paulo Lustosa, Fabiano Guasti Lima, and Clayton Melo for their significant contributions.

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Is the creation of major objectives in the European Union an objective that may constitute a challenge for the Member States of the European Union?

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Abstract. *In 2021, the issue of supporting the Member States for the European Union to ensure the transition to a normal economy as soon as possible, deeply affected by the health and economic and financial crisis. However, it is necessary to launch major objectives at Community level that give consistency to economic recovery. The approach in this article is also in this context.*

The Member States of the European Union aim individually and at the same time in a complex way to achieve superior results, in order to ensure sustainable economic growth, which would be the main factor in improving living conditions. In this sense, that of the economic growth of the European Union and of all the Member States, it is important to initiate economic objectives with the participation of as many Member States as possible. At the same time, the individual development of each stratum is important so as to ensure harmonized growth in order to pursue the second objective, which is to bring the level of economic growth closer to all Member States.

Member States' individual investments, as well as those harmonized in the context of economic objectives, are the steps by which this challenge could be achieved, could be met. There are enough contradictions in the European Union, in the sense that some states that have entered the last tranche or the last stage in the European Union, have yet to set a series of individual objectives to ensure the elimination of dysfunctions and consequently, creating a harmonization of economic developments.

The question is whether the European Union is an appropriate framework, so that actors and partners can look with confidence and confidence to achieve major goals. The example of Brexit is one that brings a new possibility of insecurity, in the sense that the United Kingdom leaves a gap in terms of individual participation in the Community budget. Under these conditions, it is likely that the annual and multiannual budget will be slightly smaller and the lack of Great Britain in the entourage of the Member States will be able to be covered only by a sustained activity on multiple levels by the Community countries.

There are a number of objectives in the European Union's strategy that must be pursued in full accordance with the national strategies of the Member States. Only a harmonized policy can ensure a development closer to the aspirations and wishes of the Member States. The European Union is also manifested in a series of contradictions that exist between some Member States, which arise between what each Member State pursues and the global policy promoted by the European Union. In this regard, in this article we will seek to identify those points that may be positive aspects of harmonization of efforts or that are discordant and should be eliminated in order to reach a possibility of correlating the intentions and measures taken, so that it can be achieve some of the challenges facing the European Union. It should also be noted that between the United States and the European Union in economic, trade, tourism there are some different positions that can have an effect on the development of the European Union and its Member States within it.

Keywords: European Union, economic objectives, challenges, economic growth, harmonization of economic growth.

JEL Classification: F02, F40.

Introduction

The Member States of the European Union aim individually and also through the Union's strategy to achieve economic growth as consistent as possible by capitalizing on the internal potential of each country, but especially by initiating large-scale economic objectives to be achieved bring as many Member States as possible.

The European Union has directives in this regard, suggesting that economic objectives must consist in the initiation of economic objectives based on advanced technology, which will ensure consistent economic growth. These are priority areas in which this individual and communal research of the Member States needs to be directed. Thus, in the field of energy there are limitations in terms of current resources, but which must on the basis of an extensive study and research program lead to the discovery of new resources, to the expansion of existing ones, so that in the context of coal resources, oil and gas are depleted over time, to provide a replacement based on other energy sources, so as to ensure the potential of the European Union.

Individual investment by Member States can play an important role in this area, but at the same time other objectives may be to work together between Member States, to ensure more consistent funding and to meet the conditions facing all mankind. I said about energy resources, food resources, the exploitation of land fertility in countries that have a penchant for this possibility of evolution, is another goal. There is also high potential in the field of transport and other areas. The efforts of several Member States must be combined in order to increase the technological potential, adjust the industry and other branches of national economies, the technological conditions offered by the present, but especially the future based on extensive research, which can be triggered.

There are a number of objectives in the European Union's strategy that must be pursued in full accordance with the interests and strategies of the Member States. This relationship between the European Union and the Member States is unequivocal in the sense that the Member States must also adjust their investment and development strategies according to the conditions and guidelines that the European Union launches in this regard. We can point out that only a harmonized policy in the field of multi-level research can provide potential in increasing the prospect of initiating objectives, let's say quite important, which will lead to the growth of the economies of all states.

We must also take into account the possibility of cooperation between the European Union as an entity of all the Member States and the other states that have great potential, with which we can work in multiple directions to achieve the objectives we were talking about.

At this point in the study, to the question *is the creation of major objectives in the European Union an objective that can be a challenge for the Member States of the European Union?* Yes but only through a coherent, well-developed European Union strategy and at the same time through the widest possible participation of the Member States, both in the development of their own research and innovation and in the participation of to the development of research and innovation within the European Union.

Literature review

In the development strategy of the European Union, the directives highlight the need to make better use of resources, technological development, the prospect of initiating major objectives, so that member countries achieve better and consequent results and consequently the European Union is in line with this pace of progress and ensuring additional income in order to achieve the goal of ensuring a higher standard of living. The issue of these challenges for Member States to start new projects is addressed extensively in the literature. Analyses, interpretations and attempts are also made to identify the current situation, especially in which the European Union and the Member States, as well as all the countries of the world, are facing a major pandemic coronavirus crisis, which will have particularly serious effects in the context of it will be combined with the effects of the economic and financial crisis, it will produce great disturbances and especially reductions of the individual economic development.

A number of authors, respectively Anghelache (2013) made a comprehensive analysis of the evolution of the national and world economy under the effect of the crisis that was in 2008-2010, foreshadowing the prospect of new delicate situations in the current context of the coronavirus pandemic crisis and especially in the perspective of the economic and financial crisis be long lasting.

Anghelache and Anghel (2017) and Anghelache, Anghel, Diaconu, Badiu, and Niță, G. (2016) they focused on using the possibilities of the evolution of the member states, in a concrete case of Romania after ten years from the accession, in the conditions in which they still felt the effects of the economic-financial crisis from 2008-2010. A number of models have also been suggested that can be used to identify the development prospects of a country's economy, but also of the European Union economy as a whole.

Anghelache, Soare, and Dumitrescu (2016) they extended an analysis on the platform used in the financial projects that can be carried out in the individual interest of the engaged countries, but also of the European Union.

Barbosa and Faria (2011) stresses that innovation must be a key, factor in the technical and scientific development and economic consequences of the European Union.

Berezin and Diez-Medrano (2008) in their work they focus on the need for a legitimate policy to support European integration.

Chalmers (2013), addresses the issue of information strategy as a need to support the practical application of advanced technologies.

Dachs and Pyka (2010) it refers to an answer to be given to the question of where the innovation is headed.

Farole Rodríguez-Pose, and Storper (2011) refers to the need for political cohesion in the European Union, so that regional development is a priority objective, through the implementation of projects aimed at reducing the differences that exist between Member States.

Goldberg and Pavcnik (2007) extends its analysis to the process of globalization, which at the present time of the two mentioned crises seems to be out of the picture, but which must nevertheless be considered as a variable to ensure further economic growth.

Lane (2006) addresses the issue of the effects of the European Monetary Union, which creates advantages for some Member States and makes other Member States somewhat difficult, from which point of view there are some difficulties for the participation of states with limited financial resources or low technological potential in large European projects.

Lima and Cardenete (2007) considers the role and effects of European funds which are likely to strike a balance in the development of the Member States and to lead to their greater participation in the initiation of major projects.

Tosun (2014) and Voigt and Moncada-Paternò-Castello (2012) addresses issues relating to the importance of the absorption of regional funds by the Member States, as well as to the prospect of intensive growth of the economies of the Member States of the European Union. The question arises as to whether the structure of the European Union can be considered in order to take action through some projects to ensure the approximation of the Member States' level of development.

Methodology

In the study we aimed to use a series of research methods, to extract the essence from the data series we took from the European Union, to analyse from the future perspective the proposals for evolution and development of the European Union in accordance with the approved strategy by 2030. The term appears longer, but no longer in a perspective in which the pillars of a complex research program are put in place, solutions can be obtained based on which to initiate large-scale economic and social objectives, which will have the effect on the one hand, economic growth of all Member States and the European Union at the same time, but also of social and consequent conditions of increasing incomes and improving the quality of life.

We used the methodology of the comparative study that put us in possession of ideas for future evolution, but taking into account the concrete conditions that are currently encountered. We have also made extensive use of induction and deduction, exploring the resources available to the Member States of the European Union, trying to identify the major needs that Member States and the European Union as a whole strictly need, but also more broadly in terms of regarding the exchange and extension of research with other non-EU states.

We have widely used data series, graphical representations, evolution based on dynamic models, but also spectral models that can highlight at the inauguration of projects if they are seasonal, cyclical and how they can influence to some extent more or less the evolution of the development of the Member States of the European Union.

From a methodological point of view, we used interpolation and extrapolation syntheses of data series, as well as estimating the evolution perspectives of some fields of activity using statistical-econometric methods that led us to obtain parameters used to estimate the future perspective.

As I mentioned, an important thing is the research, innovation and complex development of the European Union, but also the individual of all the Member States associated in this context in the perspectives offered by the European Union.

Data, results and discussions

Any economic objective that is set in motion must continue to benefit from new funding opportunities in the first place. That is why the theory of the existence of two speeds of development of the European Union in the field of research and innovation and consequently of development, can actually be combated by major projects that can be initiated by Member States.

Of course, going and adapting the research topic to the current conditions, we specify that the objective is a challenge for the Member States of the European Union, but it is not easy, unfortunately becoming more and more difficult in the current context determined by two major events.

Firstly, Brexit will have an effect on the prospects of launching major targets as the United Kingdom of Great Britain and Northern Ireland had a rather delicate word to say in initiating such targets. On the other hand, the sanitary pandemic crisis (coronavirus) is likely to hamper the prospect of initiating major objectives, primarily due to diminished funding resources of individual member countries, but also of the states included in the European Union.

Of course, without a doubt, for a period of time, the health crisis will evolve in conjunction with the economic and financial crisis that is in progress and with negative effects for the future. However, the problem is even more acute for the Member States to join forces, for the European Union's leading institutions (the Council, the European Parliament) to review the development strategy, adapt it to current conditions and identify additional development resources during the period next. Undoubtedly, the development of research and innovation, the progress of multilevel progress with the combined efforts of all Member States, is all and perhaps the basis for these evolutionary opportunities

Starting from what I mentioned in the introduction, it follows that the European Union has now entered a cone of uncertainty due to the effects of Brexit and especially the crisis caused by the coronavirus pandemic, which will be followed by an economic and financial crisis perhaps unprecedented.

Based on studies of data series and individual developments in the Member States, it is anticipated that in 2020 there will be many falls in the area of total and structured growth. A number of phenomena such as unemployment and inflation, which are detrimental to

economic growth, will have a much more consistent effect in the coming period. We anticipate on the basis of the results obtained by regression functions that the level of unemployment may be more than double at the end of 2020, of course, with a not very uniform distribution among the Member States. The countries that entered the European Union after 2004 and left with a lower level of development economy, which do not have sufficient resources for major investments and thus do not have the opportunity to absorb unemployment will be most affected. Inflation, rising prices, whether it is the consumer price index or the harmonized price index, will have a destructive effect on the economy of most Member States.

The problem of retraining remains only theoretical, as the economies of the member countries are restructuring their ability to create jobs in another field, being positive and only if they could resume work in all areas of the economy gradually.

Simultaneously with the reduction of production potential, the reduction of agricultural incomes as a result of a subsidy not exactly at the level of needs, as a result of the cyclicity in a year 2020 which is affected by an unprecedented crisis, the reduction of tourism and other activities.

As a result of strategies to stop the infection of the population with the COVID virus 19, will lead to additional costs and thus reduce the individual and global sources of the European Union in terms of improving research, innovation and development and consequently even the initiation of large-scale objectives. There may be some possibilities to reconsider the role of the European Union in the context in which each Member State will primarily want to secure financial resources, to attract more financial resources in order to return to macro stability. Macro stability will be seriously affected by the effects of the economic and financial crisis.

That is why the EBRD (European Bank for Reconstruction and Development), the International Monetary Fund, the World Bank should reformulate their strategies a little in order to be able to provide sources of financing for major projects. Here an important role belongs to the European Union, which through its own strategy ensures the perspective that at least for the common objectives that can be identified by the Member States and triggered, to obtain cheaper, more attractive sources of financing in order to make progress wanted.

We are currently witnessing, at least in the geographical area of Eastern and Central Europe, differentiated interest rates that Member States obtain from the banking system, either nationally or in Europe.

Thus, Romania pays an interest of 3%, Bulgaria of 0.2%, Poland of 0.77%, Serbia of 0.8%, Hungary of 1.2%, these are figures taken a little behind and maybe more changed over time. These conditions do not ensure equality between Member States wishing to participate in projects and to finance their projects in part, as appropriations are no longer a major source of funding for projects in some countries.

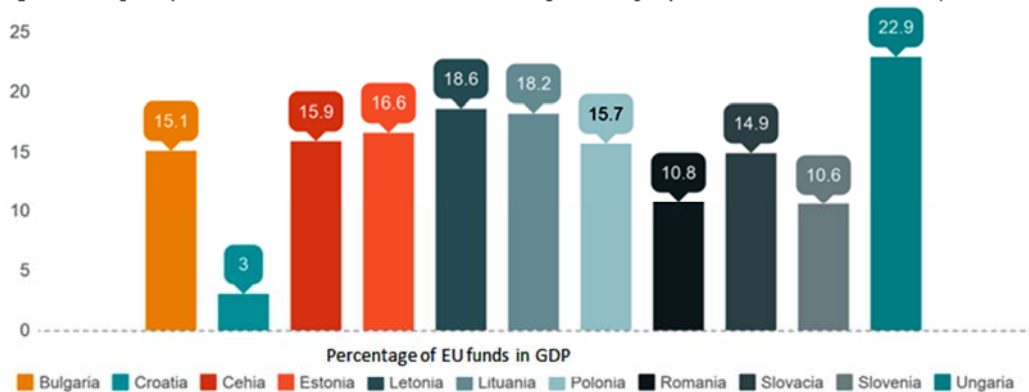
Therefore, we believe that the European Union should make a complex analysis of this situation in the program of projects and objectives to be achieved to address the issue of uniform funding, from own funds or from attractive sources, which should then be provided to Member States, Member States as an attractive source of funding. Of course, the European Union can participate directly even by allocating resources from the annual and multiannual budget to finance major investment projects.

The multiannual financial framework 2014-2020 and 2021-2027 must provide sources of funding so as to ensure the economic growth of the Member States. There is a need for projects in transport infrastructure, environmental projects, projects on the rehabilitation of historical and cultural sites, expansion of utility infrastructure in urban areas, but especially in rural areas. Projects on human resource development must be initiated through the active involvement of the population in the labour market, the development of skills in this regard to ensure the most consistent development in each country. Research projects need to be launched and some objectives set out to reduce the gap between village and city, especially in some Eastern European countries. The implementation of e-government solutions or ICT infrastructure investments must be considered.

The previous financial framework 2007-2013 took place in parallel with a global financial crisis and the effects were seen. In the perspective of 2020-2027 or 2030, it seems that we will again have to bear the effect of another economic and financial crisis that will be reflected in the evolution of the Member States, not only in the European Union, but in the world, which will have a combined effect of reducing economic growth.

The current state must allow the completion of the research, development, innovation project 2014-2020 and ensure the perspective of their evolution. Graph 1, regarding the European funds allocated to the Member States as a percentage of the Gross Domestic Product until 2019, shows that the stars also had different allocated funds available.

Graph 1. European funds allocated to Member States as a percentage of Gross Domestic Product by 2019



Source: Eurostat (data are processed by the authors).

Most of the funds are aimed at improving living standards and living standards, so that by 2025 it will increase by an average of up to 25% in most Member States. It is difficult, but

action must be taken. European co-financing remains an essential element for the development of the Gross Domestic Product, so for the economic growth in each country, but also for the provision of resources to be used by the Member States in initiating other projects that ensure on the one hand the approach of the development level at the top of the developed countries in this respect, but also individual and complex advantages for all Member States.

Table 1 presents some statistical data on the multiannual financial framework (MFF) in the period 2013 to 2019.

Table 1. *Multiannual financial framework (MFF) in the period 2013-2019*

ECE Member State	Population (millions)	GDP Billion Euro	GDP per capita Euro	EU funds Billions Euro	EU funds per capita Euro	EU funds for GDP % Euro
Bulgaria	7.2	42.00	5833	6.67	927	15.9%
Croatia	4.24	42.96	10129	1.27	299	3%
Czech Republic	10.51	154.94	14700	26.30	2502	17%
Estonia	1.32	19.53	14849	3.40	2588	17.4%
Hungary	9.88	103.00	10458	24.92	2523	24.1%
Latvia	1.99	24.06	12099	4.53	2278	18.8%
Lithuania	2.94	36.29	12329	6.78	2302	18.7%
Poland	38.48	403.08	10474	67.19	1746	16.7%
Romania	19.95	150.66	7553	19.18	961	12.7%
Slovakia	5.42	75.21	13875	11.65	2149	15.5%
Slovenia	2.06	37.25	18067	4.10	1989	11%

Source: Eurostat (data are processed by the authors).

It is found that Member States had different participations, received differentiated funds and the implementation of the MFF program until 2015, failed for the Eastern European states of the European Union to ensure a guarantee of economic growth.

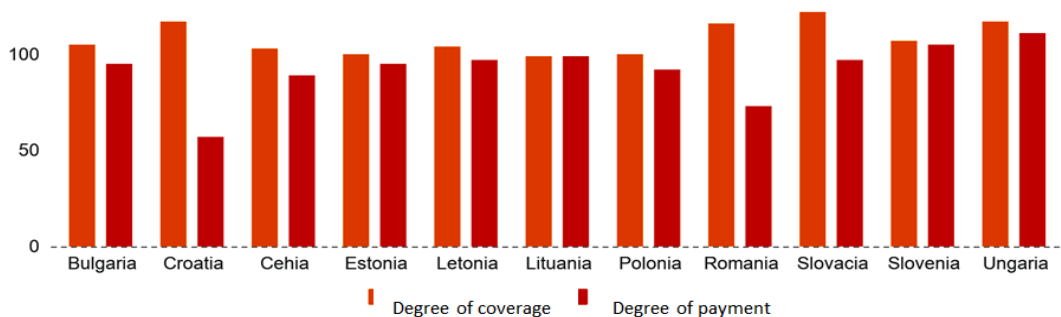
In terms of the degree of contracting and reimbursement of funds, there are differences between Member States depending on the objectives they have set for themselves, but especially in terms of the future perspective.

Currently, the official data from the 2014-2020 multiannual program highlight discrepancies in the evolution of states and access to, use and attract new funds to ensure the perpetuation of major objectives. It is important to note that in this region of the European Union, European funds continue to be an important segment of public existence. A comparative analysis of the states of Eastern and Central Europe with those of Western Europe that are much more economically and industrially developed reveals large discrepancies. Eastern European countries benefit from European funds, but there are still other conditions that often make it difficult to analyse the results of the funds used.

The following graph shows the difference between the degree of contracting and the degree of reimbursement, making it clear that the states that approached and the possibility of reimbursement of funds had evolution possibilities clearly superior to other states that encountered great difficulties in this respect.

Graph 2. Degree of contracting and degree of reimbursement of European funds

150



Source: Eurostat (data are processed by the authors).

In the case of Eastern European countries, operational programs were launched late due to lack of funding. In the absence of co-financing, beneficiaries submitted requests for reimbursement more often than necessary, which led to delays in the implementation of those programs. And from the point of view of the public procurement process, despite some managerial deficiencies, there were also financing deficiencies, which should be the basis for creating the foundation in order to relaunch the respective projects.

There is a lack of expertise on the part of managing authorities so that some evaluations have been delayed and other aspects have also been a brake on the harmonious evolution of the initiation of common programs and objectives.

At the level of managing authorities, the following causes may explain the low rate of absorption and utilization of resources available for the initiation of projects to deepen research in areas of utmost importance to the economy. Thus, there have been fluctuations in specialized staff, there are still not enough concrete guides and methodologies, programs and projects are sometimes not sufficiently anchored in the realities of that objective, in many cases technical assistance has been deficient, the mechanism of operation of the projects was hampered by many other possibilities that led to an even lower rate of absorption of fixed assets.

The level of absorption increased after the enlargement of the European Union from 2004 and then 2007 and continued along the way, but the efforts to ensure that the targets set by the European Union were met were delayed. Thus, action still needs to be taken to reduce the period of analysis of reimbursement requests, the allocation of funds from the Community budget needs to be increased, these funds need to be channelled into those areas where Member States can make individual contributions and ensure development consistency.

The indicators at the level of the main targets are still quite far in the field of transport infrastructure, road infrastructure in the first place, environmental investments, renewable energy projects, the achievement of economic and socio-cultural objectives. Social infrastructure has not been rehabilitated to the extent of the objectives of the directive aimed at increasing the income of the population and consequently the quality of life.

In the field of complex pre-university, university and post-graduate education, there are still difficulties that must underlie large-scale European Union projects, which must ensure not only the Bologna program but also the raising of the quality of complex education in all Member States.

The development of human capital requires the creation of new jobs and these can only be achieved at the expense of research projects, which ensure the creation of new jobs, which ensure the prospect of obtaining additional income and consequently to achieve with increasing proximity to the level of states with a high quality level of education.

We must not forget that this pandemic coronavirus crisis has highlighted a number of issues regarding the standard of health. In this field, national projects must be undertaken, with the support of the European Union, in order to bring this medical capacity (hospital capacity, quality of medication capacity) to a level as close as possible to the requirements of today's life. The coronavirus pandemic is just an acute fact that can deepen, can continue, but which in turn must be substantially controlled.

We are in the third millennium and this pandemic can be repeated even further through other developments that can be even more harmful, destructive. In the period 2020 and the following years, the member countries of the European Union need operational programs approved by the European Commission and completed to meet the 23 mentioned conditionality's and three other conditionality's still on the way. The Infrastructure Operational Program and the Competitive Operational Program must be financed in the Member States of the European Union, so as to eliminate all shortcomings encountered during this period.

In the following table we have highlighted the stage of absorption of funds in the period 2014-2020 by Romania, specifying that the same trend is manifested for the following periods.

Table 2. Absorption of funds in the period 2014-2020 by Romania

Programs 2014-2020	Allocation 2014-2020	Payments to beneficiaries (EU)		Amounts requested by the EC within the EU allocation of OP (current absorption rate)		Reimbursements from EC (effective absorption rate)	
		Value	%	Value	%	Value	%
0	1	2	3	4	5	6	7
OP Regional	6600000000	51476744	0.78	26969422	0.41	24272480	0.37
OP High Infrastructure	9418524484	968827098	10.29	953653087	10.13	858287778	9.11
OP Competitiveness	1329787234	146572615	11.02	86143549	6.48	59118754	4.45
OP Human Capital	4326838744	25014473	0.58	3892197	0.09	0	0
OP Administrative capacity	553191489	24709051	4.47	22964870	4.15	20668383	3.74
OP IIMM	100000000	93090000	93.09	93090000	93.09	83781000	83.78
OP Technical Assistance	212765958	49706461	23.36	49540248	23.28	44586223	20.96
Subtotal	22541107909	1359396442	6.03	1236253373	5.48	1090714619	4.84
NP Rural development	8127996402	2141031435	26.34	2106616091	25.92	1991025758	24.50
POPAM	138421371	14892225	8.84	12237475	7.27	9785156	5.81
Totl FESI	30837525682	3515320103	11.40	3355106938	10.88	3091525533	10.03
FEGA 2015-2020	11196040258	3950185560	35.28	3950185560	35.28	3282437931	29.32

Source: Ministry of European Funds.

The field of research and innovation must play an important role in the European Union's strategy for the immediate future. The year 2020 can be considered one in which not all the objectives that the European Union and the Member States have set for themselves can be met due to the impact that the health crisis will have, combined with the economic and financial crisis that will break out.

Some countries, such as Germany, Denmark and others, are heavily funding the research system and have thus easily overcome the economic and financial crisis of 2008-2010 and are likely to do so now to overcome the effects of the coronavirus crisis and the ensuing economic and financial crisis. It should not be neglected that other countries and especially those in Central and Eastern Europe due to limited resources will encounter difficulties in proposing and initiating new programs.

Research and development policy in the field of technology and innovation has so far been achieved through important projects in sensitive areas of economic life in each country. Each country has its own priorities that must be combined with the priorities of the European Union in the 2020 strategy and the period up to 2027. These priorities of the European strategy must mean an increase based on intelligence, sustainability and inclusion, as well as cooperation Member States.

The European Union's target of allocating 3% of Gross Domestic Product in all Member States to investment in research, development and innovation is an important step that must be supported in order to achieve the objectives that currently constitute individual priority objectives, and complexes of the whole union.

All countries must make a significant contribution to finding those forms of increasing economic competitiveness. The National Strategy for Research, Development and Innovation (SNCDI) must be ensured through funding contracts, which must be supported by all countries by the European Union as a whole.

It must be borne in mind that in the economic field, growth potential depends on a number of factors. The structural analysis of each national economy of the member countries of the union leads us to the conclusion that each country has a strength in the intra-community market and hence the possibilities in the interest of each country, but also in the European Union is to develop those branches, those areas that are beneficial. Of course, there have been in the past, but from completely different criteria, a policy of geographic-economic zoning of the states of the European Union. I do not refer to opinions that have a deep political character, but to some they were even worthy of consideration.

For example, we can consider as priority area of the European Union the agricultural area, of the countries that have a special natural potential and which, through national and European Union subsidies, can lead to massive growth, ensuring the internal market, the community market and for the countries respectively the increase of the international potential.

The Gross Domestic Product in each country from a factorial point of view has a different structure on resources and utilities. These resources can be the elements that underlie the economic growth of each country. Combined economic growth would have the effect of improving living conditions, raising the national standard of living that must become European.

The *PHYSICS* nuclear infrastructure project is one of the utmost importance that was given attention in the financial year 2014-2020 and will have to be continued, as it offers a high potential of all states contributing to this project and of course, to increase European performance. In other words, the European Union was created, consolidated, developed, precisely in order, on the basis of honest cooperation, to ensure the individual economic growth of each country and consequently the development of major investment projects and finally ensuring the increase of the quality of life.

It is worth considering that this *DANUBIUS* program is a European one, through the involvement of several countries, but also in the general European interest.

ELI-NP is selected and considered the most important scientific forum in the field of nuclear physics in Europe.

A major infrastructure is emerging in the long-term plan for nuclear physics in Europe. This infrastructure is *LI-PHI* which comprises two components:

- A laser system of great importance, with two laser bridges capable of reaching very high intensities.
- An intense beam that can ensure extremely high performance.

This infrastructure will create a new European laboratory with a wide range of fields of science, from basic physics to innovative nuclear physics and auto-physics with material applications that depend on a management that must be true. Of course, this project is a major one in the opinion of the authors for the European Union, but it will be able to evolve, to take a special shape in the context in which the European Union that integrated it as a program of the European Union will make the necessary efforts to reach a peak of physical engineering with extraordinary results for the large population.

The *DANUBIUS-RI* project will be a pan-European research infrastructure dedicated to the interdisciplinary studies of the appropriate system. The research will have to be a symbiotic one between the European scientific forces and those on other meridians, so as to ensure effective cooperation so that the final results benefit all Member States. This *DANUBIUS-RI* program has funding arrangements that have been granted so far by a number of four countries Germany, Italy, Romania and Spain. It is a political commitment of seven other states, namely Bulgaria, Greece, Hungary, Ireland, Moldova, the Netherlands and the United Kingdom of Great Britain and Northern Ireland. There are also expressions of interest and support from the scientific community that have been launched by these countries and in sixteen other European countries (Austria, Czech Republic, Finland, France, Lithuania, Norway, Poland, Serbia, Switzerland, Turkey, Ukraine, Azerbaijan, China, India, Morocco and the USA). Points of interest are also expressed by other

prestigious international organizations, as a process of developing renewable energy resources will be a huge resource for humanity given that non-renewable resources are particularly significant but in a negative sense. Crude oil, natural gas and coal resources are quantified at the level of international explorations as sufficient for 43 years for oil, up to 100 years for coal and natural gas. Under these conditions, there is a very serious question of how humanity will be able to regenerate new resources, ensure national consumption and produce substitutes that will give essence and perspective to the evolution of humanity. After all, the European Union's challenges in initiating projects with global validity are not their own. They are also considered by the rest of humanity.

A number of leading researchers from around the globe have expressed in papers, some quite deep the perspective that humanity will reach a terminus. Probably the millennial evolution of mankind will lead to new scientific discoveries, will lead to new adjustments in world relations, but all must be based on the correlation between population growth and the level of resources producing goods and services in the interest of the whole mankind.

The environment, the soil and the subsoil, the riches that are in this natural environment, the scientific capacity to capitalize on resources, human intelligence, the robotization of economic processes and all these together are nothing but factors that must underlie an evolution, we dare to -we call it special, of the correlated development of the population and of the resources.

In this way, a number of projects have been discussed, some objectives that need to be considered, and perhaps even stand before the European Union. They are challenges which in the European Union, in the opinion of the authors, despite other views expressed in relation to the cohesion of the European Union, must be the support for future developments within this European Union.

The study shows that no state has joined and is not trying to join the European Union in the future, except from a simplified point of view and the individual advantages it would gain within the European Union. This is a principle that must underpin the leadership, through its institutions, of the European Union in order to unite and bring together research efforts aimed at meeting the challenges ahead.

We are going over the effects that will be quite pronounced of the sanitary crisis (coronavirus) and of the financial-economic one that will follow and we believe that nevertheless by coagulating the resources and the interest of the member countries special results can be reached.

To the title question, we now answer that yes, the European Union is the appropriate framework in which the Member States and the Union as a whole can set themselves and fight for this goal, which should be pursued with interest and skill, so that coagulation can be achieved the interest of Member States to increase the European Union's individual and concentrated economic and social needs.

Conclusions

The study that formed the basis of this article, quite extensive and somewhat controversial due to the last two events – Brexit and the health crisis (coronavirus) combined with the economic and financial crisis – lead to a series of conclusions. First of all, the European Union needs challenges in order to achieve a higher level of individual economic growth of each stratum and of the European Union as a whole.

Secondly, it is easy to identify the number of challenges or the combination of challenges that must underpin the strategies to be pursued by the European Union. Member States need to align with the European strategy, taking into account the effects of a crisis, such as the one we are going through at the time of writing, with a somewhat changed idea of overcoming these difficulties and moving towards net results for the benefit of the Member States and the European Community as a whole.

Another conclusion is that without cohesion and objective analysis of the situation of the European budget, the situation of the level of development of each country, the general interest of the European Union, but combined with the individual interest of each country, the forces cannot be coagulated to overcome these challenges.

In other words, the economic and financial crisis will trigger great difficulties for most states, especially those that joined the European Union after 2004, in terms of financial resources. Therefore, the European Union must make a special effort to reconsider the multiannual budget for the period 2021-2027 so that the correlation between the contribution of the Member States and the benefit obtained by them through the funds allocated to each state is at least neutral, not producing losses. We are thinking first of all of the countries with a lower level of development that have entered the European Union with thoughts and hopes of being better.

A final conclusion is that the European Union is a community of states based on the principles of independence of each, but combined with the common effort to produce a better world with superior results that will gradually but continuously affect the quality of life, the standard of living of the population of this European entity. We do not want to, we resort to the material principle namely that only making progress in economic development and in the results obtained can coagulate that European communion that militates to meet the challenges that lie ahead.

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Romania's coal-fired power plants efficiency and pollution in the context of the European green deal

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Abstract. *This article analyses the efficiency of coal-fired power plants in Romania in the European Green Deal context. The focus is on the coal-fired power plants of the Oltenia and Hunedoara Energy Power Plants, as they generate over 97% of coal-fired electricity in Romania. Oltenia Energy Power Plant (CEO) is composed of eleven power plants with an average lifetime of 37 years while of Hunedoara Energy Power Plant (CEH) is composed of six power plants with an average lifetime of 42 years. At the same time, the article estimates the impact of the closure of these two energy groups on the main air pollutants and how close this would bring Romania to the targets set by the Green Deal for 2030. The article also estimates the losses from different energy sources incurred in the process of transforming raw electricity into electricity delivered to the consumers and finds that oil & gas and coal sectors have considerably higher losses than other electricity sources, with wind being the most efficient from this perspective.*

Keywords: Green Deal; coal; energy transition; pollution.

JEL Classification: O13; P18; P28; Q43.

1. Introduction

The European Green Deal is currently the most critical policy-framework for the long-term sustainability goals in European Union Member States. It was launched by the European Commission in December 2019 and through the 2030 climate & energy framework aimed to achieve: a cut in emissions by 2030 of at least 55% in comparison with 1990 levels (current policies will only reduce greenhouse gas emissions by 60% by 2050); the share of renewable energy in the electricity production mix should be of at least 32%; an improvement in energy efficiency of at least 32.5% and by 2050 EU should reach carbon neutrality.

Claeys et al. (2019), considers that “*European Green Deal might become a blueprint for other countries and a tangible example that pursuing climate neutrality is technically feasible and economically and politically viable*”. Consequently, to deliver the European Green Deal, the EU Member States and the European Commission must rethink their energy and non-energy policies. There is a specific need for clean energy supply across the economy and industry, production and consumption, transport and infrastructure, digitalization, food and agriculture, construction, and other economic sectors with significant environmental impact. According to Senior Advisor to the President, World Economic Forum Geneva, Martina Larkin (2020), the European Commission estimates that reaching the net-zero 2050 target will require around 1,000 billion euro of public and private investment over the next decade. Given that the European governments and institutions are responding to the coronavirus crisis with the largest stimulus packages since the Great Depression, there is a real opportunity to deploy this stimulus strategically to fast-track a fossil-free and competitive economy for Europe. Germany has agreed a package worth up to 750 billion euro to mitigate the damage of the virus, and in Spain and Italy the size of the stimulus packages is estimated to be 7.3% and 5.7% of GDP respectively. The Commission has estimated that achieving the current 2030 climate and energy targets will require 260 billion euro of additional annual investment, about 1.5% of 2018 GDP 28.

However, there are several states that strongly rely on the coal sector. Consequently, as Claeys et al. (2019) affirms, these countries can use the employment potential issues as an argument to delay the necessary transformation, while EU should provide solutions (including financial and energy security) to implement coal phase-out measures. The authors emphasize that EU efforts within Green Deal targets should be exported, having in mind that EU generate less than 10 percent of global greenhouse-gas emissions and the impact on global temperature level will be insignificant without a proper global action together with other major countries.

Among the European countries, Poland has the largest hard coal reserves, but there are also important deposits in Czech Republic, Spain and Germany and Spain. Moreover, from the perspective of lignite, Germany has the largest deposits, followed by Poland, Greece, Czech Republic, Hungary, Bulgaria and Romania (Kavouridis and Koukouzas, 2008).

Historically, coal has been one of the European economy’s primary fuels during the last century. Alves Dias et al. (2018) argues that in 1990, coal provided for almost 41% of the gross energy consumption in the EU28 Member States, and 39% of power generation. Despite the gradual decrease of its use since the 1990s, coal remains important. In particular

for many of the Member States that joined the EU in 2004 and 2007, which rely on indigenous coal for power generation. In 2015, 16% of the gross EU energy consumption was supplied by coal as well as 24% of electricity generation. Today, 6 Member States rely on coal for at least 20% of their total energy needs (Bulgaria, the Czech Republic, Germany, Greece, Poland and Slovakia), while the reliance of Poland exceeds 50%.

The article is structured in 5 sections: introduction, literature review, methodology, main results and discussion, and conclusions. It analyses the energy efficiency of coal-fired power plants, using the heat rate that represents the efficiency of conversion of fossil fuel energy input to electrical energy output. A lower heat rate represents a more efficient coal-fired power plant since it requires less heat input to generate a kWh of electricity. We built on the research done by the JRC (2018), that found that most of the Romanian coal-fired power plants have an efficiency between 30-34% and even lower, which is below the EU average, mainly because most of these coal-fired power plants were built during the communist epoch and they have exceeded their technical life span. Further the article analyses the share of electricity generated from coal energy sources in the national electricity mix using data provided by Transelectrica⁽¹⁾, and estimates the losses incurred in the process of delivering net electricity to consumers. The last part of this article estimates the impact on pollution generated by the Oltenia and Hunedoara Energy Power Plants which generate 97% of total electricity from coal sources. Using the data provided by Oltenia and Hunedoara Energy Power Plants through their annual reports we analyse what the impact of their full closure will be in terms of pollution reduction in order to find out if this will suffice in reaching the pollution targets set by the Directive (EU) 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants.

The results obtained from the current analysis show that a full closure of both energy Power Plants will only help Romania reach its SO₂ pollution target for 2030. As for NO_x and PM 2.5, other measures and public policies should be implemented, because other economic sectors (e.g. transport for NO_x, and residential, commercial and institutional for PM 2.5) are major pollution generators. Thus a full closure of the two energy Power Plants will only have a limited impact on bringing Romania closer to the 2030 targets.

2. Literature review

The green transition from coal to other energy resources generates an essential impact on both supply and consumption sides. As Melsted and Pallua (2018) showed, coal fuelled the late nineteenth and early twentieth centuries. It was “the backbone of industrial society” used for steam-powered transportation, residential heating, industrial production, and electricity generation.

Hafner and Raimondi (2020) analysed the current development of the energy transition in several European countries (i.e. Italy, UK, Germany, and Poland). They emphasized the different pace among European countries in order to implement EU energy and climate targets, based on the political commitment at national level. On one hand, Italy and the UK registered a positive trend towards renewable energy transition: Italy more state-driven

through the feed-in schemes; UK – more market-driven. On the other hand, the authors considered that Germany and Poland have failed in the energy transition implementation. In Germany, despite ambitious commitment, CO₂ emissions increased due to “coal-fired power generation that closed the power generation gap caused by nuclear decommission” after Fukushima incident (Hafner and Raimondi, 2020). The reason why coal replaced nuclear is that the cost of generating power from coal has declined over the past decade. In Poland, the main problem was related to employment (i.e. significant number of mining employees) and energy security. The most recent governmental Energy Policy valid until 2040 mentioned that hard coal would remain the single most important source of electricity production by 2040, although its role would be decreasing.

However, earlier studies considered that coal could play a full part in the energy sector in EU and could be an important element for a sustainable future (Kavouridis and Koukouzas, 2008; Bugge et al., 2006) if there are efforts aiming at technology and efficiency improvement, and a new legal framework to reduce barriers to cleaner coal power.

Bugge et al. (2006) analysed the Denmark case of new coal-fired power plants with high efficiency constructed in different locations (e.g., Skaerbaek, Nordjylland). Later on, the Danish energy authorities demanded that one of them should be converted to gas. The unit from Skaerbaek was successfully converted to gas, while the Nordjylland unit benefited from new clean technology, was fitted with flue gas cleaning consisting of high dust selective catalytic reaction NO_x removal, electrostatic precipitator and wet scrubbing SO₂ removal, thus making the plant a really clean coal plant.

Additionally, Melsted and Pallua (2018) affirmed that it is vital to eliminate fossil fuels in the long run, not only coal resources, and that the transition is more complex and requires the rearrangement of the primary energy mix. Moreover, the transition to renewable energy will not necessarily be made directly from one resource to another, but more likely will entail several phases of hybridization and multi-fuel use while the supply systems are modified. On the one hand, it must favour renewables resources. On the other hand, the fuel consumers from main sectors (like transportation, residential heating, industries, and electricity generation) must actively choose to substitute fossil fuels with renewable alternatives.

Oei et al. (2020) analysed Germany's situation from the perspective of hard coal mining phase-out in the last 60 years to identify the most important qualitative and quantitative characteristics of the largest German hard coal mining areas, Saarland and Ruhr. The analysis concludes that to achieve a fair and optimal transition, the challenges are complex, starting with the coal companies' formal and informal political influence, and reducing subsidies for the coal industry. It is also essential to diversify the economy and address unemployment with well-customized policies that attract new initiatives, including subsidies, premiums and tax concessions, depending on “the availability of labor force” and the existing local or regional endowments. Moreover, citing different other articles (Healy and Barry, 2017; Mayer, 2018; Newell and Mulvaney, 2013) on the labour market development, Oei et al. (2020) emphasize the role of the active and passive labour market and social policies for an in-time transition, mentioning measures as retraining of employees and early communication of phase-out plans. These early measures can ease the pressure of potential unemployment to face the upcoming changes, “helping coal miners to

stay in the labour market and encourage new generations to choose education and employment tracks with better future perspectives". Frigeli (2009) showed that in Germany, early retirement steps were used to alleviate labour market pressures and support miners. According to the 2007 hard coal financing law, any worker over 42 was covered from unemployment. After the end of their employment in coal mines in 2018, workers would work three years in decommissioning and then receive payments for another five years to bridge the time until they entered the regular pension fund at age 62 in 2027.

Also, in the case of Germany, Brauers et al. (2018) considered that there could be fears for energy-intensive industries to lose their competitiveness because of a higher price. Analysing the same regions of Ruhr and Saarland as Oei et al. (2020), they concluded that the coal regions usually face the challenges many rural areas have in terms of a lack of infrastructure, emigration, aging population, low fertility rates, and dependency on coal production. Consequently, there is a need in these regions for different kind of support policies to keep the population size and to attract new people, such as:

- Modern infrastructures (transport, internet, railways, etc.), including the shift toward less carbon-intensive transport vehicles or bicycle paths.
- A network of education and research facilities, with an accent on the connection with other metropolitan areas.
- Attractive living conditions (more opportunities for cultural activities and leisure time, low level of air pollution, etc.).
- Stimulus to the local entrepreneurial ecosystem and corporations that provide jobs fit for the future.

In the case of Poland, Manowska et al. (2017) affirmed that coal remains essential for the Polish energy production mix and energy safety policy, and that the production mix was strongly correlated with the effectiveness of the mining industry's restructuring program. The article also draws attention "to the search for restructuring solutions for Polish hard coal mining companies in areas other than human capital".

Complementary, Sobczyk et al. (2020) analyzed the financial situation of Polish enterprises dealing with the extraction of solid fossil energy materials (hard coal and lignite) during the restructuration period between 2013-2017, concluding that, in order to maintain its ability to settle their liabilities towards employees and suppliers, the mining enterprises were selling their assets and products usually at a price lower than production costs.

There is a lack of scientific literature regarding the energy transition from coal to other energy resources in Romania's case. Dudău and Catuti (2020) considered that, in the context of the new European Green Deal, "the protracted use of the existent energy production and infrastructure assets, many of them old, polluting and inefficient, oftentimes operating beyond their technical lifetimes, translates in flattening trajectories towards the 2030 targets for GHG emissions reduction, renewable energy sources, and energy efficiency". Also, in the same context of the European Green Deal Agreement, Ionescu (2020) considered the implementation of Green Deal will "encourage investment in renewable energy and the gradual reduction of the coal use", while the nuclear energy and natural gas levels would be maintained. However, the authors estimated that Romania will obtain up to 65% clean energy from renewable sources.

3. Methodology

In order to highlight the efficiency of coal-fired power plants in Romania compared to those in the European Union, we consolidate on the findings obtained by Alves Dias et al. (2018) which estimated the thermal efficiency of the individual power plants based on the available information on the installed capacity, the age and type of power plant. The CO₂ emissions of a power plant are proportionally related to the type of fuel used, the amount of fuel consumed during the year, and therefore the generated electricity and the efficiency. The following formula was used:

$$\text{Eff} = \frac{\text{generation} \cdot 3.6}{\frac{\text{CO}_2 \text{ emissions excl. biomass}}{\text{Intensity fuel}} + \frac{\text{CO}_2 \text{ emissions} - \text{CO}_2 \text{ emissions excl. biomass}}{\text{Intensity biomass}}} \quad (1)$$

where:

Intensity_{fuel}: The CO₂ content per calorific energy in the fuel expressed in tonnes CO₂ per TJ.

Generation: annual net generation of the power plant in MWh.

CO₂ emissions: Annual emissions in kg.

The dataset used to calculate the thermal efficiency of coal-fired power plants is from JRC Open Power Plants Database (JRC-PPDB-OPEN) (EU JRC, 2020). To emphasize the contribution of each energy source in the electricity production mix we used the data provided by Transelectrica for 2019 (Transelectrica, 2020).

In order to calculate the energy losses from the process of transforming gross energy into energy available in the network for consumption, we used Transelectrica methodology (Transelectrica, 2020) which is based on the following formula:

$$\text{NP} = \text{GAP} - (\text{PCOS} + \text{SCGS} + \text{PLTB}) \quad (2)$$

where:

NP (net power) – The power that the generator can deliver to the network for marketing purposes.

GAP (gross available power) – total electricity produced by the generator.

PCOS – power consumed in own services.

SCGS – The share of consumption of general services.

PLTB – Power losses in the transformer block.

To calculate the pollution impact of the Oltenia Energy Power Plant and the Hunedoara Energy Power Plant, we used the companies 2018 environment reports and the data provided in them in relation to CO₂, SO₂, NO_x, and PM 2.5 emissions. Next, starting with the amount of greenhouse gas emissions (SO₂, NO_x, and PM 2.5) at national level, the data used being those from the European Environment Agency (EEA, 2020), we analyzed the impact that a total closure of these two Power Plants would have in terms of reducing greenhouse gas pollution and if such a scenario is relevant for reaching the 2030 air pollution targets imposed by the EU Green Deal. The impact was calculated at national level by subtracting from the current air pollution levels, the pollution generated by the two energy Power Plants.

4. Results and discussion

4.1. Electricity production mix in Romania and energy loss by a different type of sources

Under the new climate action objectives at EU level, Romania would have to change its energy mix, in favour of a bigger share for renewables, closing down many of its coal sites. However, in Romania's energy production mix, the coal sector has a major historical contribution to energy production at around 24% of the total production registered at the end of 2019. Furthermore, the share is increasing to 40% during winter period. Two sorts of coal are mined in the country's two main basins, respectively: hard coal in Jiului Valley, and lignite in South West Oltenia region.

Energy production facilities in the CEE countries in general, and in Romania in particular, have been mainly constructed before 1990, starting with 1970s. With the addition of thermal coal power plants in the 1970s and 1980s, the Jiului Valley turned into a hub of power generation, with more than 60,000 employees in 16 coal mines in 1989. However, in the 1980s, the coal-fired plants started to cogenerate heat, which fuelled the region's district heating systems.

Starting with 1990s and until present, the mining activity has started to decline in Jiului Valley. The collapse of activity during 1997-2017, may be observed by the reduction of mining perimeters in operation from 16 mining perimeters of 163,35 km² to 4 mining perimeters of 22,3 km² (Barbu, 2020).

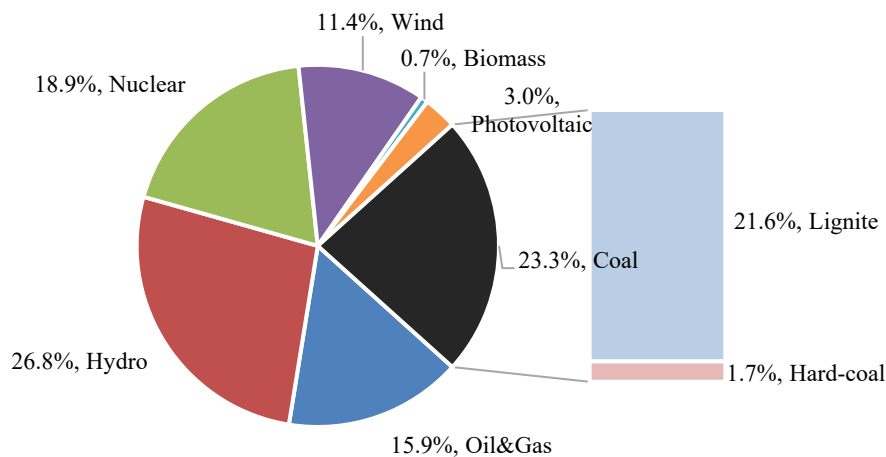
According to Transelectrica 2019 annual report the installed power decreased from 24714 MW at the beginning of 2017 to 20696 MW at the end of 2019, Romania losing more than 4,000 MW in this period mostly due to reduction of coal (-1453 MW) and oil and gas (-2553 MW) during three years, while biomass and photovoltaic slightly increased. Complementary, hydropower, and wind power decreased.

In terms of production, in 2019 compared to 2018, the variation of production by types of resources decreased in the most primary sources of power, with values between 0.94% for nuclear production, respectively 13.56% for oil and gas production. At the same time, there were significant increases in output from renewable sources, respectively wind (+7.14%), biomass (+27.56%), and photovoltaic (+0.34%). Hydropower production decreased by 10.28% compared to the previous year. This was caused by the decrease of hydraulicity on inland rivers, from 97% in 2018 – typical year, to 85% in the year 2019 – subnormal year. However, given that renewable sources' production is very volatile (variations in output over 1,000 MW between concomitant intervals), the integration in the National Electrical System of wind power plants was facilitated, to no small extent, due to variation of the production in the hydropower plants.

Figure 1 shows that even if the mix of electricity production mix of Romania is a balanced one, fossil fuels still play an important role. Any decrease in the share of electricity generated from coal or oil & gas must be covered by an increase from renewable sources because the balance was deficient, on average, throughout 2019. We must also take into account the fact that energy production from current hydro sources is declining due to the

desertification process as argued by Owen, W. Phil et.al 2018 in the report Combating desertification in the EU: a growing threat in need of more action.

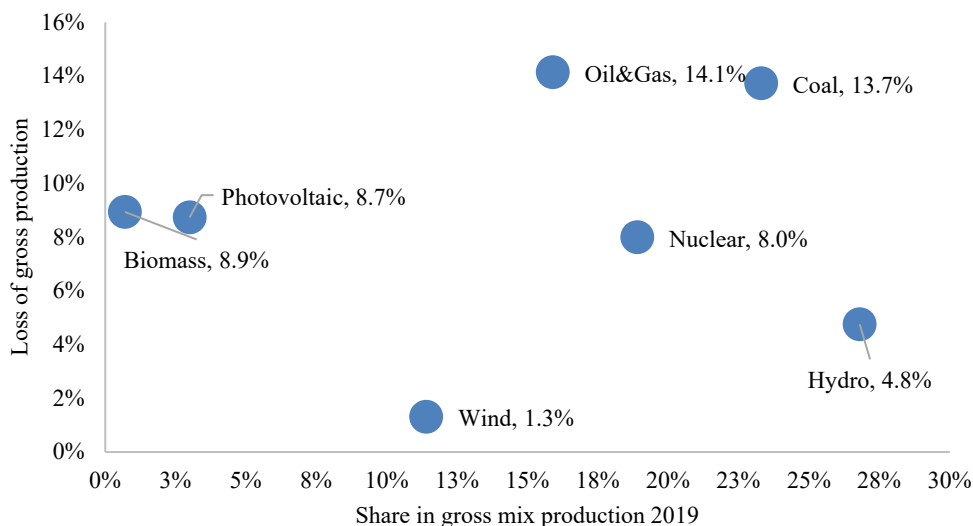
Figure 1. Electricity production mix by primary resources in Romania (2019)



Source: Transelectrica – SEN

There is a difference between gross production and net power delivered in the network in the energy production process. Using the formula (2) from methodology section.

Figure 2. Loss in energy production by source type



Source: Own calculation based on Transelectrica data.

Figure 2 shows that larger losses in energy production process are incurred for coal, oil and gas (approximately 14% of the gross energy production for both categories), having an essential share in the energy production mix (16% for oil and gas, and 24% for coal). The problem caused by these losses is all the thornier for coal-fired power plants, as they are

financially inefficient anyway due to the high costs of CO₂ allowances. A loss of 14% of the gross energy produced by these plants does nothing but put additional pressure on the budgets of the two energy Power Plants.

4.2. The potential impact of full closure of CEO and CEH on Greenhouse Gas Emissions

The five primary air pollutants according to the “Directive (EU) 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants” are nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO₂), ammonia (NH₃), and fine particulate matter (PM_{2.5}). In coal burning, besides CO₂, the other pollutants emitted are NO_x, SO₂, and P.M 2.5. The unit of measure (for the above-mentioned air pollutants) used by the European Environment Agency is Gigagram (1 Gigagram = 1,000 tons).

Table 1 shows the level of pollution produced by the two energy Power Plants responsible for 97% of the electricity generated from coal sources. In the case of CEH, we used extrapolation based on electricity produced and similar level of pollution with CEO. Given the similar efficiency and lifespan of the coal-fired power plants of the CEO and CEH, it was considered that the level of pollution per MWh generated, is similar.

Table 1. Greenhouse gas emissions generated by the Oltenia Energy Power Plant (CEO) and the Hunedoara Energy Power Plant (CEH) (2017-2018)

Emissions/Source	CEO	CEH	Total
CO ₂	5,141.304	349.063	5,490.37
SO ₂	11.83	0.867*	12.63
NO _x	14.286	0.970*	15.26
Particulate matter (P.M 2.5)	0.76	0.052*	0.82

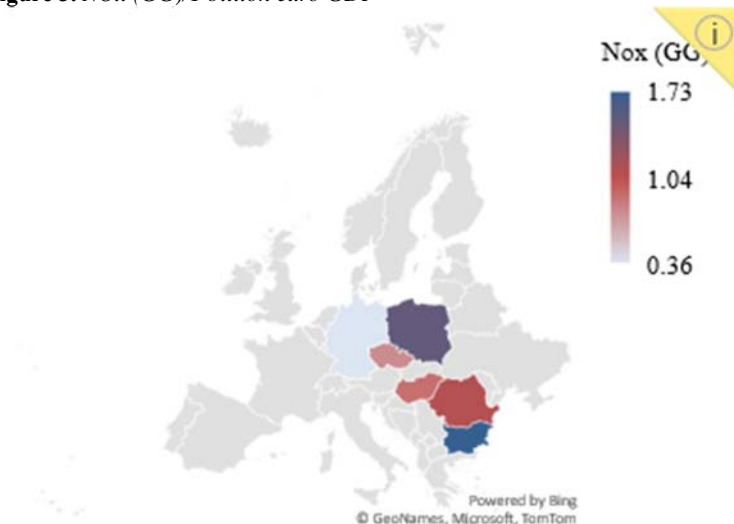
Note: All values are in gigagrams. *Extrapolation based on electricity produced and similar levels of pollution with CEO.

Source: CEO 2018 Environment report. CEH 2017 annual administrators report.

The analysis of greenhouse gas emissions must consider the economy's structural legacy; countries of Central and Eastern Europe, compared to Western Europe, have a higher share of industry in GDP. Consequently, a higher percentage of industry in GDP, especially if the extractive industry and the manufacture of low and medium gross value-added goods are the ones that make up the bulk of the industrial sector which consume more energy, will generate higher levels of greenhouse gas emissions per 1 billion euro GDP.

Compared to the other Central and Eastern European member states that have economies with a structure similar to that of Romania, our country ranks better than Bulgaria and Poland in terms of pollution with NO_x/1 billion euro GDP, being structurally closer to Hungary and the Czech Republic, although all Central and Eastern European countries have higher NO_x pollution than the EU average (see Figure 4).

The leading cause of reducing NO_x emissions from energy production came on the back of a declining share of electricity produced by coal-fired power plants (from 45% in 2007 to 25% in 2018). Moreover, higher efficiency filters have been introduced in coal-fired power plants that have continued to operate to this day, diminishing even further the NO_x emissions that eventually reach the air.

Figure 3. *NOx (GG)/1 billion euro GDP*

*EU28 average is 0.46 GG/1 billion euro GDP.

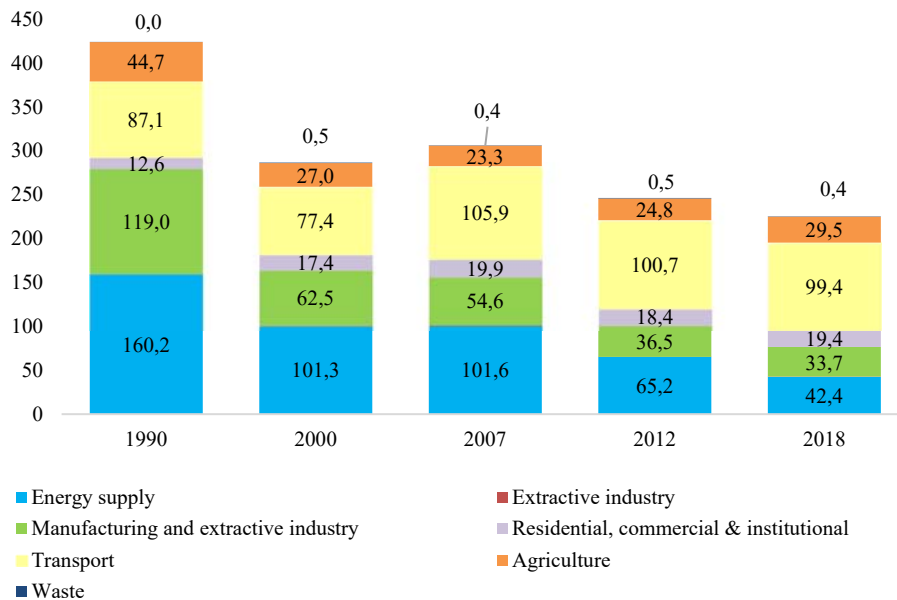
Source: Own calculation based on Eurostat GDP data & European Environment Agency National Emission Ceilings Directive emissions data.

Compared to the period of admission to the European Union (2007), Romania managed to reduce NOx emissions from 306.3 GG to 225.4 GG in 2018 (See Figures 5 and 6). The substantial reduction of these emissions comes from the energy production sector, whose contribution decreased from 101.6 GG to 42.GG. In other words, the energy production sector reduced its contribution from a share of 33.17% in total NOx emissions in 2007 to a share of only 18.8% in 2018.

Figure 4 shows the contribution of each sector to NOx emissions form 1990-2018. 1990 was chosen because is the first year after the fall of the communist regime and of central planned economy, also 1990 is the reference year for one of the targets proposed through the European Green Deal, namely the reduction of emissions by 2030 by at least 55%. From 2000 to 2007, Romania enjoyed a strong economic growth, although above the potential GDP, combined with an intensification of economic activity, which also led to an increase in NOx emissions. 2007 was the year when Romania was admitted to the European Union and started enforcing more rigorous pollution norms. Between 2007 and 2012, Romania went through the Great Depression with considerable fiscal effort, a substantial part of the decrease in the level of NOx emissions is also due to the slowdown in economic activity. The latest available data are for 2018.

Even with a complete closure of the Oltenia and Hunedoara Energy Power Plants would reduce NOx emissions by another 15.26 GG, as can be seen in Table 1, but even so, there would still be a substantial difference between the actual (2018) level of 225.4 GG and the 2030 target (122.28 GG).

Figure 4. NOx Emissions evolution by sector (GG)



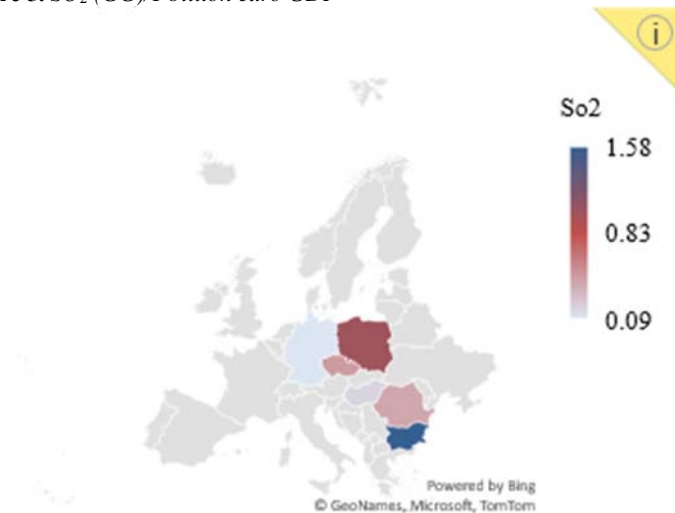
Source: European Environment Agency (EEA).

As can be seen, the primary source of NOx emissions is the transport sector. NOx emissions generated in 2007 was of 105.9, of which 89.1 GG was generated by road transport. In 2018 NOx emissions from the transport sector was of 99.4 GG, of which 89.9 was generated by road transport (see Figures 8 and 9).

We should consider that even if engine emissions regulation has become tighter, the number of passengers' cars in Romania has increased significantly in this period (approx. 3.54 million in 2007 to approx. 6.45 million in 2018), which means that better road infrastructure (including a higher number of electric charging stations) and a shift towards more efficient engines and a higher share of electric cars will have a more consistent impact on NOx emission reduction, than the closure of CEO and CEH.

Further on, we discuss SO₂ emissions which lead to acid deposition, which, in turn, can lead to changes in soil and water quality. The subsequent impacts of acid deposition can be significant, including adverse effects on aquatic ecosystems in rivers and lakes and damage to forests, crops and other vegetation. SO₂ emissions also aggravate asthma conditions and can reduce lung function and inflame the respiratory tract.

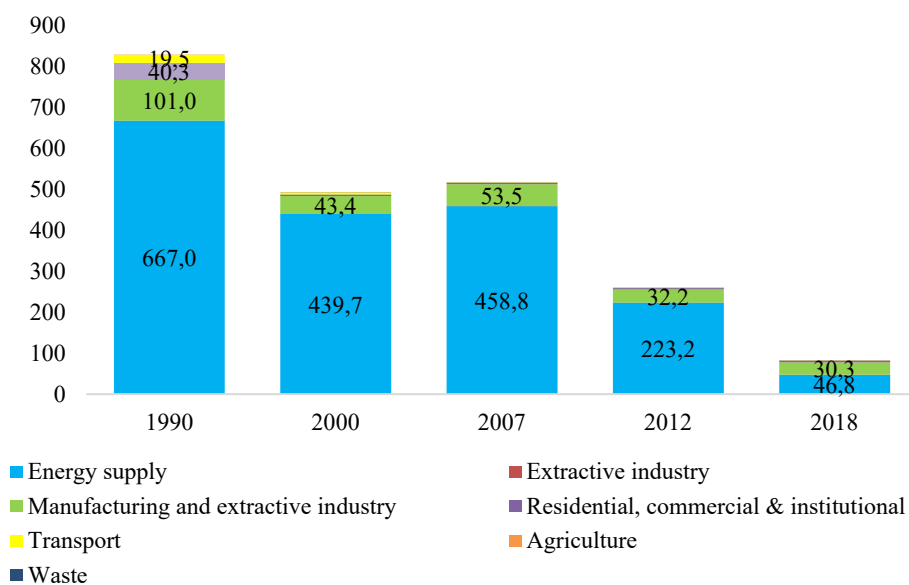
The largest source of SO₂ emissions in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities. Other sources with lower SO₂ emissions are industrial processes such as extracting metal from ore. Romania's heavy industry and the heating system based on a large proportion of thermal energy resulting from coal-burning were a significant source of SO₂ pollution in the post-communist and pre-admission to European Union era.

Figure 5. SO_2 (GG)/1 billion euro GDP

*EU28 average is 0.13.

Source: Own Calculation based on Eurostat GDP data & European Environment Agency National Emission Ceilings Directive emissions data.

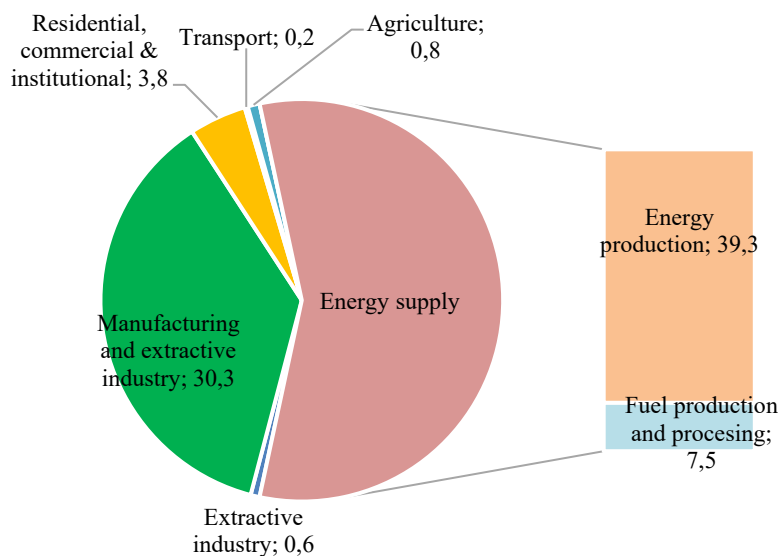
Following Romania's admission to the European Union and the implementation of pollution regulations, SO_2 emissions have been significantly reduced (see Figure 8), mainly by refurbishing the coal-fired power plants' filtering processes and closure of the most inefficient facilities. In 2007, SO_2 emissions had a value of 516.6 GG, of which 458.8 represented energy supply, meaning a share of 88.8% of total SO_2 emissions.

Figure 6. SO_2 Emissions evolution by sector (GG)

Source: European Environment Agency (EEA).

As can be seen, energy production is the main sector that generates SO₂ emissions followed by the manufacturing and extractive industry. Together these two sectors generate over 90% of SO₂ emissions. The main sources of SO₂ pollution in Romania besides energy production are the production of petrochemical products, the production of cement and non-ferrous metals.

Figure 7. SO₂ Emissions by sector (82.5 GG; 2018)



Source: European Environment Agency (EEA).

SO₂ emissions levels in 2018 were 82.5 GG, of which energy supply represented 56.72%. It is worth noting that the current level of SO₂ emissions is considerably lower than the 2020 target of 138.83 GG and slightly above the target assumed for 2030 of 72.43 GG. A full closure of the CEO and CEH would mean, *caeteris paribus*, reducing the current levels by 12.63 GG and thus reaching the 2030 target.

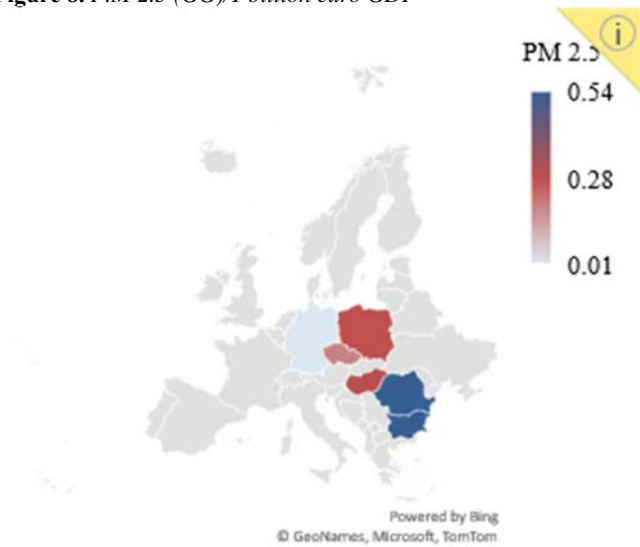
Finally, we will discuss particulate matter emissions. Particulate matter 2.5 are even more dangerous than Particulate matter 10, because they can get deep into the lungs, and some may even get into the bloodstream. Diseases that can occur due to exposure to P.M 2.5 are: irregular heartbeat, aggravated asthma, decreased lung function and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

Also, P.M 2.5 is the main cause of reduced visibility (haze), phenomenon more frequently observed in large industrial cities. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of this settling may include: making lakes and rivers acidic, changing the nutrient balance in coastal waters and large river basins, depleting the nutrients in soil, damaging sensitive forests and farm crops and affecting the diversity of ecosystems.

Figure 8 shows that Romania and Bulgaria register levels considerably higher than the EU average, and some of the main causes for particulate matter pollution are the poor quality

of infrastructure, mainly road infrastructure, and low capacity of enforcing pollution norms on construction sites.

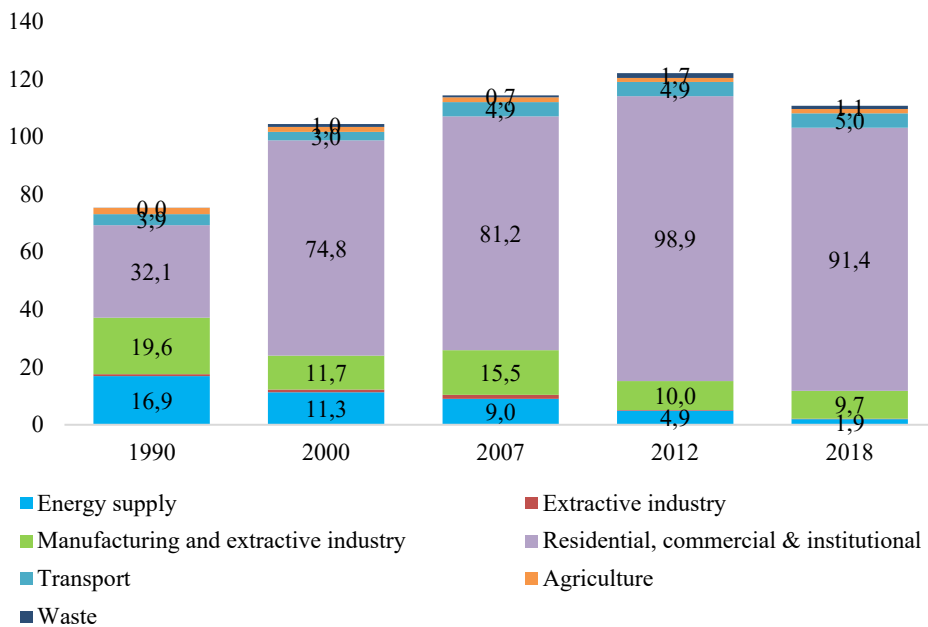
Figure 8. *P.M 2.5 (GG)/1 billion euro GDP*



*EU28 average is 0.08.

Source: Own calculation based on Eurostat GDP data & European Environment Agency National Emission Ceilings Directive emissions data.

Figure 9. *P.M 2.5 Emissions evolution by sector (GG)*

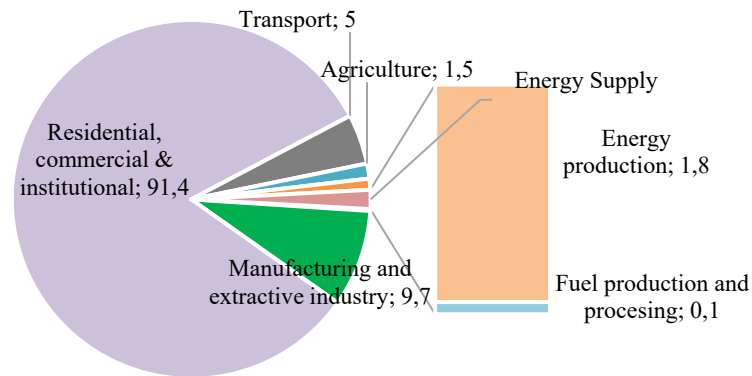


Source: European Environment Agency (EEA).

Anthropic sources of P.M 2.5 emissions are: industrial activity, population heating system, thermoelectric power plants. Road traffic contributes to the pollution with dust produced/raised in the air by the tires of moving cars, as well as by incomplete combustion of fuels (especially diesel engines) as it is show by the National Network of Air Quality Monitoring.

The Energy Supply sector does not have a significant impact on the P.M 2.5 emissions, and a full closure of the two energetic Power Plants will only reduce the P.M 2.5 emissions by 0.82 GG with no real impact on reaching the 2030 target of 50.51 GG, which represents approximatively half of the current level of P.M 2.5 emissions.

Figure 10. P.M 2.5 Emissions by sector (110.7 GG; 2018)



Source: European Environment Agency (EEA).

As it can be observed from Figure 10, the energy supply sector has a negligible contribution on P.M 2.5 pollution, the main cause for P.M 2.5 emissions being the residential, commercial, and institutional sector, which account for more than 82.5% of the total P.M 2.5. Romania currently has a total of approx. 8.5 million homes, of which about 7.5 million are inhabited. Of these, approx. 4.2 million are individual homes, and approx. 2.7 million households are apartments located in blocks of flats (condominium). Only 5% of the flats are energetically modernized by thermal insulation.

One-third of Romania's homes (almost 2.5 million) are heated directly with natural gas, using apartment plants and stoves with very modest thermic yields (at least 250,000 households). About 3.5 million homes (the vast majority in rural areas) use solid fuel – mostly wood and coal – burned in stoves with extremely low efficiency. The rest of the houses are heated with liquid fuels (heating oil, diesel, or LPG) or electricity. Unfortunately, and this is the case, especially in a rural area, more than half of the homes are only partially heated during the winter.

As timber trade is facing stiffer regulation and heat and fuel prices are liberalized, heating costs will increase, encouraging on one hand investment in thermal rehabilitation of homes, but on the other hand, puts more pressure on the short-term expenses a household has to bear with heating.

5. Conclusions

The first conclusion that can be deduced from this analysis is that the average efficiency of coal-fired power plants in Romania is below the European average. In the case of most of the still operational coal-fired power plants in Romania, they have exceeded their technical life span.

Both Energy Power Plants coal-fired power plants are financially inefficient, especially those operated by the Hunedoara Energy Power Plant, which is also in insolvency proceedings. Moreover, it is expected that the price of CO₂ European Emission Allowances will increase in the future, putting more pressure on the financial situation of both energy Power Plants.

Regarding the achievement of targets for air pollutants emissions, we can see that the closure of the two Power Plants will only help meet the target for SO₂ emissions because, in the case of NO_x emissions, the transport sector is responsible for 44.13% of the total NO_x emissions. At the same time, energy production has a share of only 15.8%, and fuel production has a share of 3%, which means that to achieve pollution targets, public policies must first address pollution from the transport sector.

Also, regarding the reduction of P.M 2.5 emissions, the impact of the two Power Plants' closure will be negligible because the main sector responsible for more than 82% of total P.M 2.5 emissions is the residential, commercial, and institutional sector. To achieve P.M 2.5 emissions, public policies must focus primarily on increasing residential, commercial, and institutional buildings' energy efficiency and thermal insulation.

It should also be noted that in the case of both coal and oil & gas electricity, there is a loss of about 14% of gross electricity in the process of transferring it to the final consumer, while in the case of nuclear energy, losses amount to 8%, 5% in the case of the Hydroelectricity and only 1% is lost in this process for wind energy, which leads to a further decrease in the financial efficiency of energy produced from fossil sources.

However, we should bear in mind, that a significant part of electricity is still generated from coal (24% of the energy production mix), which means that before we can shut down these two Power Plants, alternative sources of energy should be provided.

Without the prior provision of alternative energy sources, the closure of the two Power Plants will increase Romania's dependency on energy imports, which will result in a higher cost for consumers and a significant source of uncertainty for national energy security.

This paper accounts only for the impact of a full closure on air pollution and the gap that would remain in reaching the 2030 targets. Further research should focus on accounting the impact a full closure will have on regional employment and welfare, bearing in mind that the regions are highly dependent on coal sector activities. Also, further research should be focused on the role of coal fired power plants have in balancing the national electricity grid and on electricity supplied in heavy winter months, there were short periods of time (days) when coal fired power plants provided almost 40% of total electricity used at national level.

Acknowledgments

This article is supported by the project “STAREBEI-Sustainable Paths of Just Transition for the Coal Regions in Romania”, 2020-2021, funded by the European Investment Bank. Any errors remain those of the author. The findings, interpretations, and conclusions presented in this document are entirely those of the author and should not be attributed in any manner to the European Investment Bank.

Note

- ⁽¹⁾ Transelectrica is the Romanian Transmission and System Operator (TSO). It is responsible for electricity transmission, system and market operations, grid and market infrastructure development ensuring the security of the Romanian power system.

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Equilibrium in a Stackelberg duopoly

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Abstract. *Theory of the games offers perfect tools for modelling imperfect competition specific processes, manifested in relation with product quantity (Cournot/Stackelberg type), product price (Bertrand type) or quality. The equilibrium solution in terms of output is highlighted in a Cournot situation, whilst the price equilibrium solution can be revealed in a Bertrand scenario. Despite the different strategy type based on, the common denominator of these two models is given by the fact that strategic choices are made simultaneously. The Stackelberg model instead, represents a perfect information sequential game – firms advocating for quantity competition – having both theoretical and practical applicability. In the simplest possible case, with two players moving in two stages, the leader will always choose a certain output level, and the follower observes this decision and then establish his action path accordingly. Present paper's main goal is to analyze a duopoly market with players adopting a Stackelberg behavior. Regardless the analyzed scenario, both firms are expected to survive and a stable equilibrium will manifest (the Subgame Perfect Equilibrium). The price will be invariable at market demand curve slope, whilst player's choosed quantities and also gained profits level will be in an inverse dependence relation with it. The leader's chosen output and also registered profit levels will be double vs the follower's profit.*

Keywords: Stackelberg equilibrium, Stackelberg model, Cournot model, oligopoly, stability.

JEL Classification: C72, D01, D43, L13.

1. Introduction

As one of the fundamental oligopoly games illustration, monopoly theory can be traced back two centuries ago, at the date when Antoine Augustin Cournot first put forward the mathematical model of duopoly competition (1838). Cournot model became a starting point for oligopoly theory analysis – duopoly scenario, with firms producing homogeneous products, choosing to compete in terms of quantities, taking simultaneously individual decisions regarding production level.

After almost a century, another duopoly market model has been developed, with players competing also in quantities, but this time the decisions were taken consecutively (Stackelberg duopoly). Known also as Stackelberg competition and being an imperfect competition model based on a non-cooperative game, it actually represents an extension of the Cournot's model. It was developed by Heinrich von Stackelberg (1934) in his book "Market Structure and Equilibrium" and represent a breaking point in the market structure analysis, mainly in duopoly scenario. Based on different starting hypothesis and offering different conclusions than those of the Cournot's and Bertrand's models, the Stackelberg duopoly model is a sequential game with perfect information (unlike the Cournot's model, which is a simultaneous one).

As previously anticipated, the model has a real theoretical importance but also a practical one. It can be efficiently used in industrial organizations, to study the market structure determinants and other connected issues like market entry and entry preemption (Mueller, 1986; Sutton, 2007 and Berry and Reiss, 2007). Stackelberg model is also a perfect tool for hierarchical structure scenario's analysis. Zhang and Zhang (2009) used such a game to model the problem of spectrum allocation in Cognitive Radio Networks. Another Stackelberg game-based approach has also been used to model the efficient bandwidth allocation problem in the cloud-based wireless networks, where desktop users watching the same channel may be willing to share their live-streaming with the nearby mobile users (Nan et al., 2014). Stackelberg models have been widely used in the security domain to illustrate the attacker-defender models (Pita et al., 2009 – protection against terrorists at Los Angeles International Airport; Michael and Scheffer, 2011 – adversarial learning modelling in the setup when the opponent tries to manipulate the data miner's data to reduce the accuracy of the classifier.; Trejo et al., 2015; Clempner and Poznyak, 2015, etc.). Concluding, theoretical Stackelberg game models have been widely used to model different situations in various real market areas.

We further investigate the influence of market demand curve slope, on Stackelberg static equilibrium model, emphasising aspects such as firm stability and demand curve slope impact on the perfect subgame equilibrium theory. The principles of the related mathematic model are also described below.

2. The model

The background used is one with two firms, which sell homogeneous goods, subject to the same demand and cost functions. One of them (called "the leader") has the right to make

the first move, thanks to certain potential advantages as market power, size, reputation, historical precedence, sophistication, information, innovation and so forth. Stackelberg assumes the fact that this duopolist is sufficiently sophisticated to recognise that his rival acts on the Cournot assumption. This recognition allows him to determine his competitor's reaction curve and include it in his own profit function, acting as a monopolist in an attempt to maximise payoff. The other one (called "the follower") observes his strategy and decides about its own accordingly. His profit depends on the output level chosen by the leader which is predetermined in his opinion, therefore will be considered an invariable information.

It is worth mentioning that the leader's action is irreversible as he knows *ex ante* that the follower observes his actions, establishing his own action path accordingly. The first mover advantage is undeniable, triggering the idea that the leader yields a higher payoff than the follower does.

An example of such leadership may be Microsoft's software markets dominance. Although Microsoft can make decisions first, other smaller companies can only react by making their own decisions. The followers action, in turn, affect Microsoft. Another potential Stackelberg leadership's scenario is highlighted in the aircraft industry – Boeing and Airbus competition (Waldman and Jensen, 2016).

Let's consider a general price function $P(Q)$, better expressed as $P(q_1 + q_2)$, giving the existing duopoly scenario. q_1 and q_2 below represent the leader/the follower output level and Q represents the aggregate market demand:

$$P(Q) = P(q_1 + q_2) \quad (1)$$

We also assume that firm i cost structure is $C_i(q_i), i = \overline{1,2}$.

To solve the model and find the subgame perfect equilibrium, we need to use backward induction, as in any sequential game. The leader anticipate the follower's best reaction, more precisely the way this will respond once it has observed his decision. After that, choose his maximizing payoff quantity q_1 , to which the follower reacts by choosing the expected quantity q_2 . We should first determine the follower's best response function.

The profit function of the follower will be:

$$\pi_2 = P(q_1 + q_2)q_2 - C_2(q_2) \quad (2)$$

First order derivate expression can be found below:

$$\frac{\delta \pi_2}{\delta q_2} = \frac{\delta P(q_1 + q_2)}{\delta q_2} q_2 + P(q_1 + q_2) - \frac{\delta C_2(q_2)}{\delta q_2} \quad (3)$$

whilst setting to zero value the marginal profit expression, opens the path for finding out the follower best reply function.

We are looking forward now to the leader's best reply function:

$$\pi_1 = P(q_1 + q_2(q_1))q_1 - C_1(q_1) \quad (4)$$

where $q_2(q_1)$ represent the follower's quantity as a strictly dependent function of the leader's output, as we have previously agreed. The leader marginal profit expression, who's leading to its best reply function, can be described as follows:

$$\frac{\delta \pi_1}{\delta q_1} = \frac{\delta P(q_1 + q_2)}{\delta q_2} \frac{\delta q_2(q_1)}{\delta q_1} q_1 + \frac{\delta P(q_1 + q_2)}{\delta q_1} q_1 + P(q_1 + q_2(q_1)) - \frac{\delta C_1(q_1)}{\delta q_1} \quad (5)$$

Let's further consider a downward sloping linear demand curve scenario, with price dependence described as follows:

$$P(q_1 + q_2) = a - b(q_1 + q_2) \quad (6)$$

where $a > 0$, $b > 0$, whilst P represents the price paid by consumers for purchasing required product amount. The prior mentioned inverse demand function is getting close to the second products particular case of the formula used by Kresimir Zigic (2012) in his analyze, which presents a differentiated products Stackelberg scenario (with $b \in (0,1)$ reflecting the degree of product differentiation or substitutability)

Adjusting previously mentioned formulas to the current hypothesis, the follower's profit function expression becomes:

$$\pi_2 = [a - b(q_1 + q_2)]q_2 - C_2(q_2) \quad (7)$$

Marginal profit expressions represent the starting point in the revealing of the follower reaction function (see Appendix A):

$$q_2 = \frac{a - bq_1 - \frac{\delta C_2(q_2)}{\delta q_2}}{2b} \quad (8)$$

The spring of further equilibrium values, is represented by the leader profit function:

$$\pi_1 = [a - b(q_1 + q_2(q_1))]q_1 - C_1(q_1) \quad (9)$$

and all other mathematical calculation (related in Appendix A) leads to:

$$q_1^* = \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{2b} \quad (10)$$

$$q_2^* = \frac{a - 3 \frac{\delta C_2(q_2)}{\delta q_2} + 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b} \quad (11)$$

where q_1^* – the leader's best response to the follower's reaction, and q_2^* – the follower's reaction function. That means the market demand level in the equilibrium situation is:

$$Q^* = q_1^* + q_2^* = \frac{3a - \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b} \quad (12)$$

and further, the equilibrium price

$$p^* = \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} + 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4} \quad (13)$$

Referring now to the cost function, for the simplicity of calculation but also for a better understanding, we can impose some mathematical restrictions

$$\frac{\delta^2 C_i(q_i)}{\delta q_i \delta q_j} = 0; \quad \frac{\delta C_i(q_i)}{\delta q_j} = 0; \quad i, j = \overline{1,2} \quad (14)$$

and from all types of possible functions, we pick the linear one $C_i(q_i) = c_i q_i$. Including also this last hypothesis in the model, the Stackelberg perfect subgame equilibrium values become:

$$q_1^* = \frac{a - c}{2b} \quad (15)$$

$$q_2^* = \frac{a - c}{4b} \quad (16)$$

$$p^* = \frac{a + 3c}{4} \quad (17)$$

$$\pi_1^* = \frac{(a - c)^2}{8b} \quad (18)$$

$$\pi_2^* = \frac{(a - c)^2}{16b} \quad (19)$$

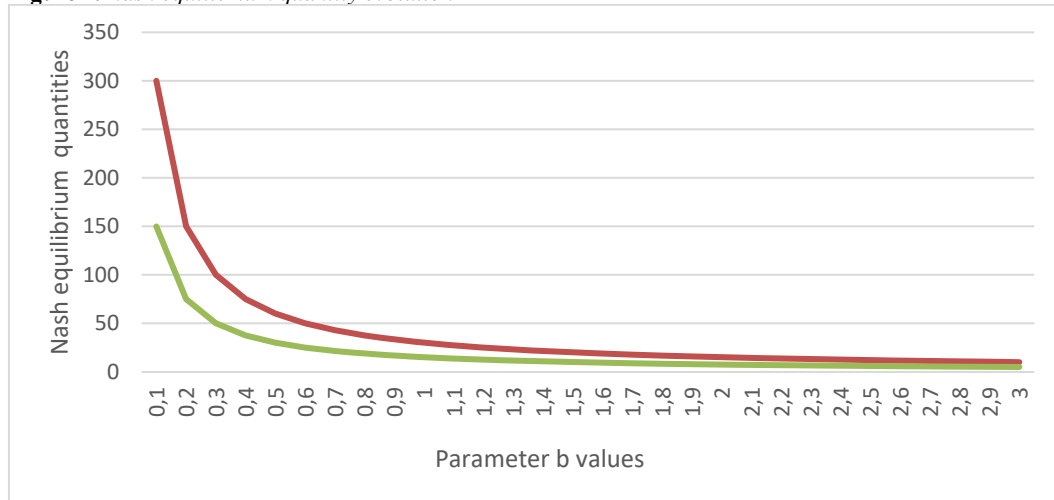
The results obtained lead to the following conclusions:

- $q_1^* > q_2^*$, meaning the leader produce more (better said, the leader's output is twice as much the follower does);
- $p^* > c$, confirming that both players have the possibility of making profits;
- $\pi_1^* > \pi_2^*$, the leader register higher (double) profit, so there is a real advantage to move first. There are two main reasons: the leader knows that by increasing his output will force the follower to reduce his own and this decision is irreversible (undoing its action we would reach the Cournot scenario).
- $Q^* > Q_{COURNOT} \rightarrow p^* < p_{COURNOT}$. The Stackelberg game leads to a more competitive equilibrium than the Cournot one does.

We are now treating the $b = 1$ situation – perfectly substitutes products. Therefore, $p = a - q_1 - q_2$ highlighting the simplest possible form for price – output mathematical relation. Thus $p + Q = a$, meaning their sum remaining constant, equalizing a parameter value. The quantity offered by the leader will be $q_1 = (a-c)/2$ whilst his follower's response is $q_2 = (a-c)/4$. The price value suffered no modification $p = (a+3c)/4$ as it isn't affected by the parameter's b variation; looking further, we can note that the leader/follower profit level become $\pi_1 = (a-c)^2/8$, respectively $\pi_2 = (a-c)^2/16$.

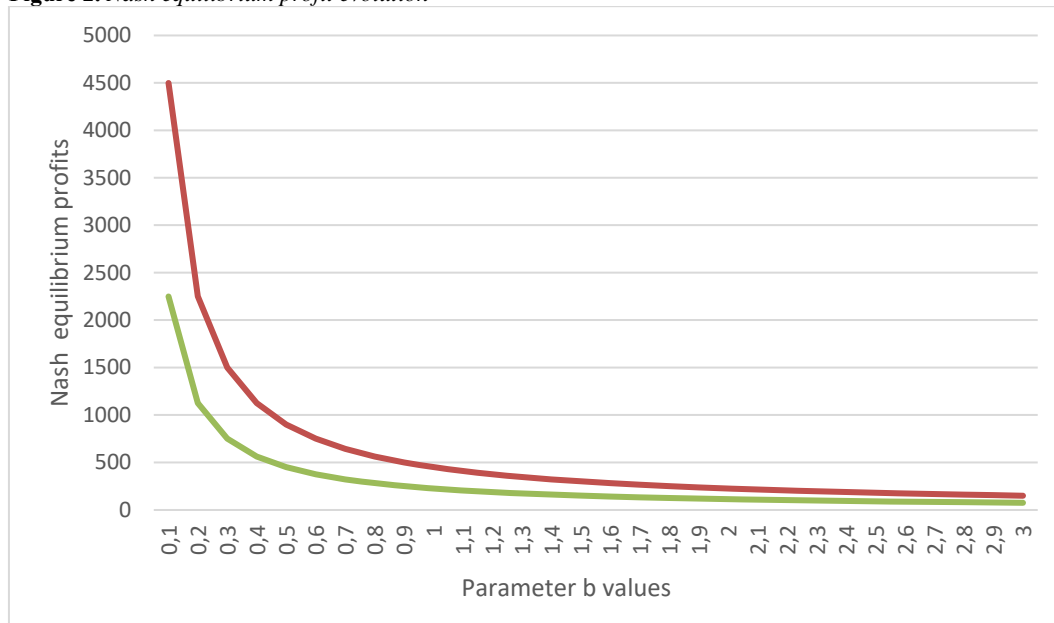
We further analyze the quantity/profit sensitivity to the changes in the level of parameter b , in a subgame equilibrium scenario (the price is not related with b parameter, being constant at any a and c hypothetical value pairs.). All the mathematical calculations representing graphical analyze basis below, are reflected by Appendix B, whilst in our simulation, we customize parameters a and c , as follows: $a = 100$ EUR; $c = 40$ EUR. Considering these assumptions, we start the parameter b gradual increasing, with a convenient ratio of 0.1, from the initial 0.1 value, up to 3.0 final value.

Figure 1. Nash equilibrium quantity evolution



Source: own processing.

Figure 2. Nash equilibrium profit evolution



Source: own processing.

Conclusions

Despite the fact that b parameter value is continuously changing, we can easily observe that the equilibrium price remain constant, with its mathematical expression depending only on a and c parameters. More precisely, regardless b level growth from 0.1 to 3, the equilibrium price keeps its initial 55 EUR value.

As for the quantity triggering the equilibrium scenario, a downward trend is observed, starting with $5*(a-c)$ (leader case)/ $2.5*(a-c)$ (follower case). The explanation is also mathematical, deriving from the fact that $q_1^{*'} = -\frac{a-c}{2b^2}$, $q_2^{*'} = -\frac{a-c}{4b^2}$ are negative expressions – kind of monotony specific for decreasing functions. Going further, $q_1^{*''} = \frac{a-c}{b^3}$, $q_2^{*''} = \frac{a-c}{2b^3}$, strictly positive second order derivates provoking the graph's convexity. Referring at figures, equilibrium quantity level follows a decreasing trend from its initial value of 300 kg (leader)/150 kg (follower), down to zero value (close to, but not tangible, because $y=0$ and $x=0$ represents horizontal/vertical asymptotes, in fact).

In profit equilibrium scenario a downward trend can be highlighted as well, starting from $1.25 (a-c)^2$ (leader) / $0.625 (a-c)^2$ (follower) down to zero, value which would also never been reached. One more time, math principles offer the key, as $\pi_1^{*'} = -\frac{(a-c)^2}{8b^2}$, $\pi_2^{*'} = -\frac{(a-c)^2}{16b^2}$, strictly negative expressions being specific for decreasing functions. For the same aforementioned reasons (second order positive derivates), we face also a function convexity scenario. Previously hypothesis being given, a downward profit trend can be observed, starting with 4.500 EUR (leader) / 2.250 EUR (follower) down to minimum rentability level (zero profit – not tangible, having $y = 0$ also a horizontal asymptote).

3. Graphic approach

In the next paragraphs, we will try to explain the Stackelberg behaviour, making use by the graphical method, based on duopolist's reaction functions. First of all, we have to deduce the leader isoprofit curve's general expression, and looking forward, his competitor's best response:

$$\pi^1(q_1, q_2) = [a - b(q_1 + q_2) - c]q_1,$$

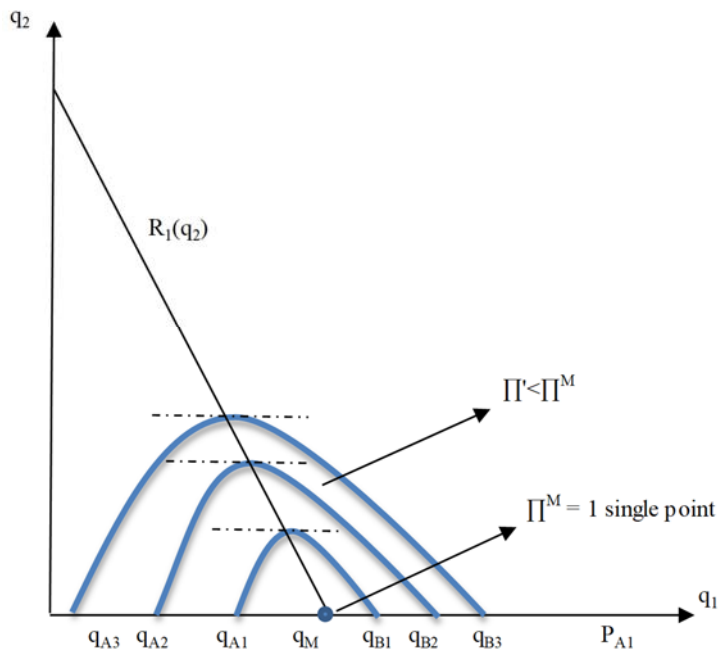
$$\text{then } \bar{\pi} = [a - b(q_1 + q_2) - c]q_1 = aq_1 - bq_1^2 - bq_1q_2 - cq_1$$

$$\rightarrow bq_1q_2 = (a - c)q_1 - bq_1^2 - \bar{\pi} \rightarrow q_2 = \frac{a - c}{b} - q_1 - \frac{\bar{\pi}}{bq_1}$$

Each isoprofit curve reflects a constant level of profit that could be obtained by a certain player at different output levels choosed by him and his rival. The follower's first order derivate expression highlights the isoprofits curves trend (ascending/descending), whilst the one related to the second order offers very important informations regarding the concavity related to the axes:

$$\frac{dq_2}{dq_1} = -1 + \frac{\bar{\pi}}{bq_1^2} \rightarrow \frac{d^2q_2}{dq_1^2} = -\frac{2\bar{\pi}}{bq_1^3} < 0$$

Figure 3. Leader's isoprofit and best reply functions



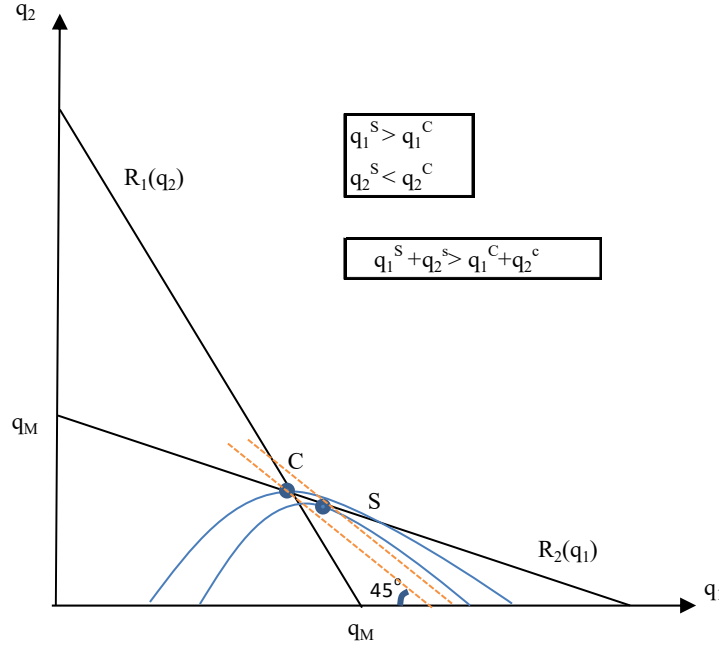
Source: own processing.

First player (the leader) will always choose its best response, highlighted by the isoprofit curve that corresponds to the maximum profit, at a q_2 given level (Figure 3).

The intersection point of the isoprofit curves with the reaction function, has the mathematical zero slope property (Machado, 2008).

$$R_1(q_2) = \operatorname{argmax} \pi^1(q_1, q_2) \rightarrow \pi_1^1(R_1(q_2), q_2) = 0.$$

Besides, we already know that $\pi^1(q_1, q_2) = \bar{\pi} \rightarrow \pi_1^1 dq_1 + \pi_2^1 dq_2 = 0 \rightarrow \frac{dq_2}{dq_1} = -\frac{\pi_1^1}{\pi_2^1}$, resulting the derivate $\frac{dq_2}{dq_1}$ should be null in leader's best response scenario $q_1 = R_1(q_2)$

Figure 4. Stackelberg equilibrium vs. Cournot equilibrium

Source: own processing.

The leader's optimal behavior is reached in the tangency point S of his isoprofit curve with the reaction curve of the follower (second player), whilst C represents the Cournot equilibrium, where the reaction curves cross and where $dq_2/dq_1 = 0$ (as we have previously mentioned). All three above mentioned relations (see Figure 4) can be easily proved either by comparing the specific equilibrium values of Stackelberg and Cournot models (see formulas (21)-(25)) or by a simple figure analyse.

$$q_1^S = \frac{a-c}{2b} = \frac{3}{2} \frac{a-c}{3b} = \frac{3}{2} q_1^C > q_1^C \quad (20)$$

$$q_2^S = \frac{a-c}{4b} = \frac{3}{4} \frac{a-c}{3b} = \frac{3}{4} q_2^C < q_2^C \quad (21)$$

$$Q^S = q_1^S + q_2^S = \frac{3(a-c)}{4b} > \frac{2(a-c)}{3b} = q_1^C + q_2^C = Q^C \quad (22)$$

$$p^S = \frac{a+3c}{4} < \frac{a+2c}{3} = p^C \xleftarrow{a>c} \frac{a+3c}{4} < \frac{a+2c}{3} \rightarrow$$

$$\rightarrow 3a+9c < 4a+8c \rightarrow c < a \quad (A) \quad (23)$$

$$\pi_1^S = \frac{(a-c)^2}{8b} = \frac{9}{8} \frac{(a-c)^2}{9b} = \frac{9}{8} \pi_1^C > \pi_1^C \quad (24)$$

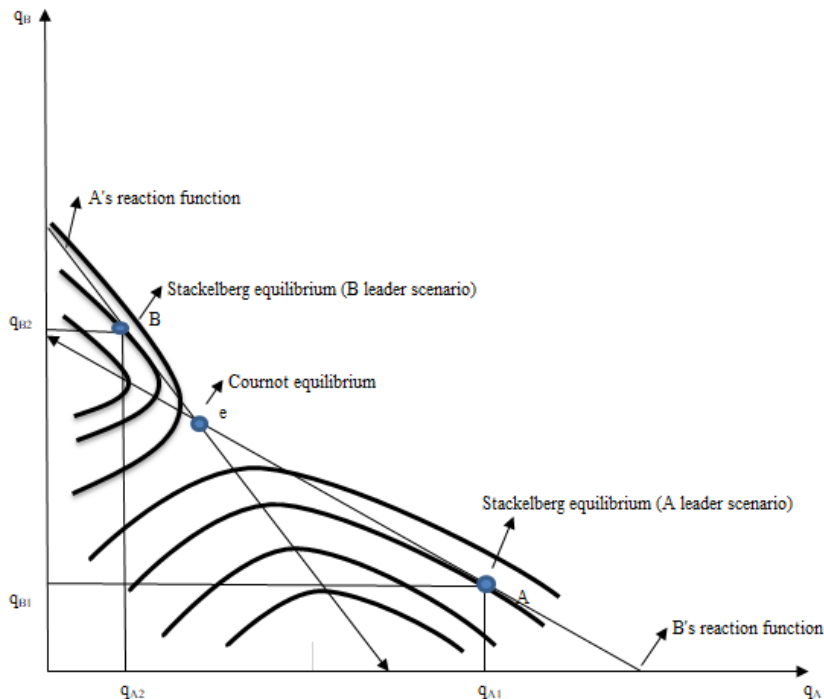
$$\pi_2^S = \frac{(a-c)^2}{16b} = \frac{9}{16} \frac{(a-c)^2}{9b} = \frac{9}{16} \pi_2^C < \pi_2^C \quad (25)$$

Conclusions: in the symmetric firms scenario (with matching costs), the Stackelberg solution is better than Cournot's one (higher aggregate output, lower price, higher aggregate profits). On the other side, leader's profit level should be no lower than in Cournot scenario because he could have always obtain the Cournot profits level by simply choosing the Cournot quantity q_1^C , to which his rival would have replied with its Cournot quantity $q_2^C = R_2(q_1^C)$, since the follower reaction curve in Cournot is the same as in Stackelberg.

We can further expand our analysis, referring less at the mathematic principles and focusing almost exclusively on the graphical approach. Moreover by offering additional details, we intend to facilitate a better understanding of the previous conclusions while also formulating new ones. Maintaining the direction, we are highlighting any possible scenario that can be found in the real market and also explaining behavioral patterns which can be rationally adopted by duopolists.

The isoprofit curves (concave to the axes, measuring players outputs) and also the duopolists reaction functions are presented in Figure 5. Assuming first player as the leader, it will consider that his competitor will always act after a stringent observation of its own reaction curve. Because of this assumption, the leader can afford to set its own output level in order to maximize its own profit. The level we are referring at, is represented by point A, situated on the lowest possible isoprofit leader's curve, highlighting the maximum profit this one can achieve given the follower's reaction curve.

Figure 5. Duopolists reaction function and also isoprofit curves



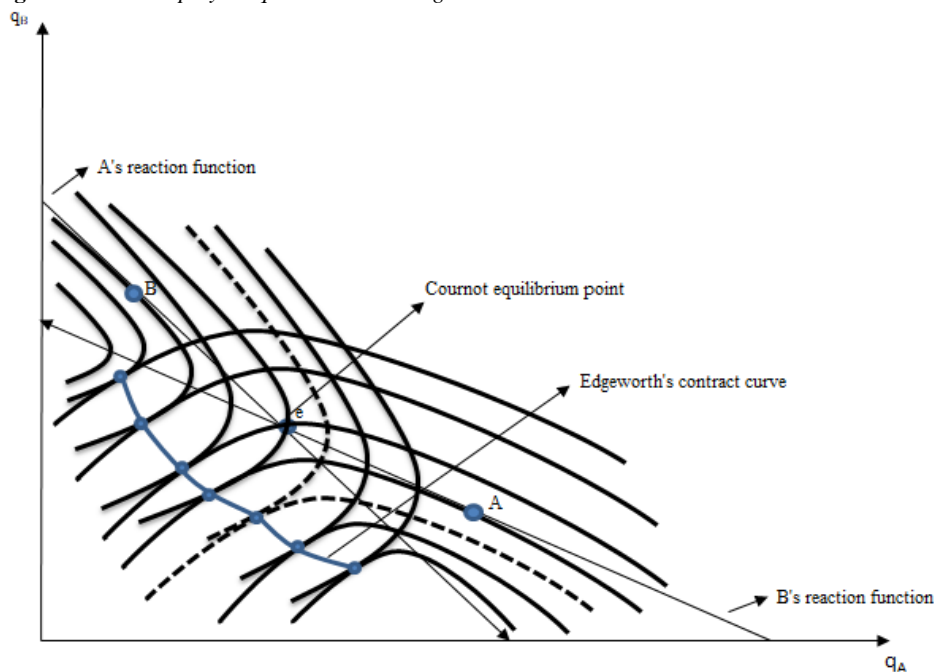
Source: own processing.

Acting as a monopolist, first player will take care to incorporate the follower's reaction function in his profit-maximizing estimations. He will choose to produce q_{A1} , and the second player will react by producing q_{B1} according to its reaction curve. The leader's market advantage is rewarding him, because in this scenario, he reaches an isoprofit curve closer to his axis than in the situation of behaving with the same naivete as the follower. The same scenario proved to be worse for the second player, comparing with the Cournot equilibrium case, since this output level allows him to reach an isoprofit curve further away from his axis.

In we consider a scenario with the second player as leader instead, his output producing decision being q_{B2} , whilst his competitor immediate reaction q_{A2} . The graphic corresponding point will be B this time, lied on first player's reaction function, measuring the largest profit level that player B can achieve, based on his isoprofit map and first player's reaction function. The actual leader register a higher profit whilst the first player has a lower profit as compared with the Cournot equilibrium scenario.

To conclude, with only one firm sophisticated on the market, emerging as the leader, a stable equilibrium will manifest and the naive firm will always act as a follower.

Figure 6. Rational player equilibrium and Edgeworth's contract curve



Source: own processing.

In the real market, duopoly' scenarios can be found, where both players having comparable market shares, sophistication, size, reputation, etc. In this situation, each of them will feel rightful to act as leader, because acting accordingly, will register a higher profit level. Such a behavior, with both having the pretence that the other one strategy being in strictly dependence of his own, will finally drive the market to instability. The situation is better

known as Stackelberg's disequilibrium and there exists only two possible scenarios to get out of it: either a price war triggers, until one player surrenders and accepts to act as follower, or a collusion is targeted. Latest option will assume that firms abandon their naive reaction functions and moves to a point closer to the Edgeworth contract curve, higher profit levels being reached by each. If the final equilibrium lies precisely on the Edgeworth contract curve, the joint industry profits are maximised (Figure 6).

The last possibility is that both firms desire to be followers. Obviously, their expectations are not materialized, since each duopolist assumes that his competitor will act as a leader, so they have to revise them. Two behavioural patterns are possible. If each duopolist aware that his rival wants to be also a follower, the Cournot equilibrium is attained. Otherwise, one player should alter his behaviour and start acting as a leader before equilibrium is reached.

Stackelberg's model analyze drives to some interesting conclusions. First, it shows clearly that naive behaviour does not work. The players should admit their interdependence. Perfect awareness of his rival's reactions allows each duopolist to increase its profit level. If both players recognise their mutual interdependence, each starts considering his rival's profits and reactions and worrying about it. In return, if they continue to ignore each other, a price war will be implacable, its final result being worse off.

On the other side, the model highlights that a bargaining procedure and a collusive agreement will be advantageous for both. In such a scenario, the players may reach a point lied on the Edgeworth contract curve, then joint profit will be maximised.

To conclude our analyze, it could be useful to mention Stackelberg's model weaknesses, loudly criticized by some experts. The Stackelberg solution successfully correlate the duopoly issue to a family of related market structures. Unfortunately, the theory is focused on the use of reaction functions, highlighting individual profit maximisation for given values of the competitor's variable. This undermine theory's practical importance, by excluding the problem of coordination and collusion between duopolists.

1. The exclusion of the collusion aspect leads to unlikely results. There isn't any doubt regarding that the leadership equilibrium (one leader and one follower scenario) includes collusion or spontaneous coordination elements. However, they represent an arbitrary coordination form when leadership is resumed only at selecting a point along a traditional kind reaction curve. Such type of equilibria carry small meaning reported at joint profit maximisation.
2. The intersection-point equilibrium is based on arbitrary and wrong notions regarding the way of the competitor's behaves. They rest on the assumption that competitor's variable value is given regardless of the duopolist's own moves. The intersection-point equilibrium emerge from a mutual attempt to follow the rival's leadership. But the selected point on the reaction function by one duopolist does not play any part in shaping the policies of his rival, meaning this analysis basical assumption is arbitrary and wrong.
3. Resulting from the leadership attempts of both duopolists, the Stackelberg disequilibrium is also based on wrong rationality and arbitrary assumptions. It may arise from the assumption that the competitor moves along a reaction curve which does not actually exist for him. Other possible explanation is based on the argument that each

competitor is forced to react along a curve which does not exist for him, being mandatory for him to act as a follower.

This way, the reaction curves of the Stackelberg problem, based on mere hypothesis, have made his theory poor and unrealistic. Despite these weaknesses, the Stackelberg model highlights the importance of mutual interdependence between duopolists. If they admit it, will be able to earn profits, but if they decide to ignore it, both will be losers. On the other way, the entrance into a collusive agreement, could maximise their jointly profits.

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Appendix A

$$\frac{\delta\pi_2}{\delta q_2} = 0 \rightarrow \frac{\delta[a - b(q_1 + q_2)]}{\delta q_2} q_2 + a - b(q_1 + q_2) - \frac{\delta C_2(q_2)}{\delta q_2} =$$

$$= -bq_2 + a - b(q_1 + q_2) - \frac{\delta C_2(q_2)}{\delta q_2} = 0$$

$$-2bq_2 = \frac{\delta C_2(q_2)}{\delta q_2} - a + bq_1 \rightarrow q_2 = \frac{a - bq_1 - \frac{\delta C_2(q_2)}{\delta q_2}}{2b}$$

$$\pi_1 = [a - b(q_1 + q_2(q_1))]q_1 - C_1(q_1) =$$

$$= \left(a - b \left(q_1 + \frac{a - bq_1 - \frac{\delta C_2(q_2)}{\delta q_2}}{2b} \right) \right) q_1 - C_1(q_1) =$$

$$= \left(a - bq_1 - \frac{a - bq_1 - \frac{\delta C_2(q_2)}{\delta q_2}}{2} \right) q_1 - C_1(q_1) =$$

$$= \frac{a - bq_1 + \frac{\delta C_2(q_2)}{\delta q_2}}{2} q_1 - C_1(q_1)$$

$$\frac{\delta\pi_1}{\delta q_1} = 0 \rightarrow \frac{a - bq_1 + \frac{\delta C_2(q_2)}{\delta q_2}}{2} - \frac{bq_1}{2} - \frac{\delta C_1(q_1)}{\delta q_1} =$$

$$= \frac{a - 2bq_1 + \frac{\delta C_2(q_2)}{\delta q_2}}{2} - \frac{\delta C_1(q_1)}{\delta q_1} = 0$$

$$-bq_1 + \frac{a + \frac{\delta C_2(q_2)}{\delta q_2}}{2} - \frac{\delta C_1(q_1)}{\delta q_1} = 0 \rightarrow q_1^* = \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{2b}$$

$$q_2^* = \frac{a - b \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1} - \frac{\delta C_2(q_2)}{\delta q_2}}{2b}}{2b} \rightarrow$$

$$\rightarrow q_2^* = \frac{a - 3 \frac{\delta C_2(q_2)}{\delta q_2} + 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b}$$

$$q^* = q_1^* + q_2^* = \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{2b} + \frac{a - 3 \frac{\delta C_2(q_2)}{\delta q_2} + 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b} =$$

$$= \frac{3a - \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b}$$

$$p^* = a - b(q_1^* + q_2^*) = a - b \frac{3a - \frac{\delta C_2(q_2)}{\delta q_2} - 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4b} \rightarrow$$

$$\rightarrow p^* = \frac{a + \frac{\delta C_2(q_2)}{\delta q_2} + 2 \frac{\delta C_1(q_1)}{\delta q_1}}{4}$$

$$C_i(q_i) = cq_i \rightarrow \frac{\delta C_i(q_i)}{\delta q_i} = c_i(q_i) = c, (\forall) i = \overline{1,2}$$

$$q_1^* = \frac{a - c}{2b} \quad q_2^* = \frac{a - c}{4b} \quad p^* = \frac{a + 3c}{4}$$

$$\pi_1^* = (p^* - c)q_1^* = \left(\frac{a + 3c}{4} - c\right) \frac{a - c}{2b} = \frac{(a - c)^2}{8b}$$

$$\pi_2^* = (p^* - c)q_2^* = \left(\frac{a + 3c}{4} - c\right) \frac{a - c}{4b} = \frac{(a - c)^2}{16b}$$

$$q_1^* = 2q_2^* \quad \pi_1^* = 2\pi_2^*$$

Appendix B

Table 1. Simulation of price, quantity and profit evolution

b	p	q ₁	q ₂	π ₁	π ₂
0.1	0.25*a+0.75*c	5.000000*(a-c)	2.5*(a-c)	1.250000*(a-c) ²	0.625000*(a-c) ²
0.2	0.25*a+0.75*c	2.500000*(a-c)	1.25*(a-c)	0.625000*(a-c) ²	0.312500*(a-c) ²
0.3	0.25*a+0.75*c	1.666667*(a-c)	0.833333*(a-c)	0.416667*(a-c) ²	0.208333*(a-c) ²
0.4	0.25*a+0.75*c	1.250000*(a-c)	0.625000*(a-c)	0.312500*(a-c) ²	0.156250*(a-c) ²
0.5	0.25*a+0.75*c	a-c	0.500000*(a-c)	0.250000*(a-c) ²	0.125000*(a-c) ²
0.6	0.25*a+0.75*c	0.833333*(a-c)	0.416667*(a-c)	0.208333*(a-c) ²	0.104167*(a-c) ²
0.7	0.25*a+0.75*c	0.714286*(a-c)	0.357143*(a-c)	0.178571*(a-c) ²	0.089286*(a-c) ²
0.8	0.25*a+0.75*c	0.625*(a-c)	0.312500*(a-c)	0.156250*(a-c) ²	0.078125*(a-c) ²
0.9	0.25*a+0.75*c	0.555556*(a-c)	0.277778*(a-c)	0.138889*(a-c) ²	0.069444*(a-c) ²
1.0	0.25*a+0.75*c	0.5*(a-c)	0.250000*(a-c)	0.125000*(a-c) ²	0.062500*(a-c) ²
1.1	0.25*a+0.75*c	0.454545*(a-c)	0.227273*(a-c)	0.113636*(a-c) ²	0.056818*(a-c) ²
1.2	0.25*a+0.75*c	0.416667*(a-c)	0.208333*(a-c)	0.104167*(a-c) ²	0.052083*(a-c) ²
1.3	0.25*a+0.75*c	0.384615*(a-c)	0.192308*(a-c)	0.096154*(a-c) ²	0.048077*(a-c) ²
1.4	0.25*a+0.75*c	0.357143*(a-c)	0.178571*(a-c)	0.089286*(a-c) ²	0.044643*(a-c) ²
1.5	0.25*a+0.75*c	0.333333*(a-c)	0.166667*(a-c)	0.083333*(a-c) ²	0.041667*(a-c) ²
1.6	0.25*a+0.75*c	0.312500*(a-c)	0.156250*(a-c)	0.078125*(a-c) ²	0.039063*(a-c) ²
1.7	0.25*a+0.75*c	0.294118*(a-c)	0.147059*(a-c)	0.073529*(a-c) ²	0.036765*(a-c) ²
1.8	0.25*a+0.75*c	0.277778*(a-c)	0.138889*(a-c)	0.069444*(a-c) ²	0.034722*(a-c) ²
1.9	0.25*a+0.75*c	0.263158*(a-c)	0.131579*(a-c)	0.065789*(a-c) ²	0.032895*(a-c) ²
2.0	0.25*a+0.75*c	0.250000*(a-c)	0.125000*(a-c)	0.062500*(a-c) ²	0.031250*(a-c) ²
2.1	0.25*a+0.75*c	0.238095*(a-c)	0.119048*(a-c)	0.059524*(a-c) ²	0.029762*(a-c) ²
2.2	0.25*a+0.75*c	0.227273*(a-c)	0.113636*(a-c)	0.056818*(a-c) ²	0.028409*(a-c) ²
2.3	0.25*a+0.75*c	0.217391*(a-c)	0.108696*(a-c)	0.054348*(a-c) ²	0.027174*(a-c) ²
2.4	0.25*a+0.75*c	0.208333*(a-c)	0.104167*(a-c)	0.052083*(a-c) ²	0.026042*(a-c) ²
2.5	0.25*a+0.75*c	0.200000*(a-c)	0.100000*(a-c)	0.050000*(a-c) ²	0.025000*(a-c) ²
2.6	0.25*a+0.75*c	0.192308*(a-c)	0.096154*(a-c)	0.048077*(a-c) ²	0.024038*(a-c) ²
2.7	0.25*a+0.75*c	0.185185*(a-c)	0.092593*(a-c)	0.046296*(a-c) ²	0.023148*(a-c) ²
2.8	0.25*a+0.75*c	0.178571*(a-c)	0.089286*(a-c)	0.044643*(a-c) ²	0.022321*(a-c) ²
2.9	0.25*a+0.75*c	0.172414*(a-c)	0.086207*(a-c)	0.043103*(a-c) ²	0.021552*(a-c) ²
3.0	0.25*a+0.75*c	0.166667*(a-c)	0.083333*(a-c)	0.041667*(a-c) ²	0.020833*(a-c) ²

Source: own processing.

Energy and economic growth. An empirical analysis

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Abstract. *This study investigates the interrelation between energy and economic growth for USA covering the time period from 1975 to 2017. Ordinary least squares method and the essential diagnostic tests are applied in order to examine the possible existence of autocorrelation, specification, heteroscedasticity and normality tests for residuals of estimated equation model. The empirical results of this study indicated that there is a linear and positive relationship between energy and economic growth for USA.*

Keywords: energy, economic growth, Ordinary least squares method, unit roots theory.

JEL Classification: O11, C22, Q40.

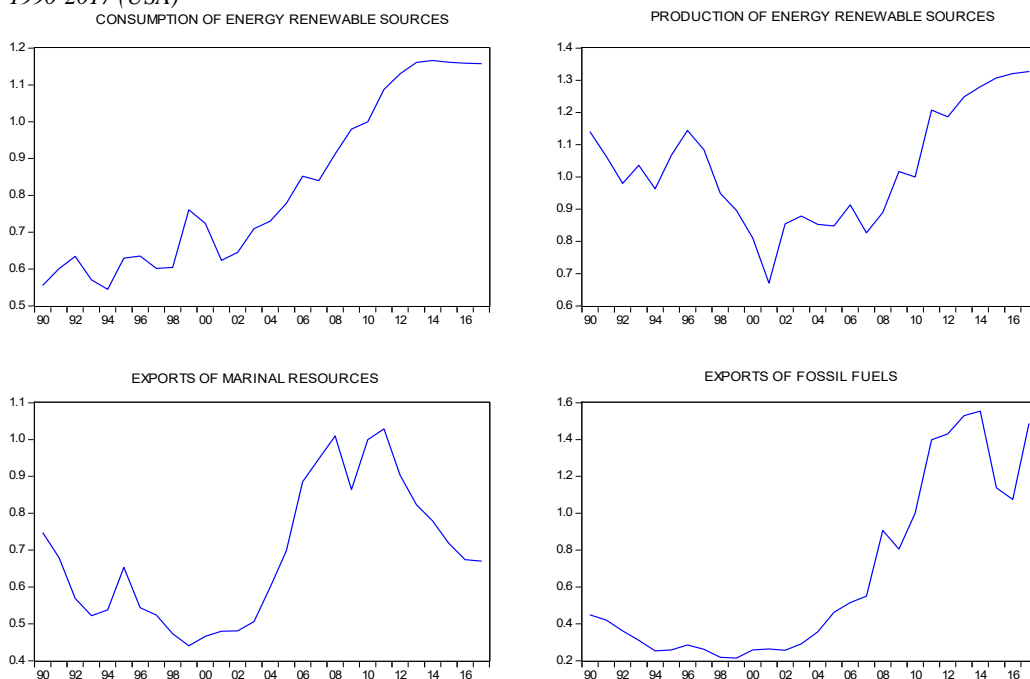
1. Introduction

The investigation of interrelation between energy and economic growth consists an important issue in the modern literature. Following the empirical studies of Hall et al. (2001), Hondroyannis et al. (2002), Stern and Cleveland (2004), it can be inferred that the energy sector encourages economic growth, through the exploitation of natural and mineral resources. Therefore, the use of energy facilitates the production from renewable sources and energy consumption respectively.

Specially, USA is regarded as a leader country in utilization of renewable energy resources the last decades, since tends to substitute highly the excessive consumption of electric power by alternative and energy nuclear. Also, USA one of the most developed countries worldly, is regarded as a dominant economy in energy sector and is mainly focused on exports of petroleum and gas fuels overcoming its competitors such as Russia and Saudi Arabia.

The energy consumption, the production renewable energy resources and the exports of mineral and fossil fuels in USA has raised remarkably from 1990 to 2017 as it seems in Figure 1.

Figure 1. Consumption and electricity production from renewable sources exports of mineral resources 1990-2017 (USA)



The ultimate goal of this study is to define the direct effect of energy growth on economic growth taking into account the positive effect of different energy resources such as alternative and nuclear energy and the use of renewable energy sources. The exploitation and the use of renewable energy sources can cause limitations of carbon dioxide (CO₂) emissions preventing the pollution of the environment.

The consumption and the production from energy renewable sources have increased rapidly the last decade in USA in conjunction with the substitution of electric power and the utilization of alternative energy sources. Exports and domestic production of USA have been augmented due to the higher demand of energy and the exploitation of its natural resources. The basic hypothesis of regression model defines that energy use, alternative and nuclear energy, electricity production from renewable sources and exports of mineral resources have a positive effect on gross domestic product in USA for the examined period 1975-2017.

This empirical study has the following objectives:

- a) To examine the interrelation between energy and economic growth.
- b) To estimate a linear equation model with ordinary least squares method in order to find out the existence or no of model linearity.
- c) To investigate the presence of statistical significance of model variables by applying diagnostic tests like autocorrelation, specification, heteroskedasticity and normality tests of residuals.

2. Literature review

The relationship between energy and economic growth has aroused an extensive academic interest in modern literature. Chontanawat et al. (2008) suggested that there is unidirectional causality from energy to economic growth in the developed OECD countries due to the reduction policy of carbon dioxide emissions to the environment and the limitations of excessive usage of energy resources. Sadorsky (2009) ascertained the positive and statistically significant effect of per capita income on renewable energy consumption estimating a linear model with panel analysis for 18 emerging countries.

Sari et al. (2008) estimated an autoregressive distributed lag (ARDL) model in order to find out the nexus between energy consumption and economic growth taking into account the effect of employment on economic growth in USA. The empirical results of their study revealed that the long-run equilibrium and the short-run fluctuations could be incorporated into the demand management strategies of energy market producers and policy makers.

Apergis and Payne (2011) examined the causal relationship between renewable energy consumption and economic growth for a panel of six Central American countries covering the time period from 1980 to 2006. The empirical results of their study indicated that there is a bidirectional causality between renewable energy consumption and economic growth both in the short-run and the long-run. Belke et al. (2011) certified that there is a bidirectional causality between energy consumption and economic growth for 25 OECD countries from 1981 to 2007. Moreover, Apergis and Payne (2012) found bidirectional causal nexus between renewable and non-renewable energy consumption-growth estimating a heterogeneous panel model analysis for 80 countries for the period 1990-2007.

Lau et al. (2011) confirmed that there is a long-run equilibrium relationship between energy consumption and economic growth for seventeen Asian countries. They supported

that energy consists an impetus of economic growth in the short-run but in the long-run, the energy consumption is fundamentally driven by economic growth. The energy conservation promotes sustainable economic development and contributes to environmental growth.

Menegaki (2011) investigated the causal relationship between economic growth and renewable energy for 27 European countries estimating a panel analysis based on a random effect model for the time period 1997-2007. In the opposite, she ascertained the neutrality hypothesis in causality analysis both in the short-run and long-run, implying that the consumption of renewable energy didn't play an effective role in economic growth in Europe, maybe due to the inefficient exploitation of energy resources and the early stages of development of renewable energy as well.

Destek (2016) examined the relationship between renewable energy consumption and economic growth in newly industrialized countries for the period from 1971 to 2011. The empirical results of asymmetric causality revealed negative shocks in renewable energy consumption caused positive shocks in economic growth for South Africa and Mexico, but negative shocks in economic growth for India, while the neutrality hypothesis of causality was confirmed for Brazil and Malaysia.

Jebli et al. (2016) verified the environmental Kuznets curve hypothesis studying the causality between per capita CO₂ emissions, gross domestic product (GDP), renewable and non-renewable energy consumption, and international trade for a panel of 25 OECD countries over the period 1980-2010. They concluded that renewable energy and trade have a negative impact on per capita CO₂ emissions caused by non-renewable energy resources. Furthermore they inferred that there is a bidirectional causality between energy and economic growth in the long run.

Finally, Adamopoulos and Kalogeridis (2019) resulted that energy consumption has a positive direct effect on economic growth, estimating a structural system equation model for Sweden covering the period from 1995 to 2015. The remainder of the paper proceeds as follows: Section 3 describes the data methodology of empirical study, while section 4 analyses the empirical results. Finally, section 5 provides the conclusions of this paper.

3. Data analysis and methodology

A linear regression model adopted to estimate the long-run effect of energy growth on economic growth. For this reason, an ordinary least squares method is applied in order to find out the interrelation between the examined variables, based on economic theory. The general form of the linear equation model is the following one:

$$GDP_t = c_1 + c_2 EN_{t-2} + c_3 ALTER_{t-1} + c_4 EL_PROD_REN_t + c_2 X_t + u_{1t} \quad (1)$$

where:

GDP – Gross Domestic Product.

EN – Energy use.

ALTER – Alternative and nuclear energy.

EL_PROD_REN – Electricity production from renewable sources.

X – Exports of mineral resources.

t – time trend.

t-i – lagged time trend.

u – residual (error term).

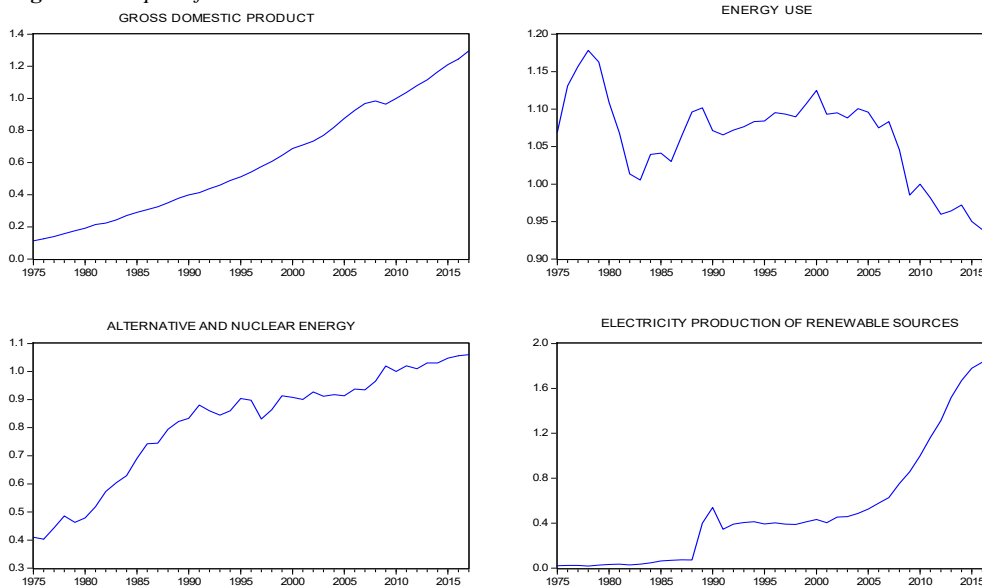
c_1, \dots, c_{21} – estimated coefficients.

Based on the studies of Katos et al. (1996), Hall et al. (2001), Katsouli (2006), Stern and Cleveland (2004), Vazakidis (2006), Apergis and Payne (2011), Adamopoulos and Kalogeridis (2019), the variable of economic growth (GDP) is measured by the real gross domestic product, while energy growth is represented by electricity production from renewable sources (EL_PROD_REN), energy use (EN), alternative and nuclear energy (ALTER).

In this empirical study annual data are used in the matter of Sweden, while the time period ranges from 1975 to 2017. Data have been obtained from the statistical database of World Bank (World Development Indicators online database). All data variables has been transformed in constant prices regarding 2010 as a base year. Eviews 10.0 (2017) software package is used to conduct the empirical results.

Statistical diagnostic tests such as autocorrelation, specification, heteroskedasticity and normality tests of residuals of the estimated model are examined in this linear regression model. The graphs of model variables are presented in Figure 2.

Figure 2. Graphs of examined variables



The higher rate of GDP, alternative and nuclear power, electricity production from renewable sources achieved in 2017, while the lower one was remarked in 1975 respectively.

3.1. Unit roots theory

According to Choi (1992), the Phillips-Perron test appears to be more powerful than the Augmented Dickey-Fuller test (Dickey and Fuller, 1979) for the aggregate data. Phillips-Perron (1988) unit root test can be used for stationarity testing for the existence of autocorrelated and heteroscedastic residuals as follows:

$$\ln(1+r) = a + b\left(\frac{t-T}{2}\right) + d \ln(1+r_{t-1}) + e_t \quad (2)$$

for $t = 1, 2, \dots, T$ where r_t denotes interest rate at time t , $(t-T/2)$ is a time trend and T is the sample size (Laopodis and Sawhney, 2007).

Equation 5 examines three hypotheses: The first hypothesis supposes that the time series contains a unit root either with a drift or both with a drift and a time trend: $H_0^1: d = 1$. The second hypothesis suggests that the time series contains a unit root without a time trend: $H_0^2: b = 0, d = 1$. The third hypothesis defines that the time series contains a unit root without a drift or a time trend: $H_0^3: a = 0, b = 0, d = 1$. The statistics tests that are used to examine each hypothesis separately are $z(t_d)$, $z(f_2)$, $z(f_3)$, respectively and are presented in the following equations:

$$z(t_d) = \left(\frac{s_0}{s_{Tl}}\right)t_s - \left(\frac{T^3}{3^{1/2}4D_{xxsTl}^{1/2}}\right)(s_{Tl}^2 - s_0^2) \quad (3a)$$

$$z(f_3) = \left(\frac{s_0^2}{s_{Tl}^2}\right)f_3 - \left(\frac{1}{2s_{Tl}^2}\right)(s_{Tl}^2 - s_0^2) \times \left[T(d-1) - \left(\frac{T^6}{48D_{xx}}\right)(s_{Tl}^2 - s_0^2)\right] \quad (3b)$$

$$z(f_2) = \left(\frac{s_0^2}{s_{Tl}^2}\right)f_2 - \left(\frac{1}{3s_{Tl}^2}\right)(s_{Tl}^2 - s_0^2) \times \left[T(d-1) - \left(\frac{T^6}{48D_{xx}}\right)(s_{Tl}^2 - s_0^2)\right] \quad (3c)$$

where:

$$f_3 = \frac{T(s_0^2 - (\bar{r} - \bar{r}_{t-1})^2 - s^2)}{2s^2} \quad (3d)$$

$$f_2 = \frac{T(s_0^2 - s^2)}{3s^2} \quad (3e)$$

s^2 is the residual variance, s_0^2 is the variance under the specific hypothesis for the standard critical t-test for $d = 1$. D_{xx} is the determinant of the $(x'x)$, where x is the T_3 matrix of independent variables in equations 3a-3e (Laopodis and Sawhney 2007).

Following the studies of Chang and Caudill (2005), Dritsakis and Adamopoulos (2004), Johansen (1988) and Osterwald-Lenum (1992) propose two test statistics in order to find out the number of co-integrated vectors: The trace (λ_{trace}) and the maximum eigenvalue

(λ_{\max}) tests statistics. The Likelihood Ratio statistic (LR) for the trace test (λ_{trace}) as proposed by Johansen (1988) has the following form:

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^p \ln(1-\lambda_i) \quad (4)$$

where:

$\hat{\lambda}_i$ – the largest estimated value of eigenvalue obtained from the estimated Π matrix.

$r = 0, 1, 2, \dots, p-1$.

T – the total number of observations of the examined sample.

The λ_{trace} statistic tests the null hypothesis that the number of distinct characteristic roots is less than or equal to r , (where r is 0, 1, 2 or 3) against the general alternative. The value of λ_{trace} will be smaller when the related values of the characteristic roots are very close to zero.

Alternatively, the maximum eigenvalue (λ_{\max}) statistic as suggested by Johansen (1988) has the general form:

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1}) \quad (5)$$

The λ_{\max} statistic examines the null hypothesis which defines that the number of co-integrated vectors is r against the alternative of $(r + 1)$ co-integrated vectors. Therefore, the null hypothesis $r = 0$ is tested against the alternative $r = 1$, then $r = 1$ against the alternative $r = 2$, and finally $r = 2$ against the alternative $r = 3$ and so on. If the estimated value of the characteristic root is very close to zero, then the λ_{\max} will be smaller respectively (Johansen and Juselius, 1990).

Specifically, Johansen's co-integration tests are very sensitive to the final selection of lag length. The VAR model is fitted to the time series data in order to define an appropriate lag number. The Schwarz Criterion (SC) (1978) is selected as the best statistical criterion in order to find out the eligible number of lags in the co-integration analysis. Table 3 indicates the estimated results from the Johansen co-integration test.

3.2. Ordinary least squares method

Initially, ordinary least squares method is applied to estimate a linear regression model for statistical significance. This method defines that the regression line is fitted to the estimated values by minimizing the sum of squares residuals, which indicates the sum of the vertical distances between each point and the relative point on the regression line. The shorter the distances, the better fitted the regression line. A regression model has a general form as follows:

$$Y_i = a + bX_i \quad (6)$$

Estimating a regression model with ordinary least squares method, mainly we have to find the estimations of constant term (\hat{a}) and the slope of equation model (\hat{b}), namely to solve the following patterns (Seddighi et al., 2000; Katos, 2004)

$$\hat{a} = \bar{Y}_t - \hat{b}\bar{X}_t \quad \text{and} \quad \hat{b} = \frac{n \sum X_t Y_t - \sum X_t \sum Y_t}{n \sum X_t^2 - (\sum X_t)^2} \quad (7)$$

The final estimated model has the general form as follows (Katos, 2004)

$$\hat{Y}_t = \hat{a} + \hat{b}X_t \quad (8)$$

3.3. Diagnostics tests

The estimation of a regression model is mainly based on some basic specification tests which employ with existence or non statistical significance problems (Vazakidis, 2006). If the assumptions of these specification tests are not violated then there are not any problems of statistical significance in coefficients and the linear model is very well estimated in accordance with statistical theory. This means that the independent variables of the estimated models have direct effect on dependent variable of the model. The null hypothesis (H0) defines that there is no statistical significance in estimated coefficients of independent variables of the examined model, when the value of probabilities is larger than 5% level of significance, while the alternative (H1) defines that there is statistical significance when the value of probability is lower than 5% level of significance.

In order to examine whether the diagnostics tests are violated we use some statistical tests as Durbin-Watson test statistic for autocorrelation, Breusch-Godfrey-Pagan test statistic for heteroskedasticity, Ramsey Reset test statistic for functional form and Jarque-Bera test statistic for normality test (Ramsey, 1969, Durbin and Watson, 1971, Breusch, 1978, Jarque-Bera, 1980, Engle, 1982). Autocorrelation test refers to the way of residuals are distributed randomly and correlated. Autocorrelation test is violated when the residuals are not distributed correctly around the regression line and are not correlated. In order to test autocorrelation we use Breusch-Godfrey (1978) (B-G) test which is regarded more reliable than Durbin and Watson (1971) (D-W) test statistic. The null hypothesis defines that there is no autocorrelation in residuals, while the alternative defines that there is autocorrelation in residuals. We reject null hypothesis when the value of Breusch-Godfrey (BG) test statistic is larger than the value of chi-squared distribution $\chi^2(2)$ (Breusch, 1978, Godfrey, 1978, Seddighi et al., 2000). In order to correct the existence of autocorrelation problem, we can use the first order autoregression model. The autoregressive coefficient defines that each disturbance equals to a portion of a preceding disturbance plus a random effect expressed by v_t namely

$$u_t = \rho u_{t-1} + v_t \quad |\rho| < 1 \quad \text{where } \rho = \text{autoregressive coefficient.}$$

Ramsey (1969) reset test statistic is used for specification test of equation model. The null hypothesis defines that there is correct specification in the equation model, while the alternative defines that there is misspecification. We reject null hypothesis when the value of Ramsey Reset test is larger than the value of chi-squared distribution $\chi^2(2)$. Breusch-Godfrey-Pagan test statistic is used for heteroskedasticity test. Under heteroskedasticity, the residuals of the estimated model don't have constant variance. The null hypothesis defines that there is homoskedasticity in estimated residuals, while the alternative defines

that there is heteroskedasticity. We reject null hypothesis when the value of Ramsey (1969) Reset (RR) test is larger than the value of chi-squared distribution $\chi^2(2)$ (Breusch and Pagan, 1979; Katos, 2004).

$$BGP = n \cdot R^2 = n \cdot \frac{\sum (\hat{Y}_t - \bar{Y}_t)^2}{\sum (Y_t - \bar{Y}_t)^2} \quad (9)$$

Normality test for residuals is examined by Jarque-Bera test statistic. The null hypothesis defines that the residuals are normally distributed in the equation model, while the alternative defines that the residuals are not normally distributed. We reject null hypothesis when the value of Jarque-Bera test statistic is larger than the value of chi-squared distribution $\chi^2(2)$. Jarque-Bera (1980) (JB) test statistic examines whether the coefficients for skewness and kurtosis are jointly zero (Seddighi et al. 2000; Katos, 2004).

$$JB = n \left[\frac{m_3^2}{6} + \frac{(m_4 - 3)^2}{24} \right] \text{ where } m_3 = \frac{Eu^3}{s^3} \text{ and } m_4 = \frac{Eu^4}{s^4} \quad (10)$$

4. Empirical results

The basic statistical measures analyzing the descriptive structure of examined variables as average, mean, standard deviation and coefficients of skewness and asymmetries are presented in this study for each country respectively in Table 1.

Table 1. Summary descriptive statistics

USA	GDP	EN	ALTER	EL_PROD_REN	X
Mean	0.809382	1.047325	0.938632	0.778732	0.686618
Median	0.794750	1.075700	0.915650	0.506200	0.672100
Std. Dev.	0.276850	0.060490	0.072096	0.515904	0.185575
Skewness	0.099406	-0.721557	0.291103	1.107768	0.435167
Kurtosis	1.769712	1.908998	1.813249	2.667453	1.928728

In order to examine the stationarity test of examined variables, Phillips-Perron (1988) unit root test is applied based on Augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1979). All data variables are stationary in their first differences, so they can be characterized as stationary and integrated of first order (Table 2, Figure 3).

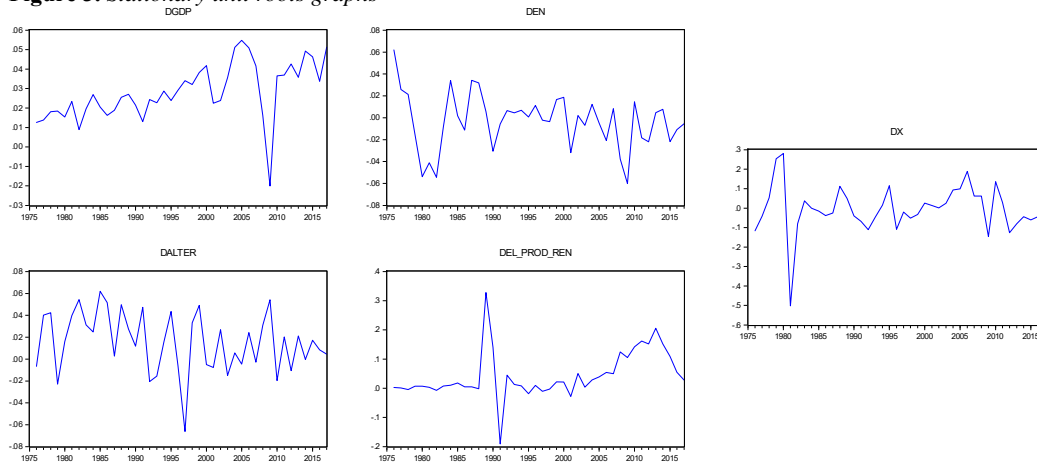
Table 2. Tests of unit roots hypothesis

USA	Phillips-Perron (PP_test stat)		
	t_n	t_c	t_t
GDP	9.16(lag=1)	1.66 (lag=0)	-2.09 (lag=4)
EN	-1.66(lag=3)***	0.15(lag=3)	-1.10(lag=3)
ALTER	1.65 (lag=0)	-0.78(lag=0)	-3.22(lag=3)
EL_PROD_REN	3.75(lag=3)	1.98(lag=3)	-0.52(lag=2)
X	-0.58(lag=2)	-1.51(lag=3)	-1.91(lag=3)
DGDP	-0.88(lag=0)*, **, ***	-3.10(lag=0)*	-3.43(lag=0)*, **
DEN	-4.91(lag=3)	-5.29(lag=3)	-5.48(lag=3)
DALTER	-5.58(lag=0)	-6.13(lag=0)	-6.02(lag=0)
DEL_PROD_REN	-3.81(lag=3)	-4.27(lag=3)	-6.01 (lag=1)
DX	-4.15(lag=1)	-4.08(lag=1)	-4.01(lag=1)*

cr_values in levels: (-3.68, -2.97, -2.65) and in 1st differences (-2.65, -1.95, -1.60) for 1%, 5%, 10% levels of sig.

cr_values for constant and trend in levels and 1st differences are -4.32, -3.56, -3.22

*, **, *** denote not statistical significance in 1%, 5%, 10% level of significance respectively.

Figure 3. Stationary unit roots graphs

Then Johansen and Juselius (1990) cointegration tests are applied in order to find out the existence of cointegrated relations between the examined variables. Table 3 indicates that the fitted number of cointegrated vectors is selected every time comparing the relative eigenvalues to the trace and maximum-eigenvalue test statistics for USA based on Schwarz criterion which is more powerful than Akaike criterion.

Table 3. Johansen and Juselius Cointegration Tests

USA				
Testing Hypothesis	Johansen Test Statistics			
	Eigenvalue	Trace statistic	Critical values 5%	Prob.
$H_0: r = 0$ and $r=1$	0.8136	137.0792	69.8188	0.0000
$H_0: r \leq 1$ and $r=2$	0.6818	74.9176	47.8561	0.0000
$H_0: r \leq 2$ and $r=3$	0.4976	32.5394	29.7970	0.0236
$H_0: r \leq 3$ and $r=4$	0.1336	7.0658	15.4947	0.5700
USA				
Testing Hypothesis	Johansen Test Statistics			
	Eigenvalue	Max-eigen statistic	Critical values 5%	Prob.
$H_0: r = 0$ and $r=1$	0.8136	62.1615	33.8768	0.0000
$H_0: r \leq 1$ and $r=2$	0.6818	42.3781	27.5843	0.0003
$H_0: r \leq 2$ and $r=3$	0.4976	25.4736	21.1316	0.0115
$H_0: r \leq 3$ and $r=4$	0.1336	5.3068	14.2646	0.7027

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level.

Max-eigen test indicates 3 cointegrating eqn(s) at the 0.05 level.

* denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis (1999) p-values.

Since all variables are tested for stationarity and cointegration existence, then a simultaneous system equation model is estimated for making simulation policies. The results of Johansen cointegration test indicated that all variables are cointegrated of order one and that there are three cointegrated vectors based on trace and maximum-eigenvalue test statistics for USA. The minimum values of Schwarz criterion determined the number of cointegrated vectors.

The significance of the empirical results is dependent on the variables under estimation. The number of fitted time lags was selected for the best estimation results and to ensure

statistical significance in each equation model. Estimating the equation model with ordinary least squares method we can infer that there is statistical significance in coefficients of independent variables, based on probabilities and t-student distribution test statistics. Their estimated values have the expected statistical sign, on the basis of economic theory.

The coefficient of determination in each equation is very high and tends to unity (is close to 0.99), indicating that there is high correlation, so the model is very well adjusted (Table 4).

Table 4. *Ordinary least squares method*

Dependent Variable: GDP				
Sample: 1977-2017				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.2021	0.4515	-2.6622	0.0115
EN(-2)	0.7061	0.4151	1.7012	0.0975
ALTER(-1)	0.9164	0.1460	6.2764	0.0000
EL_PROD_REN	0.3834	0.0630	6.0785	0.0000
X	0.1655	0.0966	1.7131	0.0953
R-squared	0.9280	Durbin-Watson stat		0.2954
F-statistic	116.01	Prob(F-statistic)		0.0000

The same conclusion is easily confirmed by studying probabilities and F- distribution test statistics. All probabilities values are lower than 10% and t-student and F-student test statistics are greater than critical values, obtained by statistical tables of t-student and F-distributions for 10% level of significance. Durbin-Watson test statistic indicates that maybe there is a possible problem of autocorrelation due to lower values, while there is a possible existence of multicollinearity problem due to the highest values of coefficients of determination.

Finally, as we can see from the estimated results, examining the economic interrelation between dependent variables and independent ones, we can infer that alternative and nuclear energy, as well electricity production from renewable sources and exports of mineral resources have a positive effect on economic growth. The empirical results of ordinary least squares method are summarized in Table 4.

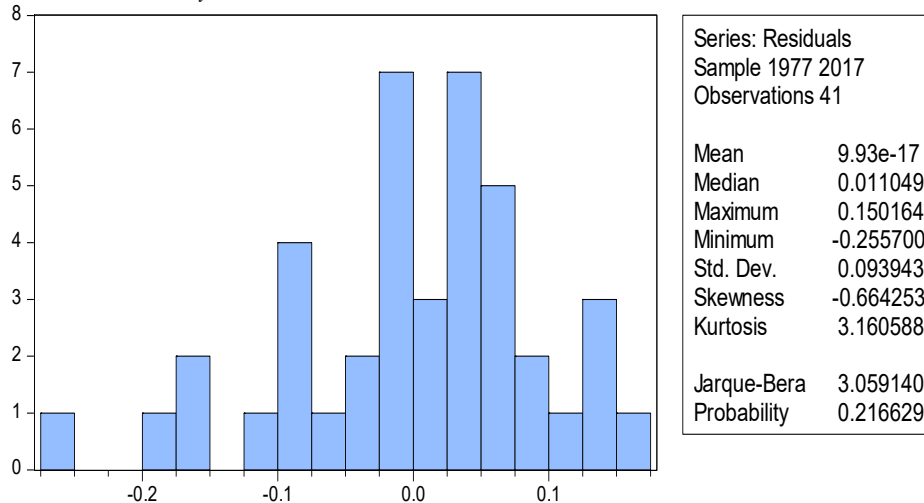
It can be inferred that an increase of energy use per 1% causes an increase of gross domestic product per 0.7, also an increase of alternative and nuclear energy per 1% causes an increase of gross domestic product per 0.91, an increase of electricity production from renewable sources per 1% causes an increase of gross domestic product per 0.38, and finally an increase of exports of mineral resources per 1% causes an increase of gross domestic product per 0.16.

The empirical results of estimated diagnostic tests indicated that there are autocorrelation, specification and heteroscedasticity problems in residuals of estimated model due to lower values of possibilities than the relative level of significance 5%, while there isn't any problem in normality test. The empirical results of estimated diagnostic tests are presented in Table 5.

Table 5. *Diagnostics tests*

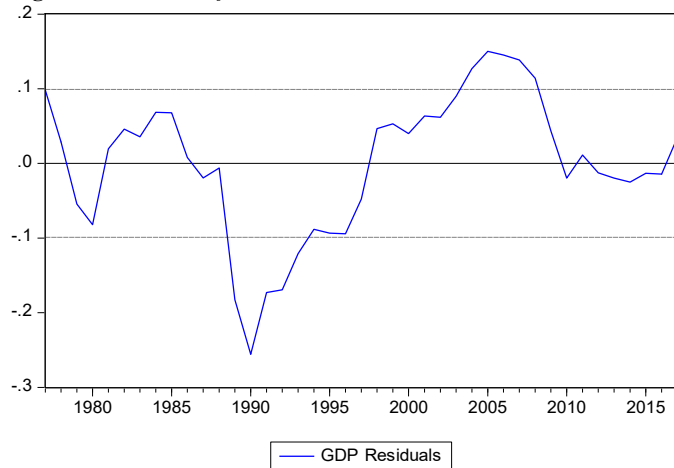
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	50.036	Prob. F(2,34)	0.0000
		Prob. Chi-Square(2)	0.0000
Ramsey RESET Test			
	Value	Df	Probability
t-statistic	4.4891	35	0.0001
F-statistic	20.152	(1, 35)	0.0001
Heteroskedasticity Test: White			
F-statistic	4.4997	Prob. F(14,26)	0.0005
Obs*R-squared	29.021	Prob. Chi-Square(14)	0.0104

The Jarque-Bera statistical test is applied for normality test of residuals of estimated model. The results of normality test are presented in Table 5a. It is obvious from the estimated results that the probabilities of Breusch-Godfrey Serial Correlation LM Test ($p = 0.0000$), Ramsey RESET Test ($p = 0.0001$), White Heteroscedasticity Test ($p = 0.0005$), are lower than 5% level of significance, while the probability of Jarque-Bera statistical test (0.2166) is larger than 5% level of significance.

Table 5a. *Normality test*

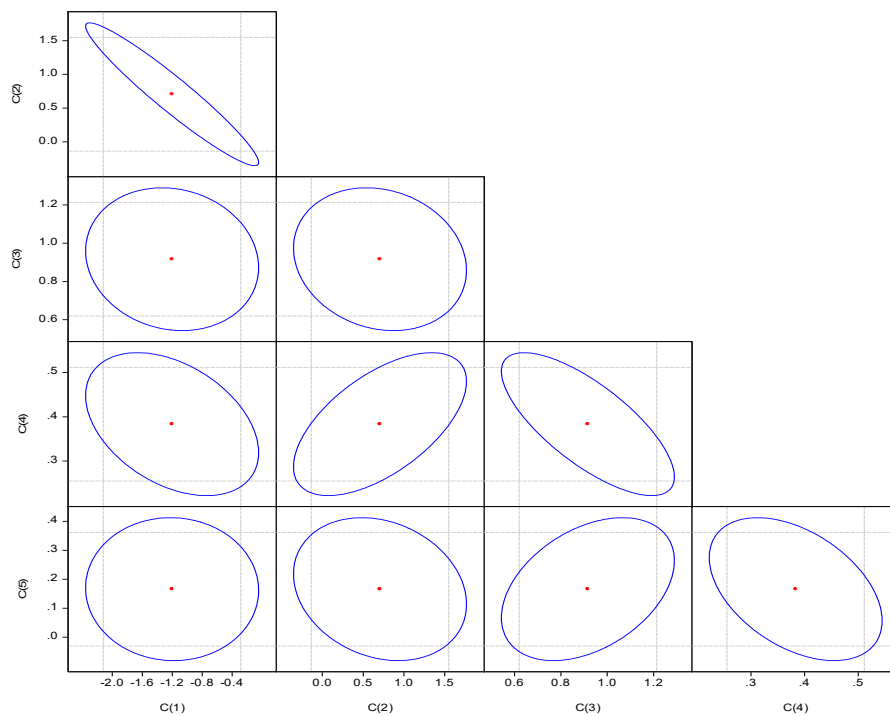
The graph of residuals of the estimated model shows that the residuals are normally distributed (Figure 4).

Figure 4. *Residuals of the estimated model*



Finally, graph of confidence ellipse of estimated coefficients of independent variables of estimated model indicates the existence of statistical significance (Figure 5).

Figure 5. *Graph of confidence ellipse of estimated coefficients*



5. Conclusions

This study investigates the interrelation between energy and economic growth for USA covering the time period from 1975 to 2017 by estimating a linear regression model with ordinary least squares method. The most important diagnostic tests are applied in order to examine the possible existence of statistical significance of the estimated equation model. The empirical results of this study are agreed with the studies of Sadorsky (2009), Apergis and Payne (2012), indicated that energy growth affects economic growth directly and positively. There isn't any problem in normality test of residuals, while there are problems in autocorrelation, specification, heteroscedasticity tests for residuals.

Summarizing, most empirical studies attempted to investigate the main determinants of economic growth emphasizing in the effects of energy sector on it. The energy consumption and the electricity production from renewable sources promote economic growth and contribute to the improvement of production and the development of standard of living. The excessive use of electric power causes an inevitable increase of pollution of environment. On the other hand the utilization of energy renewable sources declines the carbon dioxide emissions causing improvement of standard of living and quality of human life. Many empirical studies examining the main determinants of economic growth differ relatively to the sample period, the examined countries and the estimation methodology. However, more interest should be focused on the comparative analysis of empirical results for many other countries in future research.

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Fiscal competition and public expenditure composition in the era of globalization: Panel data analysis

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Abstract. *Amidst the ongoing liberalization of international trade and transnational movement of capital, each nation-state's fiscal policies have gradually become more dependent on other countries. Developing countries, especially, are forced to make changes to taxation and public expenditure in this era of globalization. It is thus important to understand what kind of relationship exists between globalization and public spending. This study aims to clarify the effects of fiscal competition on public expenditure, from the perspective of the compensation and efficiency theses. These effects currently remain uncertain, despite the growing wave of academic interest in the field. To see how fiscal competition affects the structure of public expenditure, the determinants of public expenditures have been examined for 10 Organization for Economic Co-operation and Development (OECD) countries from 2006-2014. Eleven panel data models have been set up. Public expenditures, as the dependent variable, have been addressed in 10 sub-groups – based on their distribution both as a whole and per their socio-economic functions. Thus, we analyzed the relationship between fiscal competition and both total of public expenditures and the composition of public expenditures. The study thus contributes to the existing literature on fiscal competition. It is observed that corporate tax competition has decreasing effects on all public expenditures. Falling tax revenues due to fiscal competition have the effect of reducing overall public expenditures by decreasing the resources available for use by public policymakers. We can thus evaluate corporate tax competition as having an efficiency increasing effect, by decreasing the government's share of within the economy.*

Keywords: compensation thesis, economic globalization, efficiency thesis, fiscal competition, public expenditure composition, panel data.

JEL Classification: H2, H4, H7, C33.

1. Introduction

The gradual liberalization of the international movement of goods and services – and, especially, measures to lift restrictions or prohibitions on the transnational movement of capital – is successively internationalizing the goods, services and factor markets in most market economies. Nation-states' fiscal policies have thus become progressively more dependent on other countries. Naturally – in an environment where the integration of economies makes it impossible for any country to implement policies independent of other countries, particularly given the effects of technological developments – researchers are examining various aspects of the impact of globalization on taxation and public expenditures.

Amidst this accelerating process of globalization and interdependence, countries aim to maximize their welfare by implementing policies to attract direct foreign investments. They compete with other countries for these investments, hoping to manage the changing manufacturing and employment structures in alignment with their own interests. Besides competing for taxes collected on the revenues from capital factors, countries also compete by public expenditures as an additional benefit of foreign investment.

In the globalization process, closer economic integration amongst countries changes the amount and composition of total public expenditures. Tax competition has a major impact, among countries aiming to attract more direct foreign investment. It becomes harder to maintain total public expenditures at their previous levels, since such competition reduces countries' tax revenues. Yet, when we consider the challenges of financing through debt, a reduction in total public expenditures should be expected. Globalization may thus reduce total public expenditures – especially in developing countries. To shape a more feasible investment climate, countries desiring to attract more direct foreign investment may implement a public expenditure policy, along with a tax policy. Spending on education and health, for example, may be given larger share of total public expenditures. This concept is described, in the literature, as “efficiency thesis” (Hecock and Jepsen, 2014).

In countries with open economies, the internationalization of the manufacturing processes affects the manufacturing and employment structures. Changes in manufacturing processes determine each country's share in global revenue – as well as the shares of country's domestic product that is taken by its manufacturing sector – thus creating further income inequality, both globally and nationally. To reduce the negative effects of globalization on personal income distribution, countries can implement policies that increase the proportion of public expenditures in favor of social spending that benefits low-income people. This is known as the “compensation thesis” in the literature (Hecock and Jepsen, 2014).

In this study, we intend to analyze the effects of competition caused by globalization on the composition of public spending – from the perspectives of the compensation and efficiency theses. In the current literature, many studies have examined the relationship between globalization and total public spending for various groups of countries. As a contribution to the literature, this study uses the COFOG (Classification of the Functions of Government) public expenditure classification, which was revised in 2000. Separate models were created for 10 subgroups of public expenditures, as well as for total public

expenditures. We tested whether the changes in total public expenditures and public expenditure structures, in the selected countries, supported the compensation or efficiency hypotheses. We did this by examining the effect of tax competition separately on each category of public spending. In Section 2 of the study, we review international fiscal competition and its effects – in the light of the efficiency and compensation theses – in relation to the extant literature. Section 3 consists of two sub-sections, describing the data set and the estimation results. The model used is also presented in detail in this section, as are the results of the model and a discussion thereof. In Section 4 and Section 5, we describe our conclusions and their implications.

2. Literature review

Countries' tax policies are determined by various factors. In relatively closed economies, tax policies depend essentially on domestic factors. The influence of external factors increases depending on an economy's degrees of openness. Alongside the movement of goods and services, liberalization of movement of capital has changed countries' tax systems significantly. The rapidly accelerating movement of capital and goods, through globalized trade, has pushed those countries that need to attract more foreign direct investment into tax competition. Tax competition inevitably affects both total public expenditures and the composition of public expenditures.

Until the middle of the 20th century, the basic sources of tax revenue were individual income tax, corporate income tax, social security contributions and general consumption tax. In the following era of relatively closed economies, countries implemented tax policies and determined their total tax burdens and tax structures considering their own national needs and political priorities. With the liberalization of capital movements in the final phase of globalization, taxation differences between countries have gained importance. Meanwhile, challenges and restrictions have become prominent in national taxation – including those around the competitive power of countries, fiscal evasion, tax avoidance and taxable bases crossing countries' borders – within the context of international markets (Genschel, 2005, p. 55).

Tax reforms in the USA have reduced tax rates and expanded the tax base – and have been the underlying cause of the diffusion of neo-liberal tax policies in developed countries (Swank, 2006). We argue that the USA kicked off the tax competition among developed countries and that other developed countries' policymakers carried out tax reforms particularly to attract more capital. Their relatively lower capital over labor factor, in comparison to developed countries, may lead developing countries to implement tax and spending policies aimed at attracting foreign direct investments.

Given the weight of non-tax factors – such as political and economic stability, natural resources and cheap skilled labor – in the selection of investment destination, the sensitivity of direct foreign investment movements to tax burden differences would be lower than to short-term capital movements (Zee, 1998, p. 2). Globalization affects both tax revenues and tax structures. For instance, Heinemann's (2000) study of data related to 21 OECD countries concluded that globalization leads countries to tax those tax bases that show lower

degrees of international mobility and – among developed countries – the USA, Japan and Canada have more global economies than do others.

On the other hand, countries may be in serious competition not just around tax policies but also in terms of public expenditures, due to globalization. Countries' efforts to attract foreign capital, through both their taxation and their public expenditure, are called fiscal competition. In terms of fiscal competition, the relationship between, first, economic growth and public expenditures and, second, economic growth and amount of taxation are vital. For example, Machová and Kotlán (2013) show a positive relationship between economic growth and public expenditures – and that, on the contrary, there was a negative relationship between economic growth and the amount of taxation in OECD countries from 2005-2010.

Under certain special conditions within the neoclassical approach, where government policymakers try to maximize social welfare, fiscal competition leads to efficient output production. These conditions include: administrations being smaller than the capital market, strategic elements being relatively unimportant and the public sector having access to relevant fiscal instruments. Otherwise, it is possible to encounter various distortions and sub-optimal public programs – although the degree of these distortions and their quantitative impact on social welfare are not entirely obvious. According to the Leviathan approach, which regards the public sector as expanding and ineffective and argues that public output is dictated by powerful interest groups, fiscal competition is a discipline mechanism that limits unwanted expansion of the public sector. Yet even the Leviathan view agrees that fiscal competition may cause predictable and systematic deviations in resource allocation (Oates, 2001, p. 133).

The role of government spending in attracting foreign investments may be a determinant affecting the dominance of the efficiency thesis. Hecock and Jepsen (2014) have examined exactly this question in their study – which separately explored the subject of attracting foreign capital investments for the agriculture, industry and service sectors. The study empirically considered the determining factors in attracting direct foreign capital investments for different sectors, in 15 Latin American countries. It concluded that – even in the manufacturing industry – taxes are not decisive factors for direct foreign capital investment. Although they are not among the independent variables examined, the role of human capital and public infrastructure investments in direct investments to developing countries are cited as possible reasons for this. Hence, this indicates a result in favor of the efficiency thesis.

The issue of globalization's effect on income distribution is closely related to the assertion of the compensation thesis. There are numerous studies on this topic. Kollmeyer (2015), for instance, refers to 1970-2010 data from 16 developed countries – concluding that globalization leads to income inequality at low – public expenditure levels and that, as public expenditure increases, this positive relationship gradually disappears.

Globalization may affect not just tax revenues, but also public expenditure and its composition. Globalization directs countries from the taxation of mobile factors to the taxation of fixed factors. It also leads countries to adapt their spending structures and to

implement spending policies that decrease the share of total spending that benefits fixed tax payers, while increasing the shares that benefits mobile tax payers. In one respect, the regulation of spending structures towards increasing benefits for mobile tax payers has a substitutive aspect in adjusting the tax structure, within the process of globalization (Heinemann, 2000, p. 289).

Behind the idea that globalization will decrease welfare spending, there is an assumption suggesting that – as a result of the liberalization of external trade and factor movements and due to the emerging depreciation of the income tax base and capital tax base – the welfare state would lose the ability to finance its operations. This idea, promoted by opponents of globalization, takes only the supply side into account, in terms of public policy, and ignores the demand side. The demand-side effects of globalization derive from governments' motives for maximizing political support and point to the compensation of victims of globalization by enhancing social welfare programs. The compensatory effect of globalization will abolish the efficiency effect and – according to the scope of national welfare programs – the overall effect of globalization will be mitigated (Dreher et al., 2008, p. 264).

Alongside considering the share of social spending in total public expenditure, it is also possible to consider the act of subsidizing those vulnerable sectors that may suffer from the economy's openness within the frame of the compensation thesis. Rickard (2012) emphasized that, in developing countries, these kinds of subsidies are actually used to for compensate for losses caused by unemployment, which may occur due to the economy's ever-increasing openness. Using data around developing countries' central administration expenditures, Rickard (2012) has concluded that subsidies are efficient tools against the cost of foreign expansion. It can also be suggested that the level of economic openness in developing countries will affect the measures to be taken. Nouruddin and Simmons (2009) argue that – since, in autarchic countries, there will be many serious results of increasing the economy's openness, such as unemployment and migration – representative democracies will increase their spending on security, education and health. In countries with highly open economies, social welfare cost expectations due to the increasing openness of the economy will be low. Thus, there may not be enough social demand to increase social security, education and health spending.

Gemmell et al. (2008) have inferred, from 1980-1997 data of 25 developed OECD countries, that the compensation thesis is also valid in the process of globalization. The authors concluded that the composition of public expenditure has shifted in the direction of the compensation thesis. Following the results that view the compensation thesis as the explanatory thesis for developed countries, Busemeyer (2009) has stated that it is necessary to observe globalization for longer periods of time to reveal all its effects. He has concluded – through observations over long periods – that, at first, globalization increases social welfare spending within the frame of the compensation thesis. But then, within the dynamics of economic integration, the efficiency thesis prevails and determines public expenditure.

In their study, Altay and Aysu (2013) conclude that foreign trade volume and an increase in direct foreign investments, which they take as globalization indicators, have a reducing effect on public expenditure and that efficiency thesis is valid.

Leibrecht et al.'s (2011) study examined how social expenditures' share of total public spending was affected by globalization in European countries. The study used, as indicators, not just an economy's openness to external trade and direct foreign investment, but also various KOF globalization indexes. The authors highlight the differences between Eastern and Western European countries and concluded that – while the compensation thesis prevails in Western European countries – efficiency thesis is valid in Eastern European countries.

It is important, for our subject, to note that Jiang's (2014) study of welfare spending in 21 transition economies did not find that these economies decreased welfare spending during the process of global economic integration. (The data Jiang (2014) analyzed excluded education and health spending).

Winner's (2012) pioneering study of the effects of fiscal competition on public expenditures – drawn from the 1980-2000 data of 18 OECD countries – found that globalization decreases public expenditure related to social security, welfare and housing, yet increases public spending related to transportation, communication, research and development, education and health. Hence, Winner concludes that the efficiency thesis is valid.

The question of whether the changing of composition of public expenditures is compatible with the efficiency or compensation thesis depends significantly on the degree of economic openness and tax competition. Thus, it is possible to argue that closer integration with other countries, via the trade of goods and the movement of factors like capital makes countries with a relatively closed economy raise their social, education and health expenditures – compatible with the compensation thesis – due to unemployment and relevant social problems. Yet changes in the composition of public expenditures, in a direction compatible with the efficiency thesis, may also occur due to fiscal competition for foreign direct investments. Inspired by Winner, we have chosen the dependent and independent variables in our study to test whether changes in total public expenditures and public expenditure structures support the compensation or efficiency hypotheses. Our models, data and variables are described in detail in Section 3.

3. Econometric analysis

3.1. Data set and model

This study examines the determinants of public expenditures from 2006-2014, for 10 OECD member countries: Austria, Germany, Italy, Spain, the Czech Republic, Iceland, Israel, Sweden, the USA and Turkey. Eleven panel data models were set up, and the public expenditures—as the dependent variable in the set panel data model – were addressed in 10 sub-groups, based on their distribution both as a whole and according to their socio-economic functions as defined by the National Calculations System (COFOG). COFOG

expenditure items were revised in the year of 2000, with a new classification system covering 10 expenditure items. It is thus impossible to access detailed data covering all 10 expenditure items uninterruptedly, before the year of 2005. Due to our preference to study the data of OECD member countries, the country group consists only of the 10 specified countries-the data of which can be full accessed.

The dependent variables being used in the models are: total public expenditures (EXP); general public service expenditures, covering expenditure items such as legislative and executive bodies, financial, fiscal and foreign affairs, foreign economic aids, general services, basic research and general public services (PUB); defense expenditures covering military defense, civil defense and foreign military aid expenditure items (DEF); public order and security expenditures consisting of expenditures made for police services, fire protection services, courts and prisons (SAFE); expenditures within the scope of economic affairs, made for the general economy, commerce and labor, agriculture, forestry, fishery and hunting, fuel and energy, mining, manufacture and construction, transportation, communication and other sectors (AFFAIR); environmental protection expenditures, such as for waste management, waste water management, reduction of contamination, protection of biodiversity and landscaping (ENV); expenditures made for lodging and social facilities, such as residential development, social development, water resources and street lighting (HOUSE); health expenditures, covering medicinal products, devices and equipment, outpatient treatment services, hospital services and public health services (HEALTH); entertainment, culture and religion expenditures, covering recreation and sports services, culture services, publication and release services, religious and other community services (CULT); educational expenditures made for pre-school and elementary education, secondary education, high school, higher education and other auxiliary services (EDUC); and social protection expenditures around illness, disability, senility, death, families and children and unemployment (SOC).

The model set up within the scope of the study may be written as follows, for the state in which the total public expenditures are the dependent variable.

$$EXP_{it} = \beta_0 + \beta_1 FISC_{it} + \beta_2 GDP_{it} + \beta_3 DEP_{it} + \beta_4 URB_{it} + \beta_5 CPM_{it} + \beta_6 SIZE_{it} + \beta_7 TAX_{it} + \beta_8 UNMP_{it} + \beta_9 INF_{it} + \mu_i + u_{it} \quad (1)$$

Other models, in which the sub-expenditure items exist as dependent variables, were set up in similar manner, using the same independent variables. The independent variables chosen were similar to those in Winner's (2012) study, due to the success of Winner's estimated models. Yet some of the dependent variables addressed in the models, since the COFOG public expenditure classification changed in 2000. The models established in our study thus have two purposes. The first is to contribute to the literature via the estimation results of models that apply, as dependent variables, expenditure items that have not been previously been explored. The second is to compare the existing literature with models applying public expenditure items, in the style of Winner and other researchers.

As noted, EXP specifies the total public expenditures. The data for the public expenditures, consisting of both total expenditures and sub-items, was collected from the IMF's GFS (International Monetary Fund Government Financial Statistics) database. As the public

expenditures are expressed in each country's own currency, they were first converted to USD; per capita expenditure was then calculated in proportion to each country's populations. To mitigate the effects of inflation, the figures also were deflated by each country's GDP deflator. The graphs were examined, and their logarithms were determined due to the indication of geometrical series features. Thus, the dependent variables used may be expressed as logarithmical real per capita public expenditures (\$).

FISC, from among the independent variables used in the models, expresses fiscal competition. Fiscal competition includes only tax competition, and consists of the difference between the country's legal corporate tax rate and the weighted tax rate of competitor countries:

$$FISC_{it} = \tau_{it} - W\tau_{it} \quad (2)$$

here, τ is the corporation income tax rate; this data was obtained from OECD database. W is the spatial weight matrix normalized by row. Spatial weight matrix was calculated based on whether the countries have border neighborhood. ω_{ij} is the each element of W and its normalized version is as follows:

$$\omega_{ij} = \frac{1}{b_{ij}} \left/ \sum_{j=1}^J \frac{1}{b_{ij}} \right. \quad (i \neq j) \quad (3)$$

b_{ij} is a dummy variable. Its value is 1 if two countries (i and j) have a common border; otherwise, its value is 0. In the models, i and j stand for the countries, and t stands for the time.

Per capita GDP was used as a control variable, relevant to fiscal competition. GDP expresses gross domestic product per capita. As noted, this was converted into real GDP by applying each country's GDP deflator; its logarithms were then determined. The data was obtained from OECD database. The dependency rate (DEP) and urbanization rate (URB) are other control variables used, following Winner's (2012) study, in terms of fiscal competition. The data for DEP was also obtained from the database of OECD. The ratio of people under age 15 and over age 65 to the population aged 15-65 is the dependency rate. URB data was obtained from the World Bank's WDI database, and expresses the share of urban population within the total population.

Winner's (2012) study treats CPM, SIZE, TAX, UNPM, and INF as dependent variables. These were included, in all models in our study, as independent variables determining the public expenditures. CPM is addressed as one of the most vital indicators of globalization. Unemployment and inflation rates were also included in the models as independent variables, amongst others, to enable us to consider other factors arising from the countries in the determination of capital tax rates (see Winner, 2012, p. 43). CPM expresses the capital mobility. The criterion of openness to foreign trade was used as an indicator of capital mobility. Within this frame, foreign trade volume was calculated via the formula of $(\text{import} + \text{export}) / \text{GDP}$. Import (million \$), export (million \$) and GDP (million \$) data were obtained from the OECD statistics. SIZE, the size of the country, was used indicate the difference between outward-oriented small and large economies. To express this

variable, the countries' labor force was used as an instrumental variable. The data was obtained from the database of World Bank's WDI (World Development Indicator), and the logarithm of the variable was determined. TAX was calculated via the formula of (social security contributions + wage and labor taxes + taxes collected from goods and services)/GDP, and all data was obtained from the OECD statistics. The amounts found by adding the revenue of sales taxes to the revenue of taxes exclusively on income from labor were proportioned to the GDP. This variable is important in terms of indicating the degree to which each country engages in tax competition by reducing tax rates on capital. As noted, unemployment and inflation rates were included in the models, thus enabling us to consider factors arising from within the countries in the determination of capital tax rates. UNMP, the unemployment rate (%), was obtained from the OECD database. INF indicates the inflation rate (index, 2010 = 100), and was likewise collected from the OECD database.

3.2. Estimation of results and discussion

As described, 11 models in total were estimated in this study, and their dependent variables consisted of total public expenditures and sub-expenditure items. First, the existence of individual (country) effects in the panel data model was tested with the F test and the H_0 hypothesis ($H_0: \mu_i = 0$ (for all i 's)) was rejected in all models. Next, the Hausman (1978) test was performed to determine whether the individual effects correlated with the independent variables. The H_0 hypothesis ($H_0: E(X_{it}, \mu_i) = 0$) of Hausman test is the difference between the coefficients of the fixed and random effect models is insignificant but that the random effects estimator is efficient. Therefore, it was found appropriate to use the fixed effect estimator, which is consistent under the alternative hypothesis. Since the study group concerned OECD countries, amongst which there is not a high degree of heterogeneity, we concluded that the fixed effect models were suitable. The fixed effect (within) estimator was then obtained for all models, and deviation from the hypothesis was tested before proceeding to interpret the results. The Wald test (Greene, 2000) was performed for heteroscedasticity, and the basic hypothesis ($H_0: \sigma_i^2 = \sigma^2$) was rejected in all models. It was determined that the variance changes according to units – in other words, heteroscedasticity exists. The Pesaran (2004) test was performed, to test the cross sectional dependence. The basic hypothesis that there would be no correlation among units was rejected in 6 of 11 models. Baltagi and Wu's (1999) locally best invariant (LBI) test and Bhargava, Franzini and Narendranathan's (1982) DW test were performed to test autocorrelation, and the basic hypothesis of "there is no autocorrelation" was rejected in 9 of 11 models. In the case of deviation from all three hypotheses, the parameters weren't efficient, despite the fact that they could be estimated without deviation. In this study, since the parameters were still consistent but not efficient, robust standard errors were used. According to deviation from the assumption, the estimations were repeated using robust estimators and the final results were obtained. Heteroscedasticity exists only in Models 5 and 7, and robust standard errors were obtained using Huber's (1967), White's (1980) and Eicker's (1967) robust estimator under heteroscedasticity. Both heteroscedasticity and autocorrelation exist in Models 2, 3 and 6, and the standard errors were corrected by using Roger's (1993) robust estimator. Autocorrelation, heteroscedasticity and cross sectional dependency exist in Models 1, 4, 8, 9, 10 and 11, and the standard errors were corrected by

Driscoll-Kraay's (1998) robust estimators. The endogeneity problem was checked, and – as there was a problem in the panel data model – the fixed effects model was preferred. The normality assumption of the error terms of all models was also tested, using the robust Jarque-Bera test (Brys et al., 2008), which relies on robust estimates of asymmetry and tail heaviness using *medcouple*. According to the test results, the error terms are normally distributed for all models.

The significances of all models were tested via the F test, and the H_0 hypothesis ($H_0: \beta_i = 0$, $i = 1, 2, \dots$) – expressing that the parameters are equal to 0; in other words, that the model is insignificant – was rejected. All models are statistically significant. In the main model, R^2 is about 74% and 6 of the remaining 10 models are over 70%. It is possible to say that the explanatory power of all models is sufficiently.

When the findings obtained from all the models are considered, as seen in Table 1 (Model 1), it is first observed that tax competition has the effect of reducing total public expenditures. The increased differences among the countries' tax rates have the effect of reducing total public expenditures. The decreased tax revenues, due to fiscal competition, cause a reduction of total public spending by reducing the resources available for such expenditures. This may be interpreted as an expected development in the globalization process. This result also conforms to Winner's (2012) conclusion. Yet the coefficient values estimated in this study indicate a weaker result.

Exploring the effects of tax competition on public expenditures for different purposes allows us to carry out a more detailed evaluation. In the ten different expenditure groups (from Models 2-11), it is observed that tax competition has the effect of decreasing per capita expenditures. The results of empirical research show that tax competition also has been effect of reducing the different public expenditures for other purposes – along with decreasing total public expenditure per capita.

This study has concluded that general public service expenditures per capita decrease, due to fiscal competition (Model 2). Reduced general public service expenditures, due to tax competition, may be interpreted as a result conforming to the efficiency thesis. The decrease in defense expenditures (DEF), public order and security expenditures (SAFE), environmental protection expenditures (ENV) and public expenditures for lodging and social facilities (HOUSE) – again due to tax competition – are also the results conforming with the efficiency thesis (Models 3, 4, 6 and 7). On the other hand, decreased public expenditures within the scope of economic affairs (AFFAIR), along with tax competition, do not conform with the efficiency thesis (Model 5). Yet it is clear that the effects of globalization cannot be seen as limited only to fiscal competition. In fact, tax competition is a significant result of globalization. The degree of economic openness will enable us to observe the effects of globalization more clearly. The increase of public expenditures for economic affairs (AFFAIR), along with the ratio of foreign trade volume to GDP, indicates the validity of the efficiency thesis. Notably, the estimation coefficient on this subject is 0.567.

Education and health expenditures may also be assessed within this frame. Winner's (2012) study concluded that the tax competition creates a decrease in social security expenditures

and expenditures for lodgings, and an increase in public expenditures for education, health and economic services. In our study (Models 8 and 10), the negative relationships between tax competition and public health and education expenditures may – at first glance – be viewed as results conforming with the efficiency thesis, and this point of view may be deemed reasonable in the short term. Yet in the long term, as education and health expenditures have a positive effect on productivity, the rise in these expenditures conforms to the efficiency thesis. Naturally, it should be considered that tax competition is not a cause of globalization, but a significant result of it. As we have specified before, the basic indicators of globalization is the openness of an economy – and the extent of openness of an economy is indicated by the ratio of foreign trade volume to GDP. The increase of education (0.656) and health (0.582) expenditures, along with this ratio, indicates that globalization's effects on these expenditures conform to the efficiency thesis. Naturally, in the case of a positive relationship of the ratio of foreign trade volume to GDP with general economic (AFFAIR), public education (EDUC) and health (HEALTH) expenditures – and in the case of a negative relationships with other expenditure types – it would be possible to interpret this as the existence of a competition in the field of public expenditures (Models 5, 8 and 10). Yet, since all expenditure types have positive relationships with the ratio of foreign trade volume to GDP, such an interpretation is not possible. The positive relationship (0.711) of social protection expenditures (Model 11) with the increase in the ratio of foreign trade volume to GDP allows us to interpret the compensation thesis as valid. On the other hand, it is possible to view the increased of public expenditures per capita, along with the increase of GDP per capita (Model 1), as a normal result of Wagner's law. Within the frame of Wagner's law of increasing state activity, it is observed that increased GDP per capita has positive relationships with all the sub-expenditure items, excluding public expenditures for social facilities (HOUSE). In terms of the HOUSE expenditure type, this relationship is negative. The decrease of expenditures for lodging and social facilities (HOUSE), as income per capita increases, may be interpreted as shifting such expenditures to private expenditures (see Winner 2012). Here, especially, the positive relationships of health (1.059) and education (0.817) expenditures with GDP per capita – and the coefficients of these relationships – draw attention (Models 8 and 10). In this respect, the positive relationships of GDP per capita with education and health expenditures, and the negative relationships with expenditures for lodging and social facilities are similar to Winner's (2012) results. Again, the positive relationships of GDP per capita with social (SOC) and education (EDU) expenditures – and its negative relationships with public expenditures for lodging and social facilities (HOUSE) – are in alignment with Sanz' and Velasquez' (2002) study.

Table 1. Estimation results

	Model 1 EXP	Model 2 PUB	Model 3 DEF	Model 4 SAFE	Model 5 AFFAIR	Model 6 ENV	Model 7 HOUSE	Model 8 HEALTH	Model 9 CULT	Model 10 EDUC	Model 11 SOC
FISC	-0.026***	-0.011	-0.034***	-0.017***	-0.052**	-0.032***	-0.0001	-0.023***	-0.043***	-0.026***	-0.021***
GDP	0.829***	0.662***	1.027***	0.672***	0.970	0.394	-1.638	1.059**	0.009	0.817***	0.508
DEP	-0.017**	0.006	-0.053***	-0.213***	-0.049***	-0.028**	0.012	-0.007	-0.038***	-0.030***	-0.016**
URB	-0.009	0.012	0.133***	0.052***	0.026***	-0.035	-0.150	-0.113	-0.019*	0.002	-0.017*
CPM	0.614***	0.544***	0.825***	0.703***	0.567	0.644**	0.191	0.582***	0.769***	0.656***	0.711***
SIZE	0.844***	-0.345	1.517***	1.299***	1.681**	1.154**	2.176**	1.001***	1.859***	1.334***	1.001***
TAX	0.003	0.052***	0.036*	0.0164**	0.007	0.059***	-0.051	0.004	0.032***	0.021**	0.014*
UNEMP	0.007***	0.008**	0.007	-0.003	0.001	-0.003	-0.016	0.002	-0.016**	-0.002	0.016***
INF	-0.005**	-0.002	-0.027***	-0.011***	-0.011***	-0.004	-0.019*	-0.006***	-0.008***	-0.005***	-0.001
F test ($H_0: \beta_i=0$)	14930.23***	11664.02***	423.64***	3308.96***	98.98***	10370.08***	918.96*	746.51***	286.41***	4486.98***	5927.68***
R ²	0.7399	0.7021	0.8240	0.7870	0.5156	0.4644	0.3368	0.6849	0.7379	0.7855	0.5942
F test ($H_0: \mu_i=0$)	25.44***	100.43***	288.62***	19.68***	4.74***	415.65***	4.35***	28.84***	83.71***	39.24***	48.89***
Hausman test ($H_0: E(X_{it}, \mu_i) \neq 0$)	61.06***	32.49***	22.56***	53.70***	28.35***	55.30***	26.99***	25.74***	72.63***	51.74***	67.41***
Wald test ($H_0: \sigma_i^2 = \sigma^2$)	208.26***	387.8***	227.9***	202.9***	500.1***	526.6***	1093.4***	127.4***	175.4***	169.8***	213.6***
Pesaran test ($H_0: \rho_j=0$)	3.816***	0.633	0.172	2.802***	1.673	0.439	0.863	2.665***	2.483**	3.325***	3.969***
DW test ($H_0: \rho=0$)	1.38	1.60	1.65	1.11	2.17	1.52	2.39	0.96	1.34	1.17	1.36
LBI test ($H_0: \rho=0$)	1.63	1.93	1.88	1.33	2.34	1.76	2.51	1.24	1.51	1.39*	1.68
JB test ($H_0: S=0, K=3$)	2.69	2.80	6.435	1.41	2.97	4.15	1.92	3.19	5.95	0.58	5.73

*** significant at 1%, ** significant at 5%, and * significant at 10%.

The positive relationships of the dependency rate (DEP) with social (SOC), education (EDUC) and health (HEALTH) expenditures should be deemed as the expected results of the compensation thesis. When the results of all models are considered, the relationships between the dependency rate and the relevant expenditures are negative but not strong. In Winner's (2012) study, the relationships of the dependency rate with health and education expenditures are positive, but the relationships of the dependency rate with social expenditures and public expenditures for lodging and social facilities are negative. The result we obtained, in terms of social expenditures, is similar to Winner's (2012) study.

In all study's models, negative relationships are observed between the inflation rate and public expenditures. The small size of the coefficients indicates that the negative relationships are not strong. Since these negative relationships are not strong, we can conclude that inflation rates have not had any important effects on public expenditures. When the relationships between unemployment rate and public expenditures are considered, positive relationships are observed in most of the study's models. In the models where negative relationships are observed, it is noteworthy that the coefficient values are very low. It seems that only the positive relationship of the unemployment rate with social expenditures (SOC) is meaningful for the compensation thesis. It is possible to argue that increases in the share of indirect taxes and of taxes on labor, within total tax revenue, are another indicator of tax competition – or that they are significant result of tax competition. Yet, we can argue that it is not possible to interpret the result of this study as having a high degree of importance, in terms of their effect on increasing the share of indirect taxes and taxes on labor within total tax revenue on public expenditures. Finally, it is necessary to evaluate the relationships relevant to the independent variable of SIZE, consisting of the labor force (indicator of the size of the country), per the results obtained in all models. In all the study's models, we observed that – as the working population increases – total public expenditures (EXP) rise, as do all other public expenditure types except general public services (PUB). These positive relationships are in alignment with compensation thesis.

4. Conclusion

It is observed that competition in the field of corporate taxation negatively affects not just total public expenditures, but also individual categories of public spending. The decreasing total tax revenue caused by fiscal competition also reduces total public expenditures – meaning that tax competition reduces the resources to be used for public needs. It can be argued that this is an expected development in the globalization process. In fact, we may interpret corporate tax competition as having an efficiency increasing effect on countries' economies, by decreasing the government's share.

Another vital question is that how tax competition affects the categories of public expenditure under consideration. It has been observed that this competition reduces spending per capita, in terms of 10 different expenditure groups. The decrease of general public service expenditures (PUB), defense expenditures (DEF), public order and security expenditures (SAFE), environmental protection expenditures (ENV) and public expenditures for lodging and social facilities, due to tax competition – as seen in this study

– conforms to the efficiency thesis. As for education and health spending, the negative relationships between tax competition and spending may seem, at the first glance, to conform to the efficiency thesis. Yet this is only reasonable in the short term – we must forget that the education and health expenditures have a positive effect on productivity in the long term. The fact that social protection expenditure (SOC) has positive relationships with the unemployment rate and the foreign trade volume to GDP, on the other hand, seems to show the effects of the compensation thesis. As we have observed, the working population also increases – as do both total public expenditures and all public expenditure types, excluding general public services. It may be argued that these positive relationships are a result of the compensation thesis.

Yet the effects of globalization are not limited just to fiscal competition; tax competition is also a significant result. In this respect, each economy's degree of openness makes it possible to see globalization's effects more clearly. Increased public expenditures for economic affairs (AFFAIR), along with the ratio of foreign trade volume to GDP, indicate the validity of the efficiency thesis. Naturally, the increased education and expenditures, along with this ratio, indicates that globalization's effects on these expenditures conform to the efficiency thesis. The positive relationships of all expenditure types with the ratio of foreign trade volume to GDP do not indicate the existence of competition in the field of public expenditures. The current model is likewise not suitable for such an interpretation, based on the difference in the rates of increase of different expenditure types. We must thus emphasize that the model and data used do not indicate the existence of public spending competition.

It is clear that empirical studies – covering longer periods and using more countries' data, depending on the availability of the required data sets – may more fruitful for the decision-makers. We must thus note the need for more comprehensive empirical studies to analyze the effects of tax and public expenditure competition within the frame of globalization.

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Empirics of technology and unemployment in advanced countries⁽¹⁾

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Abstract. *This study is the first attempt to investigate the empirical relation between progress in technology and unemployment of high and low skilled workers at macro level. Although there is substantial literature on the theory to associate unemployment with technology, empirical analysis of the relation is rare. The theoretical background is split between two opposing assertions: On one side, technology is claimed to increase unemployment since more advanced technology replaces labor, especially in advanced countries where the cost of labor as wages is too high. On the contrary, technology is supposed to cause the enlargement of the already existing sectors and the formation of new industries. We established a model to check for the existence of a cointegrating relation between technology and unemployment using additional control variables with Pedroni's (1999, 2001) methodology. After securing our model's adequacy, we report that technology leads to more unemployment, even in developed countries. On the other hand, we detailed the analysis by searching for the nature of the same relation with high and low skilled workers. Our estimation results revealed that the relationship is somewhat different for these skill groups.*

Keywords: technology, unemployment, skill groups, Pedroni cointegration, Panel DOLS, FMOLS.

JEL Classification: E24; J64; O32; O33.

1. Introduction and motivation

As patent applications worldwide reached 3.3 million in 2018, proving credit to Schumpeter's "Creative Destruction", the answer to the simple question, "Does technology reduce unemployment?" attracts more attention of economists and workers (WIPO, 2019). Since the very definition of technology is characterized by producing the same commodity/service less costly, technology saving more labor force leads to unemployment. That is why Ricardo's "working class" had signaled their fear of being dismissed due to innovation by destroying machines under the lead of Ned Ludd (Vivarelli, 2014). On the other hand, from a wider perspective technology enables new industries in which more workers will be employed. As Steuart put it in 1966, "The introduction of machines is found to reduce prices in a surprising manner. And if they have the effect of taking bread from hundreds, formerly employed in performing their simple operations, they have that also of giving bread to thousands". This argument is positive for the entire workforce and is correct but the ones losing their jobs are not the ones receiving "thousands of bread". A pervasive look at processes and mechanisms is required to come up with a clear answer to the seemingly simple but perplexing question posed. The following items exemplify processes leading to both more or less employment and the net effect of technological progress depends on whether such employment creating processes outweigh the others or not:

- Technological progress has to result in the output of a better product at a lower cost. Assuming that the market has the characteristic of competitiveness, the decrease in total cost will be transferred to price decrements, which will increase the demand for the commodity. To meet with higher demand, extra output asks for more employment.
- As new investment in machinery, equipment, and infrastructure is inevitable to innovate and advance technology, more workers are required.
- A huge investment in R&D aims to replace workers with automated machines, which will directly yield more unemployment.
- Workers laid off due to technological progress cannot demand as much as they used to; this will lead to a decrease in aggregate demand and a further increase in unemployment.
- As the commercialization of new products will be spread worldwide, manufacturing of all such products will invite more labor and an increase in total output due to the introduction of new products and the upgrade of existing ones.
- As more advanced technology will be implemented, some workers' wages will decrease, and demand for a cheaper workforce will be more. In return, less earning workers will demand less resulting in less output and thus employment. On the other hand, a specialized workforce will be paid more, and they will increase aggregate demand leading to more output and employment.
- The application of innovation increases productivity, which will be reflected in wages and GDP per capita. This will increase demand and in turn employment.

Corresponding literature addresses these and many other similar arguments to come up with a satisfactory answer to the question posed at the beginning in addition to several aspects of technology unemployment relation. Vivarelli (2014) highlights an extensive literature survey indicating both sides of the controversy. Although innovative

developments in other areas such as organizational structure, quality in financial services, and management style should be taken into consideration, they have been the subject of empirical works recently. Milgrom and Roberts (1990), Bresrahan et al. (2002), and Bloom and Von Reeren (2010) show that developing and changing organization structures and management styles are important factors in increasing qualitative and quantitative levels of employment. Collard and Dellas (2007) use the international Real Business Cycle (RBC) model to show that the reaction of employment to a technology shock is negative in case the degree of substitution between domestic and foreign goods is low.

Several critical studies in the literature focus on what percentage of existing jobs will destroy or not require the labor force in the future because of technological advancement. Frey and Osborne (2013, 2017), one of the most important of these studies, state that in the next two decades, 47% of the existing jobs in the USA will be replaced by technological machines due to digitalization and the remaining works will be more related to creative or social intelligence. Bowles (2014) adapts this study to European countries and states that job loss due to information and communication technologies (ICT) may reach 60% in the coming decades. Bonin et al. (2015), with a more optimistic estimate, suggest that the rate of technology-related job losses in Germany will be 12% in the future. Bonin et al. (2015) indicate a lower negative impact of technology on employment because he also considers technology-based new business opportunities while Frey and Osborne (2013) and Bowles (2014) ignore the job opportunities due to technology advancement. In other studies, such as the Boston Consulting Group (2015) and Wolter et al. (2015) that have made optimal estimates of technology's impact on employment, it is also emphasized that there will be severe structural changes in the production sector especially with Industry 4.0. However, considering the new job opportunities created by technology improvements, the negative effect on the overall number of employees will be shallow.

Acemoglu and Restrepo (2020), one of the most recent studies on this subject, examines industrial robots' impact on employment in U.S. Labor Markets. They conclude that a one-unit increase in the number of robots per thousand workers decreases employment by 0.2% and average wages by 0.42%. They also state that the number of robots in the future will be 5.25 times more for every thousand workers according to the Boston Consulting Group (2015) estimates; in this case, total employment will decrease by 1% between 2015 and 2025.

As noted in Matuzeviciute et al. (2017), although there are many studies at the micro and sectoral levels, macro-level empirical studies are limited. Besides, most of the macro-level papers focus on the overall impact of technology on unemployment. While this impact is positive in three out of the eight most recent studies, no significant findings are reported by four papers. Feldmann (2013) uses Triadic Patent Families as the core independent variable and finds that the relationship between employment and technology is negative, which means technological progress increases unemployment. Matuzeviciute et al. (2017) achieve different results using similar countries and variables.

The technology-employment relationship should not be considered as one-dimensional but be examined with diverse groups and proxies. Although there are many studies at micro and sectoral levels, there is no empirical study at the macro level in the literature, which examines different skill groups to the best of our knowledge. Since the interaction of high and low skilled workers to technology is different, skill-biased technology shocks have different ultimate impacts on the productivity and thus skill premium of the two. Because many of the technology shocks are skill-biased instead of being neutral, low-skilled workers are disadvantaged. Michaels and Graetz (2015) examine the influence of new automation systems on employment at the micro-level for 17 countries between 1993-2007. They do not detect significant evidence of an adverse effect of technology on total employment, only a negative effect on low-skilled employees and a smaller effect for middle-skilled workers.

Many studies on the direction and intensity of the relationship between technology and unemployment so far have achieved inconsistent results. But today, discussions about the effect of technology on employment have reached a different dimension. The new machines, computers, software, and other innovations developed in various sectors and industries, while offering new business opportunities, destroy some of the existing professions leading to structural unemployment. We are familiar with ready-made meal suppliers who do not have a restaurant, clothing vendors who do not have a real store, and R&D departments are currently working on driverless cars and mail delivering drones. Does this mean people working in these sectors will be removed entirely from the business world? Or, as some economists have argued, does technology bring many advantages and always compensate the damages with new job opportunities? A key feature of the laborers is the qualification of the employee.

Much consideration was paid to skill-biased technological shift that is first empirically explored by Berman et al. (1994), who proves the existence of a strong correlation between industry skill upgrading and increased investment in computer technology and R&D in the U.S. manufacturing sector. Mortensen and Pissarides (1999) establish a theoretical model to answer “Do skill-biased shocks that increase the spread of labor productivity interacting with different policy regimes, explain the rise in unemployment in Europe relative to the United States in the 1980s and 1990s?”, but do not touch on the empirics. Similarly, Pieroni and Pompei (2007) explore the link between labor market flexibility and innovation, paying particular attention to different technological regimes of economic activities and different geographic areas of the Italian economy in a micro framework. According to Caselli and Coleman (2006), developed economies have a more intense high-skilled labor force than developing countries so that they can adapt labor markets more easily to technological changes. On the other hand, Acemoglu and Autor (2011) state that especially routine jobs require fewer human resources due to skill-biased technological changes.

According to the report published in the World Economic Forum (2018), 71% of total work hours in 12 industries are performed by humans, while machines carry out 29%. In the same report, it is estimated that the share of machines in labor hours will increase to 42% by 2022. So, do these predictions mean that total employment will shrink? The

report explains that the existing 75 million jobs will move from people to machines; in other words, technology “will destroy” employment. On the other hand, 133 million new job opportunities will arise due to technology. However, the critical point here is to what extent the existing human resources will be able to adapt to new business opportunities to be created with the qualifications they currently have. It is difficult to predict at what speed employees will upgrade themselves but identifying how high-skilled and low-skilled workers are affected by technology at the macro level in developed countries will make a significant contribution in this area. Although there are considerable studies in the micro-framework, macro analyses are rare, and among them, none is focusing on the list of countries we explore, over the period we study, with the methodology we facilitate, and the emphasis on skill-biased employment. With these four features stated, our research is unique to fill the gap in the literature. The outline of our paper includes the Introduction and Motivation in Section 1 followed by Section 2 highlighting data and methodology we use in detail. Section 3 reports estimation results and interprets them. Finally, Section 4 concludes with remarks.

2. Data and methodology

The main aim of the study is to document how the unemployment rates of developed countries are affected by technological advances and to determine whether the relationship between these two variables changes with skills. For this purpose, the unemployment rate is used as the dependent variable in the first three models, while in the other four models, high-skilled and low-skilled employment rates are on the left-hand side of the equations. The abbreviations, explanations, and units of the variables are portrayed in Table 1. All dependent variables are in percentages. The unemployment rate refers to the ratio of the population not working in the country to the total labor force in accordance with the International Labour Organization (ILO) definition. Employment rates by skill levels indicate the percentage of laborers by skills in the total labor force. ILO scaled the skill levels from 1 to 4, combining groups 3 and 4 as “high skill” and named groups 1 and 2 as low ‘and’ medium, respectively. In this study, “low” and “medium” groups are combined, and the “low-skilled employment” group is formed and identified into a single variable. Research and Development (R&D) expenditure, which is the core independent variable of the study, and GDP are used as per capita in constant USD. Output per worker, which is derived from the ILO database, is used as a productivity measure, and it is also in the form of constant USD. Besides, variables such as consumer price index, public unemployment spending, trade union density, real effective exchange rate index, and real interest rate are also identified as independent variables. The baseline panel equation specified in this direction is:

$$U_{it} = \alpha_0 + \beta \ln(RD)_{it} + \alpha_1 \ln(GDP)_{it} + \alpha_2 \ln(CPI)_{it} + \alpha_3 \ln(PRD)_{it} + e_{it} \quad (1)$$

Where subscript i stands for country and t for time for the following variables: U (Unemployment rate), RD (research and development expenditure per capita), GDP (the real GDP per capita), CPI (consumer price index), and PRD (a measure of productivity – output per worker). Finally, e_{it} is an error term including other factors that affect

unemployment. Other macroeconomics variables such as *INT* (real interest rate), *EXC* (real effective exchange rate index), *TUD* (trade union density index), and *PUS* (public unemployment spending per capita) are also used in additional models.

Table 1. List of variables

Description and Units of Variables	Symbol	Source
Unemployment rate (% of total labor force)	U	ILO (2020)
High-skilled employment rate (% of total labor force)	HSE	ILO (2019), authors' calculations
Low-skilled employment rate (% of total labor force)	LSE	ILO (2019), authors' calculations
R&D Expenditure per capita (constant 2010 US\$)	RD	OECD (2020), authors' calculations
GDP per capita (constant 2010 US\$)	GDP	World Bank (2020)
Consumer price index (2010 = 100)	CPI	World Bank (2020)
Productivity (output per worker: constant 2010 US\$)	PRD	ILO (2020), authors' calculations
Public unemployment spending per capita (constant 2010 US\$))	PUS	OECD (2020)
Trade union density index (2010 = 100)	TUD	OECD (2020), authors' calculations
Real effective exchange rate index (2010 = 100)	EXC	World Bank (2020)
Real interest rate (%)	INT	World Bank (2020), authors' calculations

Although the coefficient and sign of RD_{it} are mainly questioned; there is no consensus on it as stated in the empirical and theoretical literature review. Theoretically, the effect of GDP on unemployment is negative, and studies based on Okun's Law claim that, in general, high growth rates are associated with high employment. The findings on the relationship between productivity and unemployment are different. According to Landmann (2004), employment and productivity are positively correlated with a pro-cyclical pattern. However, Barnichon (2010) argues that before the 1980s, the relationship between technology and unemployment is negative but weak, while it is positive and strong after the 1980s because of the technology shocks. In addition, due to the nature of the "output per worker" variable used in productivity measurement, a negative reflection of productivity growth on employment is always a strong possibility. The overall effect, therefore, depends on the extent to at what level is productivity translated into new investments and business opportunities in the long run.

Even though the traditional representation of the inflation-unemployment relationship is mostly based on research by Philips (1958), and Samuelson and Solow (1960), Škare and Caporale (2014) find that long-term employment is negatively affected by inflation. Feldman (2010) also indicates that high inflation causes a decline in investment and economic growth, which means lower employment in the long run. Similar to these investigations, many empirical studies are indicating that employment is negatively affected by inflation in the long run. Economic theory and empirical studies such as Nickell et al. (2005) suggest that public unemployment spending decreases the desire to search for a job. Thus, an increase in unemployment benefits means higher unemployment rates.

Trade union density indicates the proportion of employees belonging to a trade union in the country. Soskice (1990), Blanchard and Wolfers (2000), and Baccaro and Rei (2007) state that high trade union density leads to high unemployment rates. The effect of real-effective exchange rate on unemployment is discussed in the literature differently. Frenkel and Ros (2006), Frenkel and Taylor (2009), Bakhshi and Ebrahimi (2016), and He (2013) underline that there is a negative linkage between the exchange rate index and unemployment. Finally, for the real interest rate, since the higher real interest rate means

lower investment and labor demand, theoretically, interest rate and unemployment are positively correlated. Also, empirical studies such as Blanchard and Wolfers (2000) and Feldmann (2013) indicate that in the long run, a higher real interest rate decreases employment.

Table 2 recaps descriptive statistics of 21 developed countries for both high and low skilled labor between 1990-2019. The average per capita GDP of these 21 countries is approximately \$45,354, and per capita R&D expenditure is almost \$948. Besides, the average unemployment, high-skilled employment, and low-skilled employment rates are 7.38%, 36.25%, and 56.34%, respectively. Northern European countries such as Norway, Sweden, Finland, and Denmark have the highest per capita R&D expenditures, in addition to Switzerland. In these countries, the share of high skill employment rate in the total labor force is around 40%. Moreover, the overall unemployment rate in these countries is 7.56%.

We go one step further and estimate the following specifications to work out the unemployment rates of low and high-skilled labor.

$$HSE_{it} = \alpha_0 + \beta \ln(RD)_{it} + \alpha_1 \ln(GDP)_{it} + \alpha_2 \ln(CPI)_{it} + \alpha_3 \ln(PRD)_{it} + e_{it} \quad (2)$$

In Eq. (2), the dependent variable is High Skill Employment (HSE_{it}) whereas the independent variables are the same as in (1). We expect to return a positive coefficient of RD_{it} as opposed to the one in the first three equations. Both the skill-biased technological change approach and findings on the relation between job polarization and technology underline new job opportunities for high-skilled workers. Theoretically, a rise in GDP should increase the rate of high-skilled employment. However, our expectations of the coefficient signs for the other variables are not that clear. Unemployment benefits, for instance, demotivates typical laid-off workers to search for a job, but for high-skilled workers, the fringe benefits provided by companies offset this demotivation.

$$LSE_{it} = \alpha_0 + \beta \ln(RD)_{it} + \alpha_1 \ln(GDP)_{it} + \alpha_2 \ln(CPI)_{it} + \alpha_3 \ln(PRD)_{it} + e_{it} \quad (3)$$

Table 2. *Descriptive statistics*

Country	Statistics	U (%)	HSE (%)	LSE (%)	RD (\$)	GDP (\$)	Country	Statistics	U (%)	HSE (%)	LSE (%)	RD (\$)	GDP (\$)
AUT	Mean	6.58	38.84	54.48	902	47053	JPN	Mean	3.75	22.33	73.91	1324	43519
	Std. dev.	1.84	3.50	2.08	287	7365		Std. dev.	1.03	1.81	2.26	203	3095
	Max.	10.87	43.53	57.76	1336	57071		Max.	5.37	24.89	78.52	1620	49188
	Min.	4.23	33.42	51.31	452	35035		Min.	2.09	19.39	71.64	993	38074
AUS	Mean	4.80	33.33	61.85	1013	43252	NLD	Mean	4.90	45.05	49.97	872	46785
	Std. dev.	0.74	4.37	4.86	386	5346		Std. dev.	1.61	2.00	1.00	150	6203
	Max.	6.01	38.97	70.50	1641	50655		Max.	7.42	47.63	52.79	1226	55690
	Min.	3.25	26.08	55.92	458	33889		Min.	2.12	40.43	48.16	650	35703
BEL	Mean	7.76	39.30	52.95	835	40796	NZL	Mean	6.06	38.30	55.57	362	31627
	Std. dev.	1.08	3.21	3.00	249	4823		Std. dev.	1.93	4.18	3.17	93	4662
	Max.	9.65	44.20	58.88	1402	47541		Max.	10.67	44.13	59.78	532	38993
	Min.	5.36	33.97	48.94	498	32672		Min.	3.60	32.36	51.01	223	23660
CAN	Mean	7.81	37.78	54.36	755	42748	NOR	Mean	4.13	41.98	53.90	1389	82117
	Std. dev.	1.56	2.85	1.78	145	6812		Std. dev.	1.00	4.84	4.37	274	10047
	Max.	11.38	41.70	56.82	926	51589		Max.	6.31	49.60	59.00	2037	92556
	Min.	5.66	33.21	51.39	499	32503		Min.	2.49	36.04	46.33	920	60227
DNK	Mean	6.15	39.41	54.42	1385	55826	PRT	Mean	7.80	25.48	66.73	206	20978
	Std. dev.	1.77	3.74	3.11	425	5886		Std. dev.	3.51	3.91	6.19	96	2165
	Max.	10.72	43.50	59.88	2017	65147		Max.	16.18	33.39	75.50	350	24590
	Min.	3.43	32.74	50.43	677	44569		Min.	3.82	20.31	55.97	77	16668
FIN	Mean	9.94	39.23	50.75	1244	41578	ESP	Mean	17.11	24.81	58.08	306	28509
	Std. dev.	3.40	2.59	1.81	380	6735		Std. dev.	5.35	3.86	4.87	91	3479
	Max.	17.00	42.69	55.77	1754	49441		Max.	26.09	29.20	66.84	422	33350
	Min.	3.07	34.45	48.39	607	29684		Min.	8.23	17.23	49.22	176	22513

Country	Statistics	U (%)	HSE (%)	LSE (%)	RD (\$)	GDP (\$)	Country	Statistics	U (%)	HSE (%)	LSE (%)	RD (\$)	GDP (\$)
FRA	Mean	9.77	35.34	54.88	842	38684	SWE	Mean	6.58	41.37	52.00	1589	47708
	Std. dev.	1.52	4.53	3.97	78	3674		Std. dev.	2.28	4.00	3.73	308	7618
	Max.	12.59	41.11	62.43	975	44317		Max.	10.36	48.20	59.32	2023	57975
	Min.	7.06	28.44	49.63	736	32524		Min.	1.83	36.00	46.22	948	35495
DEU	Mean	7.19	37.90	54.91	1027	39769	CHE	Mean	3.84	43.18	52.99	1958	70139
	Std. dev.	2.31	3.34	2.87	240	4626		Std. dev.	0.87	4.98	5.72	449	6080
	Max.	11.17	43.01	62.20	1499	47628		Max.	4.92	50.19	64.66	2718	79407
	Min.	3.14	32.38	51.34	730	32427		Min.	1.78	33.73	45.32	1440	61603
IRL	Mean	9.27	33.18	57.48	584	46863	GBR	Mean	6.47	39.36	54.15	618	37064
	Std. dev.	4.33	5.41	3.57	213	15158		Std. dev.	1.85	4.34	3.56	77	5070
	Max.	15.78	39.35	63.11	928	79703		Max.	10.35	46.49	58.88	758	43688
	Min.	3.68	23.50	49.83	193	24315		Min.	3.74	32.91	48.18	498	28291
ISR	Mean	9.30	36.71	53.99	1093	28446	USA	Mean	5.84	38.65	55.49	1207	45843
	Std. dev.	3.12	8.26	5.90	360	3965		Std. dev.	1.60	2.04	2.17	213	5970
	Max.	14.08	49.78	63.59	1777	35293		Max.	9.63	41.65	58.52	1599	55670
	Min.	3.90	24.77	46.05	538	21520		Min.	3.67	34.94	49.73	878	35542
ITA	Mean	9.96	29.76	60.25	402	34904	TOT	Mean	7.38	36.25	56.34	948	43534
	Std. dev.	1.85	5.09	4.18	57	2136		Std. dev.	3.76	7.25	6.57	508	14661
	Max.	12.68	38.23	68.37	505	38272		Max.	26.09	50.19	78.52	2718	92556
	Min.	6.08	22.30	55.65	308	30871		Min.	1.78	17.23	45.32	77	16668

Source: Authors' calculations.

Since we are interested in the analysis of unemployment technology relation for low skilled workers also, we specified (3). In this equation, LSE_{it} indicates Low Skilled Employment rates. Skill-biased technology approaches that ignore the middle class suggest that unskilled workers may lose their jobs because of technological progress. In addition, approaches like job polarization claim that middle-class workers may lose their jobs, but low-skill workers are not affected by technology negatively since they keep on working more with even lower wages. Since we merged the middle and low classes, we expect the coefficient of RD_{it} negative, because the weight of the middle class is so high compared to the low class. This assumption does not contradict both approaches.

Economic growth is expected to influence LSE positively the same way it affects HSE . Also, the impact of variables like inflation and the real interest rate on the employment of high-skilled and low-skilled labor as well as the overall unemployment may not be the same. For instance, an increase in the real effective exchange rate may increase unemployment since the domestic production will be less competitive as domestic currency appreciates. But this increase will not be the same in all sectors, and the total impact on high and low-skilled laborers will be different.

We execute the unit root test in every time series analysis to secure our analysis from spurious regression. We make use of Im et al. (2003) to figure out the order of integration and use (4) below to test the existence of the unit root with Im – Pesaran – Shin Unit Root Test. The null hypothesis of $H_0: \rho_i = 0$ (for all i ; all series in the panel has the unit root) is tested against the alternative of “at least one series does not have the unit root” ($H_A: \rho_i < 0$).

$$\Delta y_{i,t} = z_{i,t} \gamma_{i,t} + \rho y_{i,t-1} + \sum_{j=1}^{k_i} \varphi \Delta y_{i,t-j} + \varepsilon_{i,t} \quad (4)$$

After proving that at least one variable is not stationary at its level, we use Pedroni’s (1999) panel cointegration approach to question the long-run relation among variables in series. The panel cointegration analysis shows that even if the series of economic variables are not stationary, there may be a linear combination of these series, which can be determined econometrically, to have a long-term relationship. In this context, if the series are integrated at the same order, then there may be cointegration among the series where the regression between them is not spurious. Both Pedroni (1999) and Kao (1999) panel cointegration methods are used for supporting our conclusion further. We estimate (5) above to compute the estimates of the coefficients and residuals. The panel cointegration test of (9) below has the null of $H_0: \rho_i = 1$ (no cointegration). While Pedroni allows for heterogeneity of coefficients, Kao’s Test assumes homogeneity.

$$\hat{\varepsilon}_{i,t} = \rho_j \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^k \varphi \Delta \hat{\varepsilon}_{i,t-k} + v_{i,t} \quad (5)$$

After we highlight that there is a long-term significant relationship among the variables, we make use of the panel DOLS estimator of Pedroni (2001), Kao and Chiang (2001) and

Mark and Sul (2003). Panel DOLS is a parametric approach for long-term equilibrium estimation in which the variables considered can be integrated by eliminating endogeneity and serial correlation. The PDOLS estimate that is used in this study is based on the equation $\tilde{y}_{i,t} = \tilde{X}'_{i,t}\beta + \sum_{j=-q_i}^{r_i} \Delta\tilde{X}'_{i,t+j} \delta_i - \tilde{v}_{1it}$. Besides, in order to support the PDOLS findings, the panel FMOLS estimator results are also reported.

3. Estimation results

Testing for the existence of unit roots is required before applying the panel cointegration test. We use the “IPS test” developed by Im et al. (2003) since it enables us to combine individual unit root test results and handle heterogeneity between panels. We also report LLC (Levin et al., 2002) and Fisher-ADF (Maddala and Wu, 1999) tests results.

As reported in Table 3, IPS test results indicate that seven out of eleven variables are nonstationary at levels. All become stationary at their first differences. That means we attain stationarity of all variables at their first differences. We make use of Pedroni’s Cointegration Test that requires the same order of integration for all variables, with at least one being stationary at its level. The same degree of integration for most of the variables provides the impression that the panel cointegration test is likely to conclude a stable relation among the variables in the long run.

Table 3. Results of panel unit root tests

Variables	IPS		LLC		ADF - Fisher	
	Level	First Difference	Level	First Difference	Level	First Difference
U_i	-4.428 [0.000]***	-10.926 [0.000]***	-3.445 [0.000]***	-9.894 [0.000]***	92.877 [0.000]***	196.921 [0.000]***
HSE_i	2.689 [0.996]	-17.085 [0.000]***	-1.226 [0.110]	-18.005 [0.000]***	23.141 [0.992]	315.131 [0.000]***
LSE_i	-1.492 [0.068]	-15.345 [0.000]***	-4.119 [0.000]***	-15.283 [0.000]***	61.593 [0.026]*	286.842 [0.000]***
$\ln(RD)_i$	2.048 [0.980]	-12.363 [0.000]***	-2.383 [0.009]**	-11.609 [0.000]***	38.217 [0.638]	229.033 [0.000]***
$\ln(GDP)_i$	1.2 [0.885]	-11.986 [0.000]***	-4.3 [0.000]***	-10.799 [0.000]***	28.606 [0.943]	215.402 [0.000]***
$\ln(CPI)_i$	-1.955 [0.025]*	-12.428 [0.000]***	-6.157 [0.000]***	-11.835 [0.000]***	73.446 [0.002]**	224.465 [0.000]***
$\ln(PRD)_i$	-3.211 [0.001]***	-12.596 [0.000]***	-8.578 [0.000]***	-13.718 [0.000]***	80.824 [0.000]***	236.499 [0.000]***
INT_i	-4.163 [0.000]***	-18.733 [0.000]***	-5.743 [0.000]***	-18.91 [0.000]***	90.743 [0.000]***	359.222 [0.000]***
$\ln(PUS)_i$	-1.71 [0.044]*	-6.826 [0.000]***	2.452 [0.993]	-14.097 [0.000]***	57.75 [0.054]	137.348 [0.000]***
$\ln(TUD)_i$	2.692 [0.997]	-13.003 [0.000]***	-1.704 [0.044]*	-13.57 [0.000]***	28.274 [0.948]	227.886 [0.000]***
$\ln(EXC)_i$	-3.219 [0.001]***	-14.861 [0.000]***	-2.679 [0.004]**	-15.178 [0.000]***	79.733 [0.000]***	272.091 [0.000]***

Note: The IPS tests for all variables include constant. In order to detect the optimal lag length, the Akaike Information Criterion (AIC) is used. *Rejection of the null of nonstationarity at 0.05 level, **Rejection of the null of nonstationarity at 0.01 level, ***Rejection of the null of nonstationarity at 0.001 level.

Source: Authors’ calculations.

Panel cointegration results of Equation (1) with unemployment identified as the dependent variable are summarized in Table 4. In Model 1, $\ln(RD)$, $\ln(GDP)$, and $\ln(CPI)$

are used as independent variables. In Model 2, $\ln(\text{PRD})$ is used in addition to the variables in the first model. We defined these first two models as “baseline specifications”. We append INT , $\ln(\text{PRD})$, $\ln(\text{TUD})$, and $\ln(\text{EXC})$ in the other four models. We present the Kao Panel Cointegration Test results in addition to Pedroni’s to support the initial findings. Pedroni Cointegration Test is executed without trend, which rejects the null hypothesis of “no cointegration” in all six models at the 0.05 significance level. In addition, Kao Cointegration Test concludes the same at the 0.01 significance level. In all models, at least three of five cointegration statistics highlight that there is a long-run stable relation among variables.

Table 4. Results of panel cointegration tests for unemployment

Test	Statistics	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
		<i>RD, GDP, CPI</i>	<i>RD, GDP, CPI, PRD</i>	<i>RD, GDP, CPI, PRD, INT, PUS</i>	<i>RD, GDP, CPI, PRD, INT, TUD</i>	<i>RD, GDP, CPI, PUS, TUD, EXC</i>	<i>RD, GDP, CPI, PRD, PUS, TUD</i>
Pedroni	Panel PP t	-0.105	-1.853	-2.055	-3.071	0.510	-2.168
	p-value	[0.458]	[0.032]*	[0.020]*	[0.001]***	[0.695]	[0.015]*
	Panel ADF t	-2.957	-3.708	-2.319	-2.656	-1.734	-3.188
	p-value	[0.002]**	[0.000]**	[0.010]**	[0.004]**	[0.042]*	[0.001]***
	Group PP t	0.257	-1.856	-3.289	-4.342	-2.585	-2.720
	p-value	[0.601]	[0.032]*	[0.001]***	[0.000]***	[0.005]**	[0.003]**
	Group ADF t	-4.346	-3.380	-2.097	-2.985	-1.659	-1.659
	p-value	[0.000]***	[0.000]***	[0.018]*	[0.001]***	[0.049]*	[0.049]*
Kao	ADF t	-6.200	-5.565	-5.735	-5.453	-5.835	-5.854
	p-value	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***

Note: In order to detect the optimal lag length, the AIC is used. In panel PP and ADF results, weighted statistics are reported. In Base Model 1, $\ln RD_t$, $\ln GDP_t$, and $\ln CPI_t$ are used as independent variables. Base Model 2 includes $\ln PRD_t$ in addition to the variables in Base Model 1. Four extra models are also generated including other independent variables. P-values are given in brackets. *Rejection of the null hypothesis of no cointegration at the 0.05 level, **Rejection of the null hypothesis of no cointegration at the 0.01 level, *** Rejection of the null hypothesis of no cointegration at the 0.001 level.

Source: Authors’ calculations.

After proving the existence of the long-run relation empirically, we make use of panel DOLS (Dynamic OLS) to estimate the coefficients of the variables. In addition to panel DOLS estimation, FMOLS (Fully Modified OLS) results are also reported as a robustness check. Results displayed in Table 5 and Table 6 belong to six models established for unemployment. In the analyses, the decimal fraction of U_t is used. Since the number of variables to be included in a panel with short periods has to be limited, we take care of this constraint to elaborate on the equations to keep the number of variables as low as possible. The coefficient vector β has close estimates in six equations, and both panel DOLS and FMOLS estimates of $R\&D$ are significant at 5%. Based on these results, the coefficient of $\ln(RD)$ is positive and between 0.012-0.034, which means technology increases overall unemployment. Our findings lead to the very important inference that in developed economies, technological progress makes job creation outweighed by job destruction and the compensation mechanism is not effective. Besides, $\ln(GDP)$ has a negative coefficient, consistent with the theory and previous empirical studies. The coefficient of $\ln(GDP)$ ranges between -0.17 and -0.44. The measure of inflation $\ln(CPI)$ and productivity variable $\ln(\text{PRD})$ are positively correlated with unemployment.

Table 5. PDOLS and FMOLS estimates results for the baseline specifications, *Dependent variable: U_t*

Variables	Model 1 (Base Model 1)				Model 2 (Base Model 2)			
	PDOLS		FMOLS		PDOLS		FMOLS	
	Beta	t-stat	Beta	t-stat	Beta	t-stat	Beta	t-stat
$\ln(RD)_t$	0.032	4.429***	0.034	3.706***	0.021	5.026***	0.022	3.938***
$\ln(GDP)_t$	-0.217	-14.426***	-0.174	-8.090***	-0.440	-29.208***	-0.403	-20.446***
$\ln(CPI)_t$	0.067	5.529***	0.038	2.609**	0.046	5.789***	0.044	5.241***
$\ln(PRD)_t$					0.376	18.271	0.341	14.042***

Note: For the PDOLS estimator, the AIC is used to determine the leads & lags and the pooled-weighted estimation is used as panel method. For the FMOLS estimator, sandwich method is used in estimating covariance. As the dependent variable, decimal fractions of U_t are used. *Significance at the 0.05 level, **Significance at the 0.01 level, ***Significance at the 0.001 level.

Source: Authors' calculations.

In terms of studies on the relationship between inflation and unemployment at macro level, on the one hand, the classical Philips Curve reveals the existence of a negative relationship; on the other hand, numerous empirical studies in the literature suggest the existence of a positive, insignificant or a negative relationship. In this study, it is concluded that inflation has a positive impact on total unemployment in the long run. In addition, the coefficient of $\ln(TUD)$ is positive and significant in the two models while insignificant in one model. Since the higher share of trade unions increases the wages, employers may want to hire fewer workers. These findings are in line with Soskice (1990) and Baccaro and Rei (2007). We also find a positive and significant impact of real interest rate in one PDOLS and two FMOLS estimates, while it is insignificant in one PDOLS model. On the other hand, the effect of $\ln(REER)$ is negative but insignificant according to PDOLS results.

Table 6. PDOLS and FMOLS estimates results for the additional models. *Dependent variable: U_t*

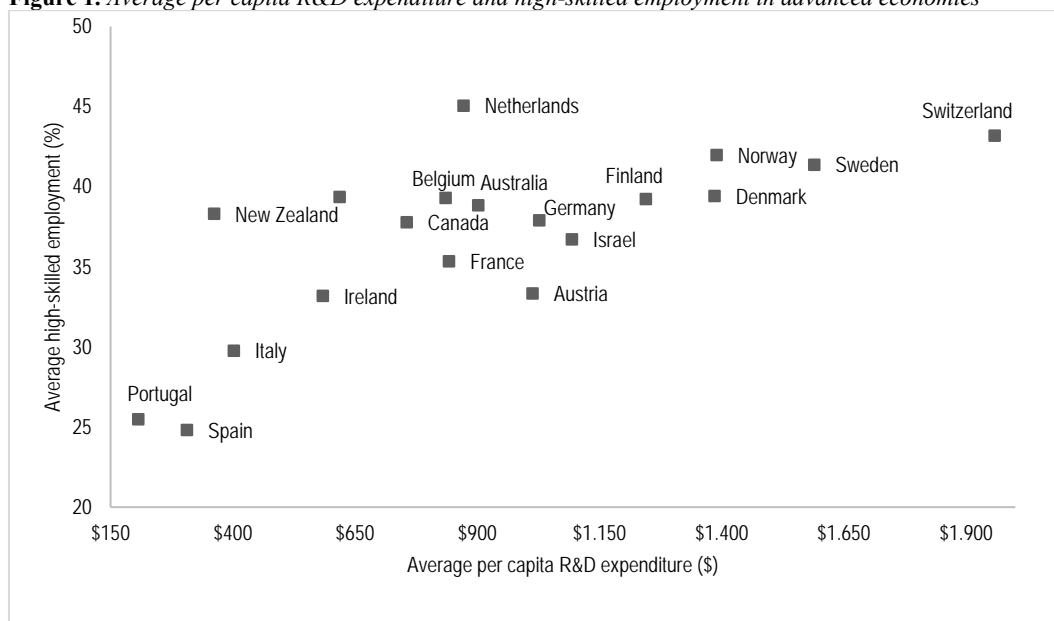
Variable	Model 3		Model 4		Model 5		Model 6	
	PDOLS	FMOLS	PDOLS	FMOLS	PDOLS	FMOLS	PDOLS	FMOLS
$\ln(RD)_t$	0.012 (2.454)**	0.015 (3.079)**	0.026 (4.663)***	0.023 (4.714)***	0.022 (2.216)*	0.025 (3.327)***	0.014 (2.628)**	0.019 (3.793)***
$\ln(GDP)_t$	-0.381 (-19.148)***	-0.364 (-19.269)***	-0.402 (-23.958)***	-0.374 (-24.572)***	-0.168 (-6.569)***	-0.135 (-7.312)***	-0.413 (-24.489)***	-0.372 (-23.502)***
$\ln(CPI)_t$	0.052 (5.070)***	0.045 (5.558)***	0.052 (5.096)***	0.050 (7.010)***	0.068 (4.035)***	0.022 (1.835)	0.058 (5.526)***	0.042 (5.634)***
$\ln(PRD)_t$	0.326 (13.265)***	0.322 (14.234)***	0.351 (13.042)***	0.328 (18.606)***			0.400 (17.081)***	0.330 (17.753)***
INT_t	0.001 (1.573)	0.001 (2.778)**	0.001 (2.599)**	0.001 (4.913)***				
$\ln(PUS)_t$	0.006 (1.505)	0.009 (5.231)***			0.014 (4.154)***	0.016 (6.814)***	0.008 (2.264)*	0.009 (5.226)***
$\ln(TUD)_t$			0.025 (2.567)*	0.018 (2.970)**	0.008 (0.686)	-0.004 (-0.443)	0.036 (3.795)***	0.011 (1.683)
$\ln(EXC)_t$					-0.012 (-0.939)	-0.022 (-2.606)**		

Note: For the PDOLS estimator, the AIC is used to determine the leads and lags, and the pooled-weighted estimation is used as the panel method. For the FMOLS estimator, the sandwich method is used in estimating covariance. As the dependent variable, decimal fractions of U_t are used. Except for interest rate, all independent variables are in natural logs, and t-statistics are given in parentheses. *Significance at the 0.05 level, **Significance at the 0.01 level, ***Significance at the 0.001 level.

Source: Authors' calculations.

In addition to the technology unemployment relation, we are interested in detailing this relation to different skill groups. Both skill-biased technological change approaches and comments on job polarization claim that the impact of technology on high or low-skilled workers is varying. In this regard, Figure 1 is illustrative and visualizes a clear picture of this difference. Per capita R&D expenditures and high-skilled employment rates are spotted over a 30-year horizon with averages for developed economies. The graph illustrates that as per capita R&D increases, high skilled employment rates also increase, which is very reasonable. Spain and Portugal have the lowest average high-skilled employment rate with the lowest average R&D expenditure.

Figure 1. Average per capita R&D expenditure and high-skilled employment in advanced economies



We enlarge our analysis to account for the skill levels with the same methodology and procedure of Equations (1), (2), and (3). To this end, Table 7 reports panel cointegration test results of four models. The null hypothesis with and without trend is rejected at 5% significance level for all models, underlining the long-term relationship. Kao cointegration test results support Pedroni's again. These results document that in developed countries, both high-skilled and low-skilled employment rates have a long run significant relation with R&D and other macro variables included.

Table 7. Results of panel cointegration tests for employment by skill levels

Test	Statistics	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
		<i>RD, GDP, CPI</i>	<i>RD, GDP, CPI, PRD</i>	<i>RD, GDP, CPI, PRD, INT</i>	<i>RD, GDP, CPI</i>	<i>RD, GDP, CPI, PRD</i>	<i>RD, GDP, CPI, PRD, INT</i>
		Dependent variable: HSE_t			Dependent variable: LSE_t		
Pedroni	Panel PP t	-2.529	-2.711	-2.868	-1.581	-2.002	-3.421
	p-value	[0.006]**	[0.003]**	[0.002]**	[0.057]	[0.023]*	[0.000]***
	Panel ADF t	-4.046	-4.569	-5.008	-3.410	-3.914	-3.508
	p-value	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
	Group PP t	-2.566	-3.225	-3.467	-1.107	-2.557	-4.331
	p-value	[0.005]**	[0.001]***	[0.000]***	[0.134]	[0.005]**	[0.000]***
	Group ADF t	-4.768	-4.625	-4.203	-3.106	-3.881	-3.449
	p-value	[0.000]***	[0.000]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Kao	ADF t	-1.648	-1.807	-2.837	-3.911	-3.671	-3.804
	p-value	[0.050]*	[0.035]*	[0.002]**	[0.000]***	[0.000]***	[0.000]***

Note: In order to detect the optimal lag length, the AIC is used. In panel PP and ADF results, weighted statistics are reported. In Model 7 and Model 11, $\ln RD_t$, $\ln GDP_t$, and $\ln CPI_t$ are used as independent variables. Model 8 and Model 11 include $\ln PRD_t$, and Model 9 and Model 12 include both $\ln PRD_t$ and $\ln INT_t$ in addition to the variables in baseline models. P-values are given in brackets. *Rejection of the null hypothesis of no cointegration at the 0.05 level, **Rejection of the null hypothesis of no cointegration at the 0.01 level, ***Rejection of the null hypothesis of no cointegration at the 0.001 level.

Source: Authors' calculations.

We go one step ahead after proving the existence of the long-run nexus among variables of interest to diagnose the direction and magnitude of the relation. Estimation results of PDOLS are reported in Table 8. Coefficients of R&D in models (7), (8), and (9) established for high-skilled employment are positive, while corresponding coefficients in models (10), (11), and (12) established for low-skilled employment are negative, and the coefficients in all six models are significant. These results are in line with the assertion that the impact of technological progress shock on employment is skill-biased. On the other hand, the rise in per capita GDP increases both high-skilled and low-skilled employment. Besides, it is concluded that an increase in productivity decreases especially low-skilled employment instead of high-skilled. Just like R&D expenditure, the impact of inflation on high and low skilled labor is contradictory since inflation is known to be increasing due to demand-pull as economic activity revives. The interesting conclusion is that our results on the high-skilled employment effect of inflation are parallel with the classical Philips Curve, while low-skilled employment is not. Finally, the real interest rate has a negative impact on high-skilled employment while it is insignificant in explaining low-skilled employment.

Table 8. Panel DOLS estimates results of the long-run relationship for employment by skill levels

Variables	Dependent Variable: HSE_t			Dependent Variable: Low LSE_t		
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
$\ln(RD)_t$	0.042 (4.438)***	0.050 (5.011)***	0.052 (4.945)***	-0.040 (-3.130)**	-0.049 (-4.030)***	-0.065 (-5.456)***
$\ln(GDP)_t$	0.112 (5.092)***	0.112 (3.868)***	0.125 (3.631)***	0.084 (3.625)***	0.239 (6.659)***	0.237 (6.068)***
$\ln(CPI)_t$	0.055 (3.531)***	0.048 (2.653)**	0.050 (2.464)**	-0.129 (-5.864)***	-0.112 (-5.289)***	-0.113 (-5.029)***
$\ln(PRD)_t$		-0.018 (-0.687)	-0.080 (-2.306)*		-0.256 (-6.531)***	-0.210 (-4.813)***
INT			-0.002 (-2.117)*			0.002 (1.944)

Note: For the PDOLS estimator, the AIC is used to determine the leads and lags, and the pooled-weighted estimation is used as the panel method. As the dependent variable, decimal fractions of HSE_t and LSE_t are used. Except for interest rate, all variables are in natural logs, and t-statistics are given in parentheses. *Significance at the 0.05 level, ** Significance at the 0.01 level, *** Significance at the 0.001 level.

Source: Authors' calculations.

4. Concluding remarks

We make use of annual data from 21 developed countries over 1990-2019 to document that there is cointegration among the set of variables including R&D expenditures and (un)employment. Our time span includes the hit of the global financial crisis to reveal the resilience of the relationship even along with the shock and thereafter. We detail the analysis to explore the impact of technology on the employment of high and low-skilled labor. Estimation results with PDOLS and FMOLS demonstrate that:

- As R&D expenditures increase, employment of the high-skilled workers increases, whereas the opposite is true for the low-skilled workers in advanced economies. The compensation mechanism is effective for high skilled workers, not the low skilled ones.
- R&D expenditures increase total unemployment, even in developed economies. The possible reason for this result is that in developed countries, the intensity of skilled workers is still less than the intensity of unskilled or low-skilled employees. If low-skilled workers become more equipped and are able to adapt to new technologies, the impact of technology on overall unemployment may reverse in the future.
- Growth declines unemployment as expected.
- To the contrary, productivity increases unemployment.
- Public unemployment spending and unemployment are positively related as the positive coefficients of PUS suggest.

Our investigation asserts concrete empirical evidence on the research and development expenditure unemployment relation coupled with skill groups, but further analyses are required, and there is room to explore the same relation along with other key variables headed by wage and working conditions.

Note

- ⁽¹⁾ This paper is created from the doctoral dissertation submitted to the Institute of Social Sciences, Department of Economics, Istanbul University, Turkey.

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Capital account liberalisation in India: Volatility of capital flows and selective policy issues

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Abstract. *This paper attempts to investigate the relationship between capital account openness and occurrence of financial risks in India by employing finite distributed lag model. Annual data from 1979 to 2018 on real effective exchange rate, real interest rate, international reserve and net capital have been used to compute Exchange Market Pressure index and the degree of capital account liberalization. The study finds that opening up of capital account will have harmful effects on the financial stability of the country in the initial years, say a year or two. However, the degree of financial risks will go down in later years by influencing capital inflows. Finally, the study has suggested that the Reserve Bank of India needs to take precautionary measures to mitigate short term volatility of capital flows before choosing fuller capital account convertibility.*

Keywords: capital account liberalization, financial stability, real exchange rate, real interest rate, foreign exchange reserve, finite distributed lag model.

JEL Classification: F20, F21, F31, F37, F41.

1. Introduction

The matter of capital account liberalization has always taken a lot of heat from the time the wave of globalization and liberalization swept over most of the emerging economies to periods of financial meltdowns, particularly that of the 2008 financial crisis which had cascading effects worldwide depending on a country's level of integration into the world economy. The objective of liberalizing capital account is to transfer and reallocate capital and assets from capital-rich nations to capital-poor nations, which is reflective of changes in the ownership patterns of the assets in an economy.

Economists of varying school of thoughts have different opinions regarding the same. On one hand, there are some economists, such as Stanley Fischer who advocate on the lines of traditional neo-classical theory. They suggest that financial liberalization can contribute to a more inclusive efficiency in the world through allocation of resources from those who have excess of it to those who are starved of it but will be able to use them more productively and effectively leading to a general upward trend in social welfare. Free capital movement would ensure that people of various countries would be able to reduce the cost of capital along with risks associated with it and gain more returns by diversifying their portfolios. This point of view argues that capital liberalization will lead to development and expansion of financial system which will in turn ensure financial stability.

It is also argued that financial liberalization can generate greater competitiveness in the economy, promoting efficiency and innovation. For instance, if barriers to capital movement are substantially reduced, then it will attract a large number of foreign financial institutions and entities to enter into that country. This may hurt the domestic financial institutions in the short-run, encouraging them to improve their type and quality of financial goods and services, subsequently promoting efficiency. This is of great importance in the context of a country like India which is considered be a relatively capital-scarce economy. On the other hand, many economists such as Dani Rodrick and Joseph Stieglitz argue that capital liberalization can lead to financial instability due to the volatile nature of short-term capital flows. One of the greatest flaw in neo-classical theory is that it assumes that market for financial and capital goods is same as market for ordinary goods and services. However, the former depends upon information-gathering which may not be perfect all the time, leading to disequilibrium in the economy. The major bone of contention that capital account liberalization leads to financial stability and decline in risks is also heavily criticised. Direction of capital flows is mainly determined by the lender's or investor's perception about risk and gain, and he/she may choose to pull his/her money out whenever they perceive there to be any kind of risk.

The numerous preconditions imposed by IMF and various committees (such as Tarapore committee in India) also require a lot of discipline, political and macroeconomic variable stability in the economy which may or may not be translated into reality. For instance, Tarapore committee had laid down various preconditions that had to be met before India opted for full conversion of rupee on capital account. It included stabilization of inflation rate within the target range of 3 to 5 percent, financial consolidation and improvement in performance of financial sector. However, this never manifested into reality as India continued to have stricter capital controls.

High capital controls in China and India have been repeatedly applauded, for having helped these economies to not get dragged into the catastrophe of Asian financial crises and financial meltdown of 2008. Even though the capital flows are heavily criticised by many, India and China happen to be two of the most popular and largest recipients of foreign direct investments. Even after attracting such high investments, both the countries have never been deeply affected by any financial crisis. According to the literature, there is no explicit positive correlation between financial liberalization and financial instability. Financial liberalization then may or may not have an impact on the volatility of different types of capital flows. One view also suggests that financial crisis can in fact lead to a better institutional and political environment.

Research conducted in China, a country which is comparable to India in various aspects such as demography, economic growth rate, purchasing power parity et cetera, has also shown that even though it employs capital controls, it is on its path to greater capital convertibility. This is of even more relevance to China due to the development of belt and road initiative along with formation and expansion of Asian Infrastructure Investment Bank. It has been revealed through various papers that when China opened up its economy to capital flows, there was instability for a time period of one year, which was later compensated by financial stability in the long-run.

Even though India opened up its economy in 1991 after the advent of LPG policy, it had not reduced its controls on capital account. Opening up of capital account remained a huge debate amongst numerous economists as many blamed it for causing numerous financial crises. Reserve Bank of India had set up a special committee to analyse and direct full capital convertibility in 1997. The committee laid down various preconditions that were necessary for the same. However, its recommendations were never fully realized. The Tarapore committee was set up again in year 2006, and similar to their earlier experience, the recommendations were again neglected. It is thus very imperative to understand why India chose to disregard the committee's suggestions and continue to have capital controls. To understand that, it is first vital to establish an association between financial liberalization and financial stability through application of econometric models that takes country-specific characteristics and time lag into consideration. Inclusion of macroeconomic variables such as real effective exchange rate, foreign exchange reserves and real interest rate will provide a correct picture of the capital account liberalization scenario in India.

Similarly, it is important to compare the Indian experience with that of other emerging economies and countries in its vicinity due to several similarities. Countries in South America and Mexico show that the economy and financial system slow down after opening up of the capital account. This can be exemplified by the Mexican exchange rate crisis of 1994 wherein the peso got severely devalued against the US dollar and is considered to be one of the first crisis due to capital openness. Likewise, countries in sub-Saharan countries also show that there is an inverse relationship between financial liberalization and financial stability. Greater emphasis then would have to be given to political environment, financial infrastructure, exchange rate regime and institutional framework for the country to reap benefits from full capital convertibility. These different perspectives and contradictions seem to baffle its readers. Hence, it is crucial to develop a model to study the impact of

capital account openness on soundness of financial and banking sector of the economy. Against these backgrounds, the major issues arises are; Will capital account liberalization lead to financial stability in the economy? How long does capital account liberalization have an influence on the stability of domestic financial system? Is the overall influence of financial liberalization on financial market positive or negative? Is the Indian institutional framework, financial infrastructure and exchange rate regime supportive of capital account liberalization to create positive effects?

Against the background and research issues, the **major objectives of the study** is to examine the relationship between financial liberalization and financial risk by employing finite distributed lag model. Also, it necessary to forecast the influence of capital account convertibility on the stability of financial system of the economy. Finally, the study test whether overall influence of capital movement on financial stability is positive or negative.

2.1. Literature review

The economic transactions of a country are reflected on its balance of payments either through the current account or the capital account. Simply put, current account reveals the net income of the economy whereas capital account shows the ownership of assets. Sequencing of the two reforms has also garnered a lot of attention, that is, which account should be liberalized first- current account or capital account? James A. Hanson (1992) criticizes the conventional theory of liberalizing current account before capital account which suggests that liberalization of the latter would lead to unwarranted real appreciation of real exchange rate. However, research shows that there is a greater availability of resources in the economy if capital account were to be liberalized first.

Most of the countries have still opted for current account liberalization before that of the capital account because of growing skepticism around the latter even when numerous research papers show that free capital movement can prove to be beneficial for the economy. For instance, Bogdan Bogdanov (2014) has identified the relationship between large capital movements and volatility of foreign exchange rate and capital flows. To test the same, the author has used propensity score matching methodology on data covering 69 countries for a period of 31 years from 1980-2011. The results of the study show that when an economy opens up its capital account, it leads to lower volatility of foreign exchange rates and that financial liberalization may or may not have an impact on the volatility of long-term and short-term capital flows. Furthermore, the study also suggests that capital account convertibility can lead to stronger institutional foundation and political stability in the economy.

Finally, there is also another group of academicians and researchers that propagate that an economy need not follow any sequence, that is, the developing economies on the path of fuller capital account liberalization can initiate both financial and external reforms concomitantly. This strategy will ensure in mitigating all the distortions in a single shot and will help in reducing costs and maximizing benefits derived from both these reforms. For instance, Philippe Bacchetta (1992) examined the bearing of a combined liberalization of financial sector and capital account by comparing both the simultaneous and sequential

strategy of liberalization. They found out that in the initial periods, a country receives more of capital inflows and is followed by capital outflows in the subsequent periods. It also leads to rise in prices of shares along with rise in the level of investment.

Similarly, Liqing Zhang and Qin Gou (2015) have explained the impact of reform sequencing and risks associated with it on capital account convertibility in China. In their analysis consisting of 50 countries in the time frame of 1973 to 2005, the authors found out that reforms of the domestic financial sector and gradual elimination of credit controls can reduce the instances of financial instability and crises. The paper highlights the importance of accelerating domestic banking reforms along with opening up of capital account and that it should be made the utmost priority for the Chinese economy and must include strengthening of insurance system, capital markets, banking and financial system as well as interest rate liberalization.

Still, many economists remain ardent and long-standing critics of capital account convertibility. Capital account liberalization has constantly become a burning issue time and time again, especially during the times of financial crises. Asian financial crisis of 1997 and financial meltdown of 2008 are convincing evidences for the critics to keep blaming capital account for the fall and slowdown of well-managed and advanced economies such as United States and South Korea. Joseph Stiglitz (1999) in his paper titled “Capital Market Liberalization, Economic Growth and Instability” develops a case against the liberalization of capital account by finding empirical weaknesses in the cases supporting the same. He highlights the importance of having an effective regulatory framework in place instead of opening the capital account hastily. He has focused on the effectiveness of the short-term capital flows instead of the long-term capital flows such as FDIs as he believes that such “investment brings with it not only resources, but technology, access to markets and (hopefully) valuable training, an improvement in human capital”. He questions the traditional theory which propagates that more transparency and better access to information can decrease the occurrence of financial crisis, suggesting that capital flight can be beneficial. However, in Scandinavian countries such as Norway, Sweden and Finland, where transparency is the highest amongst all the nations, incidence of financial crisis has also been very high. There is also a great deal of speculation regarding the reforms dedicated to strengthening of the foundation of financial institutions in emerging and poorer economies. It is alleged that EMEs and poorer nations cannot reduce the adverse impact of capital account, when even the developed and financially strong nations continue to face the brunt of full capital convertibility.

On the same lines, Ismail Ceviz and Cem Kadilar (2001) have investigated the impact of short-term capital movements on the Turkish economy through application of vector auto-regression model. The authors have found out that the policies which promote high interest-low exchange rate result in larger amount of short-term capital inflows which as mentioned above happen to be very volatile in nature. They propose certain controls on capital inflows such as taxation on capital imports, stronger government intervention and sterilization policies to safeguard EMEs from macroeconomic instability due to international speculation.

While many economists consider the volatility of short-term capital flows to be the main culprit for financial instability, some believe that foreign direct investments (FDIs) can also lead up to financial fragility. For instance, Ajit Singh (2003) has analyzed the impact of liberalizing capital account on free long-term capital flows, financial crisis and economic development of a country. He has addressed many controversies surrounding the subject matter by asking questions such as why is there an increase in crises in emerging economies after capital account liberalization and if these adversities can be compensated by faster economic growth in the long run. He has claimed in his paper that FDIs, which are strongly supported by numerous economists such as Stiglitz himself, may not lead to financial and economic development of a nation. The author believes “that even FDI, if unregulated, may do more harm than good to many countries”. He has also found weak empirical evidence for faster long run economic growth after full capital convertibility.

While full capital convertibility remains a topic that baffles many, it is a general consensus amongst numerous economists that there are certain preconditions that need to be met before opening up the capital account. For instance, Daianu and Vrancean (2003) have examined various policy issues for developing countries when they open up their capital account. In 1980s, it was widely believed that financial liberalization would lead to greater economic gains, however higher incidence of crises distorted the relationship between development and capital liberalization. The authors propose various prerequisites before opening up the capital account such as: (i) stabilized inflation and exchange rate; (ii) well-organized information and statistical system; (iii) low corruption and money laundering, (iv) increase in competitiveness through appropriate policy measures, and (v) development of an efficient financial system.

Apart from these prerequisites, other factors such as adaptability of domestic financial institutions also play a big role. Allegret, Courbis and Dulbecco (2003) have discussed the influence of financial liberalization on stability of the financial system from the institutional perspective. They highlight on the importance of adaptability of domestic financial institutions when financial reforms are employed. When the capital account is opened, international investors play a dominant role. At this point, it becomes very imperative to develop a well-organized and efficient financial institutional infrastructure which makes use of capital controls to help stabilize the financial system.

While some give importance to the adaptability of financial institutions in the emerging economies, some highlight on the importance of political environment that can help smoothen the hostile impacts of liberalization. Xiang Li and Dan Su (2016) have analyzed the impact of free capital movement on the level of bank risk using bank-level data. The authors have taken a large bank level dataset for 75 countries for a time period of 18 years from 1995-2013. The study reveals that both individual bank risk and systemic bank risk tend to escalate during financial opening of the economy. However, these unfavourable impacts can be softened by suitable political and economic environment.

In India, the task to suggesting a pathway to full capital account convertibility was assigned to the Tarapore Committee (1997) which was created by the Reserve Bank of India. The committee mentioned several preconditions for the same such as: (i) Fiscal consolidation, (ii) mandated inflation target between 3 to 5 percent, and (iii) strengthening of financial

system through reduction in non-performing assets and average affective cash reserve ratio (CRR). The first time the committee was set up, they had recommended the operation of capital account convertibility for a period of three fiscal years from 1997-1998 to 1999-2000. However, the committee's proposal was never translated into full convertibility, and India still employed capital controls which are now worldwide appreciated to have reduced the impact of various financial crises. Some can argue that the reason why India escaped Asian financial crisis was because of its reforms of partial convertibility. The second time the committee was again set up in 2006, wherein they suggested three phases for 100% capital liberalization. Certain preconditions were again laid down for the same such as: (i) increase in external commercial borrowings (ECB); (ii) Provision of tax benefits and higher investment opportunities to NRIs, and (iii) improvement in banking regulations. The recommendations of the committee were again met with the same unfortunate fate.

M.J. Manohar Rao has examined the interaction effect of several variables such as foreign exchange reserves, inflation rate, money, interest rates and growth rate to critically evaluate the suggestions that have been laid down by the Tarapore committee. The author found out that the recommended 6 percent growth rate and 5 percent inflation rate are inconsistent with the recommended foreign exchange reserve requirements, however they are consistent with the current foreign interest rates if the economy makes use of tighter monetary policies. The paper also cautions the economy and its policymakers to not take any hasty decisions regarding capital account convertibility. It is extremely crucial for an economy like India to strengthen its financial sector and other preconditions before opting to take such a big step.

On the other hand, researchers such as Nachane (2010) believe that India is facing reduced fiscal space, loss of sovereignty of monetary policy and unpredictability in exchange and equity market due to its incompetence in imposing capital controls at the right time. As it would also result in uncertainty regarding investment decisions, he proposes that India should make use of complementary set of policies, that is, capital controls on inflows such as: (i) interest equalization taxes, (ii) sector-wise regulation of FDI, (iii) taxes on external commercial loans and controls on outflows such as exchange controls along with financial regulations.

However, in contrast, even though large capital flows are associated with high inflation, financial sector fragility, real exchange rate misalignment and imbalances in current account, India has been worldwide appreciated to have absconded macroeconomic and financial instability. Rakesh Mohan and Muneesh Kapur (2009) have analyzed various macroeconomic and external sector policies and reforms to explain less volatility of capital flows in India. Various policy measures such as: (i) active management of capital account; (ii) tighter restrictions on access of financial institutions, entities and intermediaries to external borrowings; (iii) Managed floating exchange rate, (iv) expansion of financial markets, and (v) timely regulations of financial sector have resulted in low inflation and financial stability even at times of financial meltdowns. India serves as an example for many countries and suggests that capital controls can be effective by making use of multiple instruments that are at the disposal of the central bank rather than implementing just a single one.

For a deeper understanding of relationship between capital convertibility and financial stability, various economists and researchers have extensively studied the cases of transitional and emerging economies. For instance, Sheng Li in his paper has attempted to theorize the concept of capital account convertibility in the context of developing countries. While there is a general consensus in the traditional economics that developed countries gain at the expense of losses and risks faced by their developing counterparts when they open their capital account, the author in the paper proves that that reverse can also actually be true. By pushing their developing counterparts on the path of full capital convertibility, developed nations may reduce their own first-mover advantage when it comes to strategic bargaining for capital mobility benefits.

Willem Buiter and Anita Taci have studied the impact of financial and capital account liberalization on financial development of countries that are still in the transitional phase from partial convertibility to full convertibility. Capital account transition has led to substantial restructuring and development of financial sector. However, this progress has not been equitable in all the countries. Even the advanced countries with financially strong institutions have not been successful in achieving an efficient banking sector. It is crucial for these economies to work on making their financial infrastructure stronger. Irrespective of level of banking reform, timely regulation and monitoring, stricter enforcement of laws and corporate governance are very important for overall financial development of the economy.

Literature on capital liberalization of economies such as China, Pakistan and Bangladesh (that lie in the vicinity of India) and other Latin American, Middle-eastern and African countries are of great significance as they are comparable to India in various aspects. Li-Gang Liu (2005) has analyzed the impact of capital account liberalization on domestic financial institutions of China through application of gravity model. The study shows that financial liberalization has proved to be a stimulus for China's financial system. As more and more foreign banks are setting up, their influence over Chinese financial structure is increasing which will rise more when there is a higher decline in barriers and capital controls. This will help in encouraging efficiency in the banking sector.

Another paper by Yuanyuan Shen and Lu Yang (2015) has given a detailed analysis on the impact of capital movement on the financial stability of the Chinese economy. The authors have employed finite distributed model to test the same. The authors suggest that financial liberalization will have adverse impact on financial stability for a one year period but will aid financial stability in the long run. The authors have also suggested various policy measures such as: (i) improvement in economic restructuring; (ii) development and expansion of foreign exchange markets, and (iii) managed floating exchange rate.

Similarly, Joseph Ollo (2018) has also established a relationship between capital account liberalization and financial stability through the application of finite distributed lag model employed in 31 sub-Saharan African countries for a time period of 19 years from 1996-2015. He has made use of exchange market pressure index (EMP) to measure financial risk. He concludes that financial liberalization has a negative impact on financial stability of African countries and suggests improvement in macro-economic and institutional setting

for enhancement of financial development. A major limitation of this paper is that it has failed to take specific country characteristics or heterogeneity into consideration.

Batuo et al. (2017) has also analyzed the impact of financial liberalization on financial stability, economic growth and financial development in 41 African countries for period of 25 years from 1985-2010. The findings of the paper expose that financial liberalization has indeed led to greater financial instability. Even though higher economic growth can help in reducing financial instability, the rate of reduction is much slower in post-liberalization period than in pre-liberalization period.

Ganesh Kumar Nidugala (1997) did a comparative analysis on the journey of capital account liberalization of India and Mexico. Through this paper, the author tries to explain why and how India was able to evade a crisis similar to the peso crash that occurred in Mexico in 1994. The author cites several reasons for the same, such as: (i) India followed a correct pattern of reform sequencing and went for a gradual opening of the capital account whereas Mexico went for the reverse; (ii) Financial sector reforms were slow in India compared to rapid growth of the same in Mexico; (iii) Gradual trade liberalization in India and (iv) the fact that India had moderate restriction on long term capital flows such as foreign direct investment and tighter restrictions on short-term portfolio flows (which are very volatile in nature) in contrast to full liberalization of both long and short term capital flows in Mexico during the same time period.

Ashima Goyal (2012) has discussed the future of capital account liberalization in South Asia. The author has compared Indian experience with that of other South Asian countries such as China, Bangladesh and Pakistan. India has adopted a strategy of deepening of the domestic financial market into the world economy and improvement in government finances before full capital convertibility. China and India have had similar strategic capital controls and hence are considered two of the fastest growing economies in the world. Whereas, Pakistan which has had more open capital account has faced many BOP crisis and has had to turn to IMF for help numerous times. Bangladesh, on the other hand, has had more severe controls and has needed aid only once.

Sarah M. Brooks (2004) has analyzed capital account liberalization in Latin America and the OECD countries for a sample period of two decades. The paper shows that countries in South America with more fragile domestic financial system and institutions face higher risks of transitional costs following liberalization and move slowly towards openness. In the OECD countries, however, financial weakness is linked with lower transitional costs and hence, move at a relatively faster pace than South American nations. Analysis of the transitional costs of financial liberalization thus helps us to understand how market pressures may act as a stumbling block, rather than stimulus, for market-oriented reforms in Latin America.

Aidi Wafa (2013) evaluates the liberalization dynamics and its implications on financial stability of nine middle-east and North African countries (MENA) for a period of 28 years from 1980-2008. The study has made use of Hansen model to show that financial and capital openness has a nonlinear relationship on exchange pressure and incidence of

financial crises. It is hence vital, and a challenge to maintain a balance between financial and commercial integration.

Even though most of the literature on CAL suggests that financial crisis give a nudge to economies to liberalize their capital account, some economists like Thomas B. Pepinsky (2012) believe that it is actually the reverse that is true. As a consequence of crisis, most of the economies are found to impose capital control in the pretense of self-help. Through his research, he proves that crises are often associated with “capital account closure” in many developing and emerging economies. Hence, the results are inconsistent with the conventional theory that periods of financial meltdowns and depressions lead to adoption of neo-liberal policies.

Literature on liberalization of capital account has also faced scrutiny, especially in their approach towards testing its impact on financial variables. Peter Blair Henry (2007) has tested a theory to explain the impact of financial liberation on cost of capital, investment and economic growth of the country. He links capital account liberalization to neo-classical growth model to ask a very imperative question: “If evidence lines up with the theory, then why does liberalization have no real effects?” This is because of the fact that most research papers have used cross-sectional approach which fails to provide accurate results due to measurement errors and country heterogeneity. The paper suggests a policy-experiment approach to capital account liberalization as it will take into account the differences in economic reforms of distinct economies. The major findings of the paper are that when a nation liberalizes its capital account, the cost of capital falls which subsequently increases investments as well as economic growth rate. He concludes by mentioning that while conducting research, one should not commit the mistake of ignoring the temporary rise in investments as it can permanently raise the standards of living of an economy.

Similarly, Eswar S. Prasad and Raghuram G. Rajan (2008) have shown that there is a little connection between capital account liberalization and economic growth of developing countries due to the failure in methodology of not taking heterogeneity into consideration, such as domestic savings of different countries as proposed by neo-classical model. They also advice that financial liberalization is not an appropriate policy for poorer countries that are tainted by weak policies and institutions. It is thus prudent to have disciplined policies as well as stronger institutional framework before opening up the capital account.

As proposed by above mentioned papers, Dennis P. Quinn and A. Maria Toyoda (2008) have tested the relationship between capital account liberalization and economic growth. They have used pooled time-series, system GMM estimators and cross-sectional OLS to evaluate economic growth rates for a period of 49 years from 1955-2004 for 94 countries. The authors have established that financial liberalization has positive impact on growth of both advanced as well as emerging economies as opposed to prior research papers that couldn't establish such a relationship due to measurement errors and usage of different time periods in the study that would lead to high multicollinearity among explanatory variables.

2.2. Research gap

It has been established, as mentioned above, that capital account openness can lead to financial instability in the economy as also exemplified by the financial crisis of 2008, 1994 Mexican exchange rate crisis and Asian financial crisis of 1997. However, some studies have also shown that there is no direct correlation between financial liberalization and financial instability. This makes it extremely imperative to test whether capital account convertibility will lead to financial soundness or not. Moreover, in the Indian context, researchers have not employed any model to test the same. Application of finite distributed lag model can assist in estimating the degree of capital account openness and financial stability in the economy. Most of the researches done in this area have concentrated on theoretical analysis of the same with detailed examination of policy measures that were adopted by India. There also has been no analysis on how long the capital account liberalization will have an effect on stability of domestic financial institutions and entities.

Moreover, India opened up its economy in 1991 after the advent of LPG policy, it had not reduced its controls on capital account. Opening up of capital account remained a huge debate amongst numerous economists as many blamed it for causing numerous financial crises. Reserve Bank of India had set up a special committee to analyse and direct full capital convertibility in 1997. The committee laid down various preconditions that were necessary for the same. However, its recommendations were never fully realized. The Tarapore committee was set up again in year 2006, and similar to their earlier experience, the recommendations were again neglected. It is thus very imperative to understand why India chose to disregard the committee's suggestions and continue to have capital controls. To understand that, it is first vital to establish an association between financial liberalization and financial stability through application of econometric models that takes country-specific characteristics and time lag into consideration. Inclusion of macroeconomic variables such as real effective exchange rate, foreign exchange reserves and real interest rate will provide a correct picture of the capital account liberalization scenario in India. Hence, the present study occupies higher level of significance for empirical estimations.

3. Research methodology

In this section, the author describes the variables that help establish a relationship between capital account openness and financial stability in the economy. Then, the paper models the equation using a finite distributed lag model. This section also covers the reasons for selecting the period of study along with sources of data.

3.1.1. Model specification

Exchange Market Pressure Index (EMP) as an indicator for the degree of financial risk. To measure and quantify the degree of financial instability and risk, the paper employs exchange market pressure index (EMP) as a proxy variable for the same. Exchange Market Pressure Index, also popularly known as "currency crisis stress index" is an aggregation of a standardized change in exchange rate, interest rates and foreign exchange reserves. As

the name suggests, the purpose of this index is to analyze the occurrence of currency crisis in a country at a given point of time.

According to Eichengreen et al. (1996) in their paper “Contagious Currency Crises”, currency crisis is seen as an excess pressure that the monetary authority can help prevent or keep in control by running down their foreign exchange reserves or by raising the interest rates or through currency depreciation. Thus, EMP is a weighted average of the changes in real interest rates, real exchange rate and international reserves. Hence, this index is considered to be one of the most comprehensive and significant indicators of financial instability.

According to the author, exchange market pressure index is defined by the following equation:

$$EMP_t = \lambda_{RER} \frac{\Delta RER_t}{RER_{t-1}} + \lambda_{RIR} \frac{\Delta RIR_t}{RIR_{t-1}} + \lambda_{FER} \frac{\Delta FER_t}{FER_{t-1}} \quad (1)$$

where EMP_t is the exchange market pressure index and the formula for it includes summation of variables such as RER which is the real exchange rate, RIR which is the real interest rate and FER which is the foreign exchange rate. ΔRER_t is the change in real exchange rate, ΔRIR_t is the change in real interest rate and ΔFER_t is the change in foreign exchange reserve. The symbols λ_{RER} , λ_{RIR} and λ_{FER} are the weights for the variables as specified.

Even though application of unweighted formula of EMP_t will lead to simpler outcome and time-saving computation, taking weights proves to be an extremely crucial step as it takes into consideration the volatility aspect of these variables. Taking a weighted average will ensure that no one variable among the three dominates the entire index. Therefore, to ensure that the conditional variance of the three components are equal, we use weights as defined by the following formula:

$$\lambda_i = (1/\sigma_i) / (1/\sigma_{RER} + 1/\sigma_{RIR} + 1/\sigma_{FER}) \quad (2)$$

where σ_{RER} , σ_{RIR} and σ_{FER} are the standard deviations of real exchange rate, real interest rate and foreign exchange reserves.

The table below shows the standard deviations and the weights for the three variables which have been computed with the help of the equations given above:

Table 1. Standard variance and weights of RER, RIR and FER

	Real Exchange Rate	Real Interest Rate	Foreign Exchange Reserve
Standard Variance (σ)	24.78	2.58	884771
Weight (λ)	0.0943	0.9057	2.64104E-06

3.1.2. Definition of capital account liberalization

Removal of restrictions on capital account ensures that there is free mobility of capital flow, both of long-term FDI and short-term portfolio flows and therefore “scale of capital flows” can be used to estimate the degree of capital account openness. The extent of capital account openness (LB) can be measured by taking the difference between capital outflows

and capital inflows and then dividing it by the country's GDP for the specific year. According to the paper "Capital Account Liberalization and Economic Performance: Survey and Synthesis", this definition of LB shows the long-term trends that exist in the capital markets, which reflects the changes in capital account convertibility in a longer period.

$$LB = \frac{\text{Net Capital}}{GDP} \quad (3)$$

3.1.3. Overall estimations

In this section of the paper, the author tries to establish a relationship between the degree of financial risk and capital account openness and determine how movements in capital flows have an impact on the occurrence of financial crisis in the economy. For this purpose, both the lagged and current influences of capital account openness i.e. LB are taken. The paper has used finite distributed lag model on data covering a period of 39 years from 1979-2018.

Thus, the author estimates the following equation with the help of variables as described in sections 3.1.1 and 3.1.2:

$$EMP_t = \alpha + \beta_0 LB_t + \beta_1 LB_{t-1} + \beta_2 LB_{t-2} + \beta_3 LB_{t-3} + \dots + \mu_t \quad (4)$$

where the exchange market pressure index (EMP_t) is the response variable and measures the degree of financial risk, LB_t is the explanatory variable and measures the degree of capital account openness and μ_t is the residual term. The subscript "t" indicates the time period for the particular variable. β_0 is the impact or short-run multiplier and measures the change in the mean value of EMP_t due to a unit change in the LB_t in the same time period. The summation of all the β 's ($\beta_0 + \beta_1 + \beta_2 + \dots$) gives the total or the long-run multiplier, measuring how the current and lagged values of the independent variable have an impact on the dependent variable over a period of time.

3.2. Period of study and sources

The paper has covered 39 years of data on real exchange rate, real interest rate, foreign exchange reserve and net capital flows from 1979 to 2018 to compute and establish a relationship between the degree of financial risk and degree of capital account openness. The author has taken data from 1979 to understand the flow of capital into the country even before the advent of LPG policy in 1991 i.e. fuller current account convertibility. The author has collected data on net capital, GNP (at current price), foreign exchange reserve, real effective exchange rate from the RBI's Handbook of Statistics on Indian Economy and data on real interest rate has been collected from IndiaStat.com.

4. Empirical results

As an economy opens up its capital account, it becomes more susceptible to financial risks due to the effect of sudden and short-term capital flows. However, this impact is an accumulation of both current and lagged influences of capital account liberalization as shown in Eq. (4).

Test for stationarity (Unit Root Test)

To test for stationarity, the paper has employed Augmented-Dickey Fuller test (ADF) and Phillip-Peron test, two of the most common and popular unit root tests available. The results for the same are tabulated in Table 1. From the table, it can be observed that the time series data for both capital account openness (LB) and exchange market pressure index (EMP) is stationary at level i.e. raw data is stationary and therefore, regression analysis can be implemented.

Table 2. Test for stationarity and causality

	EMP	LB
ADF test	-5.6087 (0.0000)	-6.1166 (0.0000)
Phillip-Peron test	-5.7002 (0.0000)	-6.1880 (0.0000)

Note: The values in cell show the t-statistic for the ADF test and adjusted t-statistic for the Phillip-Peron test for both the variables with probability values in the brackets below. Null hypothesis for ADF test is that the variables EMP and LB have unit root.

Granger causality test

Table 1 shows that the null hypothesis for LB i.e. LB does not Granger Cause EMP is rejected and is significant as its probability is 0.0163 (less than 5%). This proves that LB is useful in forecasting the dependent variable (EMP). Whereas, we reject the null hypothesis for EMP as the p-value is more than 5% level of significance (p-value is 0.0826).

Table 3. Test for Granger causality

	EMP	LB
Granger Causality test	2.3195 (0.0826)	3.6741 (0.0163)

Note: The values in cell show the F-statistic for the variables with probability values in the brackets below. The null hypothesis for Granger causality test for EMP is that EMP does not Granger Cause LB while null hypothesis for LB is that LB does not Granger Cause EMP.

As the results derived from ADF test, Phillip-Peron test and Granger Causality test are significant, we can run regression analysis successfully.

Empirical findings

A finite distributed lag model has been performed as prescribed in the Eq. (4) using EViews Software, which has provided the following results:

Table 4. Estimated regression equation

$$EMP_t = 0.146927 + 16.43942LB_t^* - 24.53080LB_{t-1}^{***} + \mu_t$$

$$S_e = (0.319093) (8.548737) (7.738147)$$

$$t = (0.460453) (1.923023) (3.170113)$$

$$R^2 = 0.2594 \quad S_e = 0.8133$$

Note: The numbers in parenthesis below indicate the values of standard error and absolute values of t-statistic of the estimated coefficients. *, **, *** indicate that the estimated coefficients are statistically significant at 0.1, 0.05 and 0.01 level respectively. *EMP* = exchange market pressure index (indicator of the degree of financial risk); *LB* = degree of capital account openness.

The regression results show that the influence of time delay of capital account convertibility on the financial stability of India lasts for about a year. It can also be inferred from the above results that the short-term/ impact multiplier effect of the degree of capital account openness is significant (at 10%) and positive, with the value of 16.43942. This shows that there is a direct relationship between the explanatory and response variables. Thus, more open the capital account, the degree of financial risk as measured by the exchange market pressure index (EMP) also increases. Whereas, the long-term multiplier effect of the same is negative, valuing at (-) 8.09138 i.e. as capital account gets liberalized gradually over the years, financial risks associated with it will fall. This shows that capital account openness can lead to volatility in financial market in the initial years, however can aid in financial stability in the long run.

This result has been proved by numerous authors and economists who suggest that fuller capital account convertibility can lead to financial risk due to increasing amount of capital inflows and outflows, especially the sudden and highly volatile short-term flows. This would give rise to financial instability, reflecting the volatility of foreign exchange market. However, in the long run, to accrue the benefits of CAC, the economy will device various policies to improve the financial environment of the country through reforms related to foreign exchange rate, interest rate and foreign exchange reserves.

However, one needs to keep in mind that because of low R squared, the data also suggests that there are other variables apart from those that we have already considered in computation of capital account openness that have an impact on the degree of financial risks in the Indian context.

5. Conclusion and policy implications

The paper attempts to establish a relationship between fuller capital convertibility and level of financial risks in India i.e. whether opening capital account in India would have a positive or negative impact on the financial stability of the economy. Using annual data from 1979 to 2018, the author has formalized two key variables of the model i.e. exchange market pressure index (EMP) and degree of capital account liberalization (LB) by using crucial macroeconomic variables such as real effective exchange rate, real interest rate, international reserves and net capital flows.

The paper has then employed a finite distributed lag model to understand how current and lagged values of capital flows-both inflows and outflows-have an impact on the degree of financial risks in the economy. From the empirical analysis, it can be observed that the immediate impact or the short-run effect of capital account liberalization is harmful for the overall financial stability of the economy. This is because there is a positive and significant relationship between EMP and LB. However, within one year of opening up of capital account, the economy starts to accrue the benefits of fuller capital account convertibility as with time it leads to financial stability. Therefore, capital account liberalization should be adopted by the economy even if it experiences harmful effects in the very beginning. Nevertheless, this effect will only last for a period of one year in the Indian economy according to the data that has been analyzed for a timeframe of 39 years.

However, there are several suggestions that the policymakers need to keep in mind before opting for fuller capital convertibility. Firstly, the monetary authority of India needs to take precautionary measures to mitigate the adverse impact of short-term, sudden and highly volatile capital flows

Moreover, the economy also needs to take several measures to strengthen its banking sector as it has been proposed by the Tarapore committee in 2006 such as: (i) incorporation and formalization of shadow banking sector; (ii) providing encouragement and incentives to institutions that help or back up private banks as such private banks have proved to be extremely successful; (iii) conversion of non-banking financial companies into full-functioning banks; (iv) alignment of voting rights of the investor to that of the Companies Act; (v) reevaluation of the performance of the top management and employing measures to strengthen it; and (vi) ensure that all banks, both in private and public sector have a level playing field.

The economy also needs to take several measures for the development of its financial market which is inclusive of equity market, corporate bond market, money market, government securities market etc. by focusing on three main aspects i.e. (i) development of physical infrastructure in terms of IT and technology, disaster management and communication services; (ii) adoption of techniques to improve skills and capabilities of the top management and people who lead the offices in the financial sector; and finally (iii) improvement of quality of regulatory arrangements that are already in place.

In addition to this, it is also extremely imperative for the Indian government to develop and create a strong foundation for its foreign exchange markets which can help the economy in realizing proper resource allocation, price discovery as well as prevention of financial risks and uncertainty. Government can also incentivize banks that have a stronger balance sheet to lend and borrow from foreign banks for both short-term and long-term, however at the same time have restrictions on banks with weaker balance sheet.

Finally, several policies should come into place to ensure that there is a proper diversification of portfolios and investment strategies to reduce systematic financial risks. The government and other related bodies such as SEBI also need to focus on promotion of healthy investment environment for the benefit of the national and international investors. Promotion of a healthy investment environment will require creating an extensive regulatory and legal capacity that can manage capital inflows, promote policies that attract long-term investments on physical infrastructure and manufacturing and encourage responsible business conduct of MNCs. India needs to pay heavy attention on not only the quantity of capital flows, but also the quality of capital flows to ensure that there is persistence of financial stability in the country.

Limitations of the study

One of the limitations of the study is that the R squared for the study is quite low. This suggests that there are other variables apart from those that have already been considered in computation of capital account openness that have an impact on the degree of financial risks in India. Due to lack of data availability on debt creating and non-debt creating capital flows, the author has not been able to focus on their impact on overall financial stability.

Future scope of the study

Using the same model, a comparative analysis can be conducted for emerging countries to find out if the results for these countries are same or not, and if they are, an investigation can be carried out to find out the differences that lead to financial stability in some countries and financial instability in other countries. In this panel data, country specific characteristics should be taken into consideration such as different types of exchange rate regimes that are in force in each country that are considered in this study.

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Health, health production and input financing: A theoretical note

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Abstract. *We develop a health production model with input financing in the spirit of standard health capital model. Health production depends not only on tangible inputs required to produce health services, but also depends on institutional set up or governance, and general awareness about health and related issues. In our model, part or all of inputs required to produce health is financed through tax revenues. Using Cobb-Douglas utility and production function, we explore the optimum tax rate under various scenarios of health care financing through tax revenues. The model is further extended to account for increasing returns to scale where input elasticity parameters in health production are not same. We find that increasing returns to scale in health production calls for higher tax rate to finance health productions.*

Keywords: health demand, Grossman model, behavioral factors, government policy.

JEL Classification: I12, I18, D11.

I. Introduction

Grossman's (1972) health capital model is probably the most influential set up in theoretical health economics literature. Following his pioneering paper, later Grossman developed another structure to introduce human capital formation and demand for health (Grossman, 1999). In a sense Grossman's work is critically based on Becker (1964). In what follows Wagstaff (1986a) also proposed a static version of health capital model. Grossman's original (1972) model was a dynamic one which is relatively complicated for analytical policy implications purpose whereas Wagstaff's (1986a) version is relatively simple and apt for policy oriented extension.

In the same line several interesting papers have been written later on. This includes Wagstaff (1986b), McGuire et al. (1988), Lukas (2013) Tavares (2007) etc. The issues of uncertainty and health care productivity in health production function were brought into health capital model by Koc (2004a, 2004b). On the other hand, the issues of poverty, growth and financing of health inputs in developing economy are elegantly addressed in Kida (2009), Coppola (2012), Morand (2005), Gottret et al. (2006), Evans (2002), Kumar (2011), etc.

Here in this paper we formulate a health demand model closely following Grossman (1972) and Wagstaff (1986a). Unlike the standard literature we assume that health (H) cannot be produced only by technical health input (T). It requires some other inputs like governance or administrative system, awareness of the person or the society (s) he belongs to. People's awareness, essentially, determines the demand for health and as there is no room for excess supply, this helps conceiving the amount of supply required. Such idea captures the essence that a society with little awareness demands less, and hence production is lower as well. On the other hand, consumer optimizes utility that depends on the consumption of H and a composite consumption good, C.

The consumption behavior is constrained by consumer's total income, Y and the health production function discussed above. In contrast with the conventional wisdom we try to focus on the framework where all health inputs and C are either sold in the market or provided by the state. State's provision of such inputs are financed by tax collected from individuals (i.e., income tax) ensures supply of health inputs. In such a structure we derive the optimum amount of all health inputs and composite commodity. We also calculate the optimum tax rate in any economy under different production techniques. We further extend the model to look at the desired tax rate when different combinations of health inputs are financed through tax revenues.

The basic results that we derive in this essay are as follows:

- a) Consumer's utility maximization requires marginal rate of substitution (MRSS) between H and C to be equal to the ratio of shadow prices of inputs. Shadow price indicates the ratio of nominal price of input and its marginal productivity (MP) in health production function.

- b) Optimum tax rate to finance health inputs depend on the nature of utility function and the nature of financing health inputs.
- c) More health consumption calls for higher tax rate.
- d) Economy should go for higher rate of tax if health production exhibits increasing returns to scale (IRS).

Remaining paper is structured as follows. The next section outlines the environment of the basic model and individual behavior in a health capital model. Then we extend it for a specified utility and health production function. This is followed by an analysis for different alternatives where inputs are either sold in the market or financed directly by government through tax revenues. The last section provides policy implications along with concluding remarks.

II. Environment and the consumer behavior

We specify a model of individual behavior with health demand in a standard utility maximization problem and health production function. We develop a static model following Wagstaff (1986a). Unlike the conventional literature we bring in a health production function that not only depend on technical health inputs but also on inputs like governance, consumer's awareness etc. which are qualitative, per se. Despite the qualitative nature of the later inputs we consider them as "simple" inputs and focus on their financing options.

The representative individual's utility is a function of two variables: H – health, and C – composite consumption good. In this model, H is a product or service which has to be either bought from the market or supplied by the government in exchange of certain tax paid, a-priori. Though, implications are not identical in these two alternatives as tax financing is mandatory even if the individual does not need medical care whereas in case of market determined price the individual only pays when he needs it. Despite differences in implications we should not forget that good health has positive externalities which depends on general environment or hygiene of the neighborhood generally provided by the government. This partially justifies the necessity of tax-financing. In particular developing countries also face the problem of less importance of H for relatively poor which subsequently handicaps the economy's prospect to do good later. Financing of H though can also take care of such long run problems. So, the utility function that an individual faces is

$$U = U(H, C) \tag{1}$$

H is produced by factors T, G and A, where T indicates tangible technical health inputs such as infrastructure, number of medical personnel and equipment. G stands for institutional set up or governance – poor institution means poor governance, whereas good governance ensures proper and timely delivery of services as and when required.

A implies awareness which may define the level of education, role of media, role of non-governmental organization (NGO), access to social and cultural gathering etc.⁽¹⁾ Therefore health production function takes the following form

$$H = H(T, G, A) \quad (2)$$

The representative individual has to maximize utility subject to health production function given in (2) and the income of the consumer, Y . If all inputs, except G , are procured from the market the budget constraint yields

$$P_t T + P_a A + P_c C = Y \quad (3)$$

P_i = price of the inputs and the composite commodity ($i = C, T$, and A)

Note that institution, G , has no price per unit. It is, however, reasonable to introduce a flat tax on income that is used to finance institution or governance G . As long as tax is fixed (share of Y) and is deducted from total income, Y , it does not invoke any qualitative change in the optimization solution. Say the tax rate is τ ; $0 < \tau < 1$. Note that an increase in τ may not guarantee good quality H production as this may not directly influence G due to some socio-economic-political, bureaucratic, corruption, pressure of some lobby etc. Nonetheless, we ignore such concern for the time being. So τ has a direct relation with G , and G positively influences H .

The modified objective function of the individual becomes

$$\max_{T, G, A, C} U = U\{H(T, G, A), C\} \quad (4)^{(2)}$$

$$\text{Subject to } P_t T + P_a A + P_c C = Y - \tau Y \quad (5)^{(3)}$$

Therefore, the Lagrangian is $\mathcal{L} = U\{H(T, G, A), C\} + \lambda[Y - \tau Y - P_t T - P_a A - P_c C]$

Where λ stands for standard Lagrange multiplier.

For the time being we replace τY by $P_g G$ in order to develop the basic foundation for further analysis.

The standard optimization principle yields

$$\lambda = \frac{\frac{\delta U \delta H}{\delta H \delta T}}{P_t} = \frac{\frac{\delta U \delta H}{\delta H \delta A}}{P_a} = \frac{\frac{\delta U \delta H}{\delta H \delta G}}{P_g} = \frac{\frac{\delta U}{\delta C}}{P_c},$$

where $MU_k = \frac{\partial U}{\partial k}$ ($k = H$ and C); $MP_j = \frac{\partial H}{\partial j}$ ($j = T, A$ and G).

Simple manipulation of the optimization principle delineates the following conditions to guarantee both production equilibrium for health production and consumption equilibrium for utility maximization comprising H as a consumption good as well. Conditions are:

$$MRSS_{h,c} = \frac{P_t / MP_t}{P_c} = \frac{P_a / MP_a}{P_c} = \frac{P_g / MP_g}{P_c} \quad (6)$$

It is also important to note that $P_t/MP_t, P_a/MP_a, P_g/MP_g$ are essentially shadow prices of health in terms of T, A and G respectively (see Wagstaff, 1986a; Koc, 2004a). The production equilibrium is shown as

$$\frac{MP_t}{MP_a} = \frac{P_t}{P_a}; \frac{MP_t}{MP_g} = \frac{P_t}{P_g}; \text{ and } \frac{MP_a}{MP_g} = \frac{P_a}{P_g} \quad (7)$$

These conditions resemble tangency condition (marginal rate of technical substitution between two inputs) between production possibility curve and factor price ratio(s).

Now, if we replace $P_g G$ by τY , the equilibrium conditions will be slightly modified keeping the essence intact. In the latter case we won't have substitution of any input with G as there is no scope for the producers or for the consumers to adjust the production and/or consumption of G. We will, however, use the combination of the structures that we already developed in the subsequent analysis as we strive to determine the optimum level of tax to finance either G or other health inputs.

III. Cobb-Douglas functions and input financing

We use Cobb-Douglas (CD) utility and production functions. The utility function takes the following form:

$$U = H^\alpha C^\beta \quad (8)$$

Where α and β have their usual interpretations – responsiveness of utility when quantity of commodity changes.

We further presume that health production function is not additive; rather it is a multiplicative one. Reason is that production of H must need all the factors in tandem. H becomes zero even when one of the factors is non-functioning. So, factors are absolutely complementary with each other in true sense. Therefore,

$$H = T \cdot G \cdot A \quad (9)^{(4)}$$

This modifies the utility function as

$$U = (T \cdot G \cdot A)^\alpha C^\beta = T^\alpha G^\alpha A^\alpha C^\beta$$

So, the Lagrangian becomes $\mathcal{L} = T^\alpha G^\alpha A^\alpha C^\beta + \lambda[Y - P_t T - P_a A - P_c C]$; traditional optimization technique gives

$$\left. \begin{array}{l} P_t T = P_g G = P_a A \\ \frac{\alpha}{P_t T} = \frac{\alpha}{P_g G} = \frac{\alpha}{P_a A} = \frac{\beta}{P_c C} \end{array} \right\} \quad (10)$$

$$\text{Therefore, } P_c C = \frac{\beta}{\alpha} P_t T = \frac{\beta}{\alpha} P_g G = \frac{\beta}{\alpha} P_a A$$

In what follows we get the equilibrium quantities of health inputs and C as follows

$$\left. \begin{aligned} T &= \frac{Y}{P_t} \frac{\alpha}{3\alpha+\beta} \\ G &= \frac{Y}{P_g} \frac{\alpha}{3\alpha+\beta} \\ A &= \frac{Y}{P_a} \frac{\alpha}{3\alpha+\beta} \\ C &= \frac{Y}{P_c} \frac{\beta}{3\alpha+\beta} \end{aligned} \right\} \quad (11)$$

Equation (11) denotes Marshallian demand functions for T, G, A, and C. Once we know the values of T, G and A, the value of H can easily be solved for any given, income, tax rate and price.

Note that if we assign relatively more weights for H in the utility function, the values of T, G and A increases whereas that of C will fall. It is quite obvious that an increase in α leads to an increase in demand for H and decrease in C.

III.A. G is financed by Tax, τ

We have mentioned before that $\tau Y = P_g G \Rightarrow G = \frac{\tau Y}{P_g} \Rightarrow P_g = \frac{\tau Y}{G}$. Plugging this into the

Marshallian demand function of (11) $G = \frac{Y}{\tau Y/G} \frac{\alpha}{3\alpha+\beta} = \frac{GY}{\tau Y} \frac{\alpha}{3\alpha+\beta}$

$$\Rightarrow \tau^* = \frac{\alpha}{3\alpha+\beta} \quad (12)$$

τ^* signifies the optimum tax rate when only G is financed through tax revenue. So, in a system where only governance is managed by tax revenue, optimum tax rate should not be an arbitrary one. It has to be in tune with how much weight we put for H or for other inputs used in producing H and C. From (12) it is also obvious that $\tau^* = \frac{\alpha}{3\alpha+\beta} = \frac{1}{3+\beta/\alpha}$, where an increase (decrease) in α (β) increases the value of τ^* . Taking clue from the arguments of previous sub-section we understand that increase in α leads to higher demand for H. So, supply of H needs to be increased to match with higher demand. This requires some more health inputs – T, G and A. This can only be procured or financed by higher tax revenue which is also guaranteed in equation (12). Therefore, the following proposition holds

Proposition 1: *Optimum tax rate depends on the nature of utility function.*

III.B. All inputs are financed by Tax, τ

Now let us extend our analysis for a system where all health inputs including G are financed by government's tax collection. This phenomenon is generally observed in most of the developing economies where all T, G and A are the responsibility of the government. So, once the tax rate, τ is determined, given the total income of an individual and/or the economy, we get to know the amount of revenue to be collected. The collected revenue would be shared among all the health inputs. Say, the share of revenue allotted for T, G and A are γ_t , γ_g and γ_a respectively. $0 < \gamma_t, \gamma_g, \gamma_a < 1$ and $\gamma_t + \gamma_g + \gamma_a = 1$.

Therefore broadly speaking $\gamma_t \tau Y = P_t T$; $\gamma_g \tau Y = P_g G$; and $\gamma_a \tau Y = P_a A$.

This implies $T' = \gamma_t \frac{\tau Y}{P_t}$; $G' = \gamma_g \frac{\tau Y}{P_g}$; and $A' = \gamma_a \frac{\tau Y}{P_a}$.

Comparing this with the value of G in the preceding section

$$G' = \gamma_g \frac{\tau Y}{P_g} < G = \frac{\tau Y}{P_g} \quad (13)$$

Given the values of P_g , Y and τ , amount of H produced in the latter case would be lower and so will be the amount of other health inputs. This is easily understandable as same amount of revenue is used to finance three inputs in the latter case whereas it was used to finance only G in the first case.

Now let us move further to determine the optimum tax rate when the amount of G and all other health inputs remain same as in the previous case. Taking clue from (10)

$$\begin{aligned} \tau Y &= (\gamma_t + \gamma_g + \gamma_a)\tau Y = P_t T + P_g G + P_a A = 3P_g G \\ \Rightarrow P_g &= \frac{(\gamma_t + \gamma_g + \gamma_a)\tau Y}{3G} \end{aligned} \quad (14)$$

Using (11) and (14)

$$\begin{aligned} G &= \frac{Y \cdot 3G}{(\gamma_t + \gamma_g + \gamma_a)\tau Y} \frac{\alpha}{3\alpha + \beta} \\ \Rightarrow \tau^{**} &= \frac{3}{(\gamma_t + \gamma_g + \gamma_a)} \frac{\alpha}{3\alpha + \beta} = \frac{3\alpha}{3\alpha + \beta} \text{ (as } (\gamma_t + \gamma_g + \gamma_a) = 1) \end{aligned} \quad (15)$$

Comparing (12) and (15) $\tau^{**} = \frac{3\alpha}{3\alpha + \beta} > \tau^* = \frac{\alpha}{3\alpha + \beta}$. Optimum tax in the latter is thrice of that of in the initial case as in the latter case three inputs need to be financed. The result also points to an interesting possibility that all inputs are financed in same proportion. It can be reassured as well from the arguments we developed before. Recalling optimization in the basic model

$$P_t T = P_g G = P_a A \text{ and } \gamma_t \tau Y = P_t T; \gamma_g \tau Y = P_g G; \gamma_a \tau Y = P_a A.$$

Hence, $\gamma_t = \gamma_g = \gamma_a$.

Again since $(\gamma_t + \gamma_g + \gamma_a) = 1 \Rightarrow 3\gamma_g = 1 \Rightarrow \gamma_g = 1/3 = \gamma_t = \gamma_a$.

$$\text{So equation (15) can be modified as } \tau^{**} = \frac{1}{\gamma_g} \frac{\alpha}{3\alpha + \beta} \quad (16)$$

Equation (15) and (16) are essentially identical as $\gamma_g = 1/3$.

Proposition 2: Rate of increase in optimum tax rate will depend on how many health inputs are financed.

Proof: See discussion above.

IV. Unequal responsiveness of factors in H

Unlike the previous section here we assume that the health production uses inputs where output elasticities of inputs are not same. One special case of such form could well be defined as equal output responsiveness of input case. Say the health production function assumes the following form

$$H = T^{\theta_1} G^{\theta_2} A^{\theta_3} \quad (17)$$

Note that θ_1, θ_2 and θ_3 are the input elasticities of output for T, G and A respectively. Utility function of (8) and health production function of (17) help us formulating the Lagrangian denoted below

$\mathcal{L} = T^{\theta_1} G^{\theta_2} A^{\theta_3} C^\beta + \lambda [Y - P_t T - P_g G - P_a A - P_c C]$; First order condition for optimization provides

$$P_t T / \theta_1 = P_g G / \theta_2 = P_a A / \theta_3 \text{ and } P_c C = \frac{\beta}{\theta_1 \alpha} P_t T = \frac{\beta}{\theta_2 \alpha} P_g G = \frac{\beta}{\theta_3 \alpha} P_a A \quad (18)$$

Equilibrium usage and consumption of various health inputs and composite commodity are calculated and we get the equilibrium quantities of health inputs and C as follows

$$\left. \begin{aligned} T &= \frac{Y}{P_t} \frac{\theta_1 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \\ G &= \frac{Y}{P_g} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \\ A &= \frac{Y}{P_a} \frac{\theta_3 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \\ C &= \frac{Y}{P_c} \frac{\beta}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \end{aligned} \right\} \quad (19)$$

IV.A. G is financed by Tax, τ

When only G is financed by tax $\tau Y = P_g G \Rightarrow G = \frac{\tau Y}{P_g} \Rightarrow P_g = \frac{\tau Y}{G}$. Substituting this into the Marshallian demand functions described in (19)

$$\begin{aligned} G &= \frac{Y}{\tau Y / G} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} = \frac{GY}{\tau Y} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \Rightarrow \\ \tau^{***} &= \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \end{aligned} \quad (20)$$

If the production function exhibits CRS, $(\theta_1 + \theta_2 + \theta_3) = 1$. In that case optimum tax rate derived in (20) reduces to $\tau^{***} = \frac{\theta_2 \alpha}{\alpha + \beta}$ (21)

If one compares (20) with (12) it would be apparent in a moment that $\tau^* > \tau^{***}$.⁽⁵⁾ This is because optimum tax depends on the output elasticity of the factor which is financed by tax. In the basic model it was 1 and in the modified set up it is $\theta_2 < 1$. This calls for imposition of lower tax rate to finance such an input that in turn produces relatively lower output. The inference that we draw is that if the degree of responsiveness is low, government should not emphasize on such input as the desired change in H would not be

that much. Note that in the basic model $\theta_1 = \theta_2 = \theta_3 = 1$ and $(\theta_1 + \theta_2 + \theta_3) = 3$. Even in the modified structure if we use these values we get

$$\tau^{***} = \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} = \frac{\alpha}{3\alpha + \beta} \quad (= \tau^*) \quad (22)$$

Proposition 3: *The optimum tax rate depends on θ_2 , the output elasticity of G .*

Proof: See discussion above.

IV.B. All inputs are financed by Tax, τ

In this subsection we extend the modified structure to explore the tax rate when all health inputs are financed through government tax. Following the assumption of III.B and the arguments developed in (18)

$$\begin{aligned} \tau Y &= (\gamma_t + \gamma_g + \gamma_a) \tau Y = \frac{\theta_1}{\theta_2} P_g G + P_g G + \frac{\theta_3}{\theta_2} P_g G = P_g G \left(\frac{(\theta_1 + \theta_2 + \theta_3)}{\theta_2} \right) \\ \Rightarrow P_g &= \frac{\tau Y}{G} \frac{(\gamma_t + \gamma_g + \gamma_a)}{(\theta_1 + \theta_2 + \theta_3)} \theta_2 \end{aligned} \quad (23)$$

$$\text{Using (19) and (23) } G = \frac{Y}{\tau Y} \frac{G(\theta_1 + \theta_2 + \theta_3)}{(\gamma_t + \gamma_g + \gamma_a) \theta_2} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \Rightarrow$$

$$\tau = \frac{(\theta_1 + \theta_2 + \theta_3) \alpha}{(\gamma_t + \gamma_g + \gamma_a) \{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta\}}.$$

Since $(\gamma_t + \gamma_g + \gamma_a) = 1$

$$\tau^{****} = \frac{(\theta_1 + \theta_2 + \theta_3) \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} \quad (24)$$

When $(\theta_1 + \theta_2 + \theta_3) = 3$ like the basic model, equation (24) boils down to (15). However, if health production function H exhibits CRS, $(\theta_1 + \theta_2 + \theta_3) = 1$ then equation (24) becomes

$$\tau^{****} = \frac{\theta_2 \alpha}{\alpha + \beta} \quad (25)$$

Comparing (24) and (21) $\tau^{****} = \frac{(\theta_1 + \theta_2 + \theta_3) \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} > \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3) \alpha + \beta} = \tau^{***}$. For that in the last case all health inputs need to be financed without changing the equilibrium input and / or output combination.⁽⁶⁾

A careful investigation of (12), (15), (20) and (24) dictates that variations of model described in section III are the special cases of models of section IV. We could arrive at the results of (12) and (15) from (20) and (24) if $\theta_1 = \theta_2 = \theta_3$ and $(\theta_1 + \theta_2 + \theta_3) = 3 > 1$ pointing at health production function displaying IRS. Therefore, we propose that

Proposition 4: *The optimum tax rate is determined simultaneously by α , β , θ_1 , θ_2 and θ_3 .*

Therefore, in all the four cases demand elasticities of products (i.e., α and β) and output elasticities of inputs in health production function (i.e., θ_1 , θ_2 and θ_3) determine the

optimum tax rate. Desired rate of tax must not be set on an adhoc basis. Depending on the preference pattern of the representative consumer and the nature of input combinations required for H, government should design the tax rate and tax policy.

V. Concluding remarks

In this paper our endeavor was to develop a simple model of utility maximization where representative individual's utility depends on a composite commodity, C and health simultaneously.

We have not considered the issue of C production; C can be procured directly from the market. Production of H, however, is taken into account that needs three factors, T, G and A. In such a set-up we tried to explore the determination of optimum tax rate in different circumstances such as C-D production function with CRS, IRS, financing of G only, financing of all health inputs etc. It has been found in the analysis that in any of the above mentioned circumstances tax rate can never be an arbitrary one. It depends on how inputs and outputs are used in production and utility function, and how many inputs the government intends to finance by tax.⁽⁷⁾

The message we derive from the analysis: IRS in the production of H is an indication of economy's comparative advantage in H. Therefore, the country should emphasize on the production of H. Relatively more T, G and A have to be used in this direction. And when financing of such inputs in greater amount comes in, it can only be managed through higher tax rate.

It is also to be noted that when H increases, utility of the representative consumer goes up in particular and the economy reaches higher social indifference curve in general.

Notes

- (1) This variable may also measure the degree of access to health care service that directly or indirectly depends on knowledge, distance, empowerment, nature of employment if any, control over family decision etc.
- (2) Both H and C are "good" in economic sense indicating positive marginal utilities to the individual. However, preference for H may vary among different groups of people with varying levels of income and status concern. We guess that this phenomenon can also be analyzed using the structure that has been developed here. In that case the concern regarding status has to be modelled as a function of relative income. We apprehend that in such a situation marginal utility of H may vary significantly and at one extreme H may turn out to be a neutral good.
- (3) For brevity, financing of G can be expressed as $\tau Y = P_g G$. Where P_g could be the salary of administrators and G may stand for the number of health administrators or supervisors. Therefore, for any given P_g and Y, any change in τ must be matched by equi-proportionate change in G, i.e. $\hat{\tau} = \hat{G}$.

- (4) We will later modify the H production function using different weights for T, G and A. Even one can further extend it with weightage or importance in consistence with human development index. If we look at equation (9), it would be apparent in a moment that here all T, G and A have identical weights equal to unity. So this can be regarded as a special case of weights for various inputs.
- (5) $\tau^* = \frac{\alpha}{3\alpha+\beta} = \frac{1}{3+\beta/\alpha}$ and $\tau^{***} = \frac{\theta_2\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} = \frac{1}{\frac{(\theta_1+\theta_2+\theta_3)+\beta}{\theta_2}}$. When we consider CRS and weights are equal for all inputs, i.e. $\frac{1}{3}$, $\tau^{***} = \frac{1}{3+\frac{3\beta}{\alpha}}$. Therefore, $\tau^* > \tau^{***}$. Tax under IRS is greater than tax under CRS.
- (6) In line with footnote 7 if we compare $\tau^{****} = \frac{(\theta_1+\theta_2+\theta_3)\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta}$, with $\tau^{**} = \frac{3\alpha}{3\alpha+\beta}$, we find $\tau^{**} > \tau^{****}$. Therefore irrespective of financing options tax under IRS is greater than tax under CRS. Underlying arguments run as before.
- (7) We believe that similar analysis can also be used to determine tax for any commodity or services that could be provided by the state.

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The response of monetary policy to the COVID-19 pandemic in Turkey. The path of a credit-based economic recovery

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Abstract. *The goal of this paper is to investigate the reaction of monetary policy in Turkey to the coronavirus disease pandemic through the credit channel. For this purpose, the paper employs nonlinear smooth transition models considering nonlinearity. The empirical findings show a positive reaction of monetary policy to the confirmed cases and deaths. Therefore, the paper discovers the credit channel in Turkey is likely to play a critical role in the fast recovery of the Turkish economy during the pandemic period.*

Keywords: COVID-19 pandemic; monetary policy; credits; Turkey.

JEL Classification: C22, E51, E58.

1. Introduction

The novel coronavirus disease (COVID-19) which emerged in December 2019 in Wuhan, China has spread all over the world in a few months. As it has a specific ability in terms of being transmitted from one person to another quite simply (Shehzad et al., 2020), it became a global pandemic, with nearly 66.5 million cases and more than 1.5 million deaths as of December 5, 2020 (Worldometers, 2020).

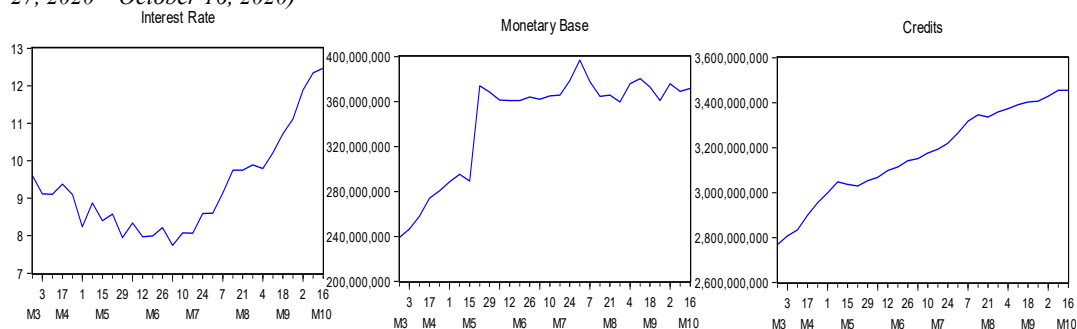
The COVID-19 pandemic has spread anxiety and fear among people (Mnif et al., 2020) and has severe impacts on economies (Rizwan et al., 2020). Accordingly, as Elgin et al. (2020) and Azimli (2020) denote, infected employees cannot join the workforce, leading to a serious decrease in activities in manufacturing and services sectors and an increase in layoffs and unemployment rates. Besides, increasing uncertainty and worsening expectations along with losses in stock markets result in a decrease in expenditures, which implies the demand-sides of economies are also damaged. In its most up-to-date World Economic Outlook in October 2020, International Monetary Fund (IMF) foresees that the global economy will contract by 4.4% in 2020 (IMF, 2020).

Policy makers around the world have applied stimulus packages to alleviate the negative impacts of COVID-19 and to restore investor confidence (Cepoi, 2020), namely injecting liquidity to banks and lowering interest rates (China), fiscal stimulus to support the businesses and decreasing interest rates (the USA), fiscal stimulus to enterprises and asset purchases from banks to supply liquidity (Europe), and lowering interest rates, fiscal stimulus to firms, and asset purchases from banks to provide liquidity (Canada) (Rizwan et al., 2020).

Before the COVID-19 pandemic, the policy makers in Turkey were very far from achieving macroeconomic stability. For instance, as per Turkish Statistical Institute (2020) data, the inflation and unemployment rates were respectively 11.8% and 13.7% at the end of the year 2019. Besides, GDP of Turkey diminished from the last quarter of 2018 to the second quarter of 2019, implying the Turkish economy suffered from a recession. After the emergence of the COVID-19, the policy makers in Turkey took some measures to lessen the impact of the pandemic just like policy makers in other countries did. From the fiscal policy side, on March 18, 2020, the Turkish government announced a stimulus package worth 100 billion Turkish Liras (TRY) mainly including the deferment of tax liabilities, social security premiums, and loan payments, the prohibition of layoffs, temporary income supports for employees working in firms that halt production, and temporary assistance for needy families, etc. On the other hand, the Central Bank of the Republic of Turkey (CBRT) lowered the policy rate from 9.75% to 8.25% during the period March-May. Additionally, the CBRT injected quite liquidity to the financial system to stimulate lending activities of banks to households and firms.

Figure 1 exhibits two main monetary policy indicators, namely the interbank rate (overnight interest rate set at the Borsa Istanbul Repo/Reverse Repo Market) and monetary base, along with total credits in Turkey.

Figure 1. Interest rate (%), monetary base (thousand TRY) and TRY credits (thousand TRY) in Turkey (March 27, 2020 – October 16, 2020)



Source: CBRT (2020).

One can observe from Figure 1 that from March to June while the interest rate decreased, monetary base and credits increased rapidly, implying an expansionary monetary policy of the CBRT. Specifically, the state-owned banks with their considerable shares in total assets in the Turkish banking sector lent to households and firms with lending rates which were lower than the interbank rate. Hence, the main policy measure to combat the economic impacts of the COVID-19 pandemic was to increase credits especially through the state-owned banks to support consumption and investment expenditures. Put differently, the credit channel in Turkey was tried to be effectively used during the pandemic. He/she can observe this rapid credit growth in Turkey during the pandemic period from Figure 1. This policy measure led the Turkish economy to recover rapidly and to grow by 6.7% in the third quarter of 2020 after contracting by 9.9% in the second quarter of 2020. On the other hand, because of the depreciation of TRY against foreign currencies stemming from expansionary monetary policy, the interbank rate increased depending on the increase in the policy rate of the CBRT and monetary base followed a horizontal path. However, credits proceeded to boost in Turkey.

With a special focus on credits, this paper examines the response of monetary policy to the COVID-19 pandemic in Turkey. More clearly, the paper examines the impact of the confirmed cases and deaths on the credit volume in Turkey. It uses weekly data from March 27, 2020 to October 16, 2020. This paper posits that linearity is a very strong assumption in a time series analysis as many time-series variables exhibit nonlinear behaviours (Enders, 2015). Moreover, in a nonlinear time series analysis, the transition between regimes is likely to be smooth rather than sharp. In other words, the parameters tend to slowly change in a nonlinear model. These models are defined as smooth transition models in the econometrics literature and are considered to be more realistic for economic time series data sets.

The remainder of the paper is organized as follows: Section 2 presents the methods while Section 3 gives the model and data. Empirical results are reported in Section 4. Section 5 concludes the paper.

2. Methods

2.1. Unit Root Test

Kapetanios et al. (2003, hereafter KSS (2003)) propound a unit root test to test for the null hypothesis of a unit root process against the alternative hypothesis of a nonlinear exponential smooth transition autoregressive (ESTAR) process that implies stationary. They begin with the following ESTAR model:

$$y_t = \beta y_{t-1} + \gamma y_{t-1} [1 - \exp(-\theta y_{t-d}^2)] + \varepsilon_t \quad (1)$$

Equation (1) can be restated as below:

$$\Delta y_t = \varphi y_{t-1} + \gamma y_{t-1} [1 - \exp(-\theta y_{t-d}^2)] + \varepsilon_t \quad (2)$$

where $\varphi = \beta - 1$.

They regard φ as 0 and d as 1 and produce the following specific ESTAR model:

$$\Delta y_t = \gamma y_{t-1} \{1 - \exp(-\theta y_{t-1}^2)\} + \varepsilon_t \quad (3)$$

They utilize a first-order Taylor series approach for the ESTAR model and use the regression below:

$$\Delta y_t = \delta y_{t-1}^3 + \varepsilon_t \quad (4)$$

They obtain the following t-statistic (t_{NL}) for $\delta = 0$ against $\delta < 0$ as follows:

$$t_{NL} = \hat{\delta} / \text{s.e.}(\hat{\delta}) \quad (5)$$

where $\hat{\delta}$ and $\text{s.e.}(\hat{\delta})$ respectively stand for the ordinary least squares (OLS) estimation of δ and the standard error of $\hat{\delta}$. If t_{NL} statistic is greater than the critical values, the null hypothesis of a unit root is rejected, implying the series is stationary.

2.2. Cointegration test

Kapetanios et al. (2006, hereafter KSS (2006)) develop a cointegration test through nonlinear exponential smooth transition (ESTR) error correction models. They test the null hypothesis of no cointegration against the alternative of ESTR cointegration. They state that the small-sample performance of their nonlinear cointegration test is better than those of linear Engle and Granger (1987) and Johansen (1995) cointegration tests. After utilizing some mathematical and statistical models and making some assumptions⁽¹⁾, they use the following ESTR error correction model:

$$\Delta y_t = \phi u_{t-1} + \gamma u_{t-1} (1 - e^{-\theta(u_{t-1} - c)^2}) + \omega' \Delta x_t + \sum_{i=1}^p \psi_i' \Delta z_{t-i} + e_t \quad (6)$$

$$\Delta x_t = \sum_{i=1}^p \Gamma_{xi} \Delta z_{t-i} + \varepsilon_{xt} \quad (7)$$

$$\hat{u}_t = y_t - \hat{\beta}_x' x_t \quad (8)$$

where $\hat{\beta}_x$ denotes the OLS estimation of β_x . One of the tests statistics used by Kapetanios et al. (2006) is called F_{NEC} . They estimate the following model to develop the F_{NEC} statistic:

$$\Delta y_t = \delta_1 \hat{u}_{t-1} + \delta_2 \hat{u}_{t-1}^2 + \delta_3 \hat{u}_{t-1}^3 + \omega' \Delta x_t + \sum_{i=1}^p \psi_i' \Delta z_{t-i} + \varepsilon_t \quad (9)$$

The null hypothesis of no cointegration is defined as $H_0: \delta_1 = \delta_2 = \delta_3 = 0$. If the F_{NEC} statistic is greater than the critical values, the null hypothesis of no cointegration is rejected, implying there exists cointegration in the empirical model.

3. Model and data

The paper uses two indicators for the magnitude of the COVID-19 pandemic: confirmed COVID-19 cases and deaths originating from the COVID-19. Hence, the paper uses the following empirical models to measure the response of credits to the COVID-19 pandemic in Turkey:

$$\ln CRE_t = \alpha_0 + \alpha_1 \ln CASE_t + \varepsilon_t \quad (10)$$

$$\ln CRE_t = \beta_0 + \beta_1 \ln DEATH_t + \varepsilon_t \quad (11)$$

where CRE, CASE, DEATH, and ε respectively stand for TRY credits, confirmed COVID-19 cases, deaths stemming from the COVID-19 pandemic, and the error term. All variables are in their natural logarithms described by ln. The data are weekly and cover the period March 27, 2020–October 16, 2020. While data for the COVID-19 pandemic are sourced from the Republic of Turkey Ministry of Health (2020), data for credits are obtained from the CBRT (2020).

4. Results

For the empirical analysis, the paper first performs the Broock et al. (1996, hereafter BDS) nonlinearity test of which the null hypothesis is linearity. Table 1 exhibits the results for the BDS test. As is seen, the null hypothesis of linearity is rejected for all variables, implying nonlinear models must be utilized.

Table 1. BDS nonlinearity test

Variable	Dimensions				
	2	3	4	5	6
lnCRE	0.192* (0.000)	0.328* (0.000)	0.424* (0.000)	0.493* (0.000)	0.543* (0.000)
lnCASE	0.127* (0.000)	0.232* (0.000)	0.309* (0.000)	0.350* (0.000)	0.374* (0.000)
lnDEATH	0.096* (0.000)	0.191* (0.000)	0.243* (0.000)	0.257* (0.000)	0.272* (0.000)

Notes: * illustrates 1% significance level. Values in parentheses show prob. values.

The results for the KSS (2003) unit root test are depicted in Table 2. Accordingly, the null hypothesis of a unit root cannot be rejected at level, whereas it can be rejected at first difference for all variables. Hence, the KSS (2003) unit root test yields that all variables are integrated of order one and that the cointegration relationships in the models can be examined.

Table 2. *KSS (2003) unit root test*

Variable	Test statistic	
	Level	1st difference
lnCRE	6.285	-1.938***
lnCASE	-0.002	-2.937*
lnDEATH	0.125	-2.370**

Note: *, **, and *** respectively illustrate 1%, 5%, and 10% levels of significance.

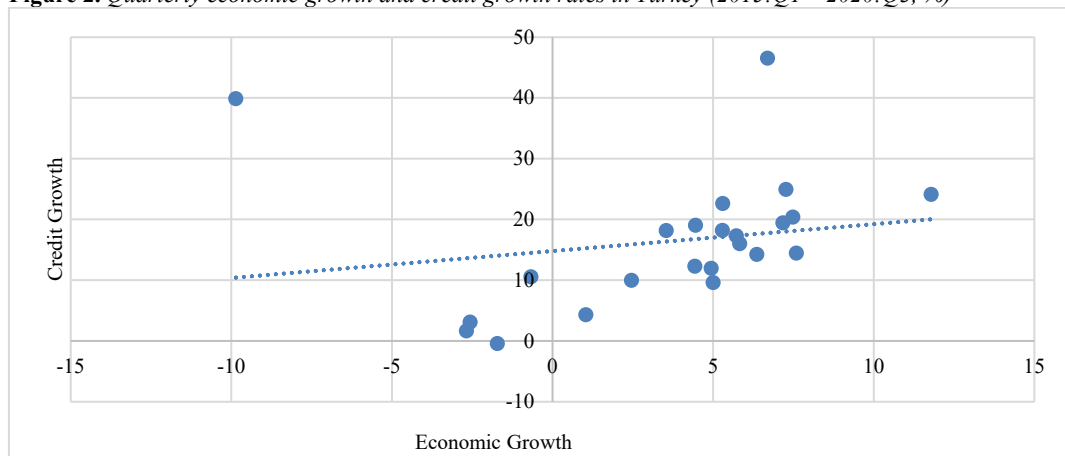
The outputs of the KSS (2006) cointegration test are reported in Table 3. Accordingly, panel A and panel B respectively show the findings for the first and the second empirical models established in the previous section. As is seen, the null hypothesis of no cointegration is rejected for both models, implying parameters can be estimated. Besides, the coefficients of lnCASE and lnDEATH respectively are 2.968 and 5.859 and both are statistically significant.

Table 3. *KSS (2006) cointegration test and parameter estimation*

Panel A: lnCRE-lnCASE relationship			
Panel A1: Cointegration test			
Test statistic		28.117*	
Panel A2: Parameter estimation			
Variable	Coefficient	Std. error	t-statistic
lnCASE	2.968*	0.032	91.192
Panel B: lnCRE-lnDEATH relationship			
Panel B1: Cointegration test			
Test statistic		34.168*	
Panel B2: Parameter estimation			
Variable	Coefficient	Std. error	t-statistic
lnDEATH	5.895*	0.203	29.001

Note: * illustrates 1% level of significance.

Therefore, the empirical findings explore that monetary policy in Turkey responded to the severe effects of the COVID-19 pandemic through the credit channel. Put differently, as the COVID-19 pandemic deepened through cases and deaths, credits increased in Turkey to support expenditures of households and firms and to alleviate the negative impacts of the pandemic on economic activities.

Figure 2. *Quarterly economic growth and credit growth rates in Turkey (2015:Q1 – 2020:Q3, %)*

Source: CBRT (2020).

Figure 2 exhibits the relationship between annual economic growth and credit growth in Turkey during 2015-2020. As is observed from the figure, there exists a positive relationship between economic growth and credit growth in Turkey, meaning the credit channel is an important tool to influence economic activities in Turkey. Overall, this paper yields that the credit channel in Turkey seems to result in a rapid economic recovery during the pandemic period if the empirical findings of this paper are considered along with the positive nexus between credit growth and economic growth rates.

5. Conclusion

This paper examined the reaction of monetary policy in Turkey to the COVID-19 pandemic using the credit channel. The findings of the nonlinear smooth transition models discovered a positive reaction of monetary policy to the confirmed cases and deaths. Hence, the paper explored the credit channel in Turkey appeared to lead the Turkish economy to rapidly recover during the pandemic period.

It should be noted that the fast credit growth in Turkey led to an increase in macroeconomic imbalances in Turkey. For instance, TRY seriously depreciated against foreign currencies in the last months, which can negatively affect the Turkish economy with high foreign debts. Second, lending to households and firms with lending rates that are lower than the interbank rate is likely to result in a deterioration in the balance sheets of the state-owned banks in Turkey. Hence, the policy makers in Turkey should take these imbalances into account in the following period not to suffer from financial instability and a possible financial crisis.

Note

⁽¹⁾ See Kapetanios et al. (2006) for the details of the cointegration test.

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The co-integration and causal relationship between saving and economic growth in India

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Abstract. *The role of saving in promoting economic growth has received considerable attention all over the world. Saving is considered as real driving force behind the growth of an economy. The aim of this paper is to examine the casual relationship between economic growth and savings in India. To analyze this relationship time series data from 1960 to 2019 was used. To check the stationarity of data ADF and PP test were used. The Johansen co-integration test was employed to check the relationship between the variables. Finally Granger causality test was applied to see the direction of causality. The results have shown that all the variables are non stationary. The Johnson method shows that both the variables share the relationship with one another. The econometric evidence supports that savings do cause economic growth and economic growth in turn to savings. The bi-directional casual relationship was observed, which suggests that in India higher economic growth leads to higher savings and higher savings to more economic growth.*

Keywords: GDP, economic growth, saving, casual relationship, integration.

JEL Classification: E20, E21, O1, O4.

Introduction

India has started the process of economic development through the establishment of planning commission in March 1950, hoped to achieve economic growth in an established manner and subsequently launched its first five year plan in 1951 based on Harrod Domar model (Hashmi and Sedai, 2016). The Classical economists believed that the existence of savings is a necessary and sufficient condition for investment creation and subsequently for economic growth. They believed that if savings go up, investment increases because the rate of interest rate will decrease and economic growth will prevail in the economy (Najarzadeh et al., 2014).

The Keynes model states that saving is the function of economic growth, it is the saving which leads to economic growth, in contrast to Solow model of growth that suggests saving is the determinant of economic growth; therefore it is the economic growth which is the function of savings.

Economic growth is a key factor to most of the economies these days. Everybody wants to live with comfort having better standard of living and a better welfare. Government in each nation wants to reduce the poverty and increase the level of national income. Therefore to achieve the main target of increase in economic growth, policy makers have implemented various kinds of policies to encourage savings and therefore stimulate investment.

With the inception of planning process, India has made considerable progress in terms of GDP growth and volume of savings. The GDP growth rate at constant prices increased from 3.6% in 1950-51 to 7% in 2018-19, with an average of 5.2%. There are some exceptions when the GDP growth rate was very high (10.3% GDP growth rate in 2009-10) and very low (1.2% GDP growth rate in 1990-91). On the other side, saving rate has been constantly increased since planning process, from an extremely low level of 8.2% in 1952-53 to 30.5% in 2018-19 (Figure 1).

It is also important to mention here that Indian economy has undergone several transformations. These evidences were given by many researchers. Rajkrishna (1983) found long term rate of growth of 3.5% and called “the Hindu growth rate”, Dandekar (1992) states improvement in GDP growth rate from early 1980’s in India. The growth trajectory of the Indian economy is often conceived in terms of transitional dynamics from one crisis to another. These are the evidence which showed India’s dynamic growth.

The role of savings in promoting economic growth has received considerable attention all over the world (Verma, 2007). The central idea of Lewi’s theory (1955) and Harrod-Domar (1956) growth models specified saving as the key factor in promoting economic growth. The neoclassical models like Solow (1956) also proposed that higher savings leads higher growth in per capita capital and per capita income from the transition to the steady-state of economic growth.

The endogenous growth models also suggested that higher saving rate contributes to long term growth rates. The policy implication of these models for development is that those countries that manage to increase their saving rate, and therefore investment, will increase their rate of growth (Alguacil et al., 2004). The importance of savings for economic growth can be witnessed in the economic progress made by countries like China, India, Indonesia, South Korea, Singapore, Thailand and Malaysia (Joshi et al., 2019).

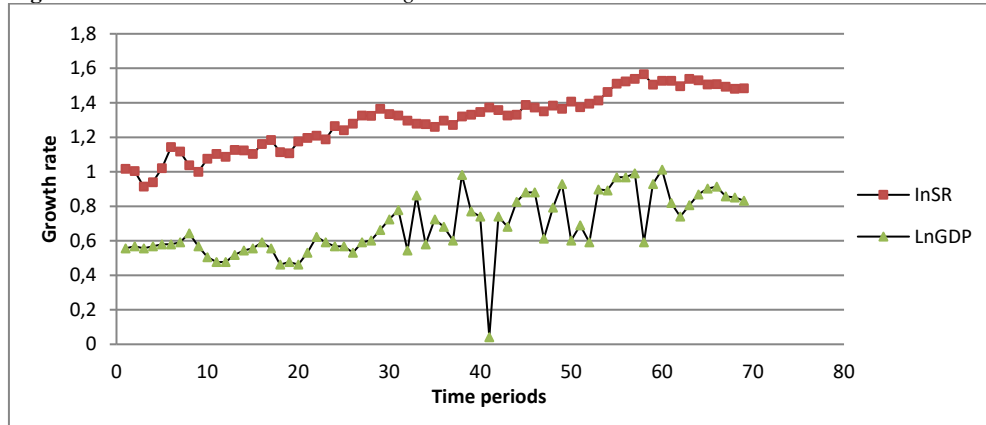
The post-neoclassical endogenous theory of economic growth that came into picture since the mid-1980s predicts that increase in savings generate a higher rate of economic growth through its positive effects on investment and capital accumulation (Mankin et al., 1992; Barro and Sala-i-Martin, 1995; Lucas, 1988; Romer, 1986).

The casual relationship between economic growth and savings were examined by many researcher across the globe had not reached any settled conclusion. There are three approaches regarding the casual relationship between saving and economic growth.

1. Fundamentalists view states that a casual relationship runs from saving to economic growth which is supported by set of studies like Bacha (1990), Otani and Villannueva (1990), DeGregorio (1992), Levine and Renelt (1992), Hebbel et al. (1992), Jappelli and Pagano (1994), Sinha (1999), Misztal (2011), and Jangili (2011) concluding that higher savings contribute to higher economic growth.
2. Keynesians view that growth contributes to saving. This hypothesis gets support from the studies by Keynes model (1936), Houthakker (1960, 1965), Marglin (1976), Cullison (1993), Carroll and Weil (1994), Anoruo and Ahmad (2001), Agrawal (2001), Sahoo et al. (2001), Alguacil et al. (2004), Narayan and Narayan (2006), Lorie (2007), Verma (2007), and Abu (2010). All these empirical studies view that higher economic growth rate proceed higher savings.
3. A third set of studies conducted by different researcher's supported the view that causality runs from both sides and concluded that savings and economic growth reinforce each other. This hypothesis is supported by Schmidt et al. (1996), Singh (2010), Foul (2010), Bayer (2014), Najarzadeh et al. (2014), and Hashmi and Sedai (2016). These researchers are of the view that there is a bi-directional causality between saving and economic growth.

Data and methodology

Annual data of India from 1960 to 2019 were used collected from internet websites of World Bank and RBI. The data which was used in this study are all in the form of growth rates. Economic growth has been measured using GDP growth rate and saving in the form of Gross Domestic saving. The graphical representation of the data is shown in Figure 1 given below.

Figure 1. Growth rate in GDP and saving rate in India

The figure shows that variables are moving in the same direction. Therefore, before using any econometric technique to analyse the data, it is important to know the stationarity of the data. For this purpose Augmented Dickey-Fuller (ADF) model (Dickey and Fuller, 1981) was used at 5% level of significance. The model is shown as:

$$\Delta Y(t) = \mu + \gamma Y(t-1) + \vartheta T + \sum_{i=1}^k \delta(i) \Delta Y(t-i) + e(t) \quad (1)$$

In addition to ADF test, the Phillips-Perron (PP) unit root test was also used to cross check the results. It is very important to select the optimal lag length, because all the econometric tools are very sensitive to number of lags used. For this purpose Schwarz Information Criteria (SIC) technique was employed to fix the optimal number of lags used in the model.

Further to check whether there exists a co-integration between economic growth and saving, we use the multivariate co-integration method by Johansen and Juselius (1990) and Johansen (1992) to verify the co-integration among the variables. The Maximum Eigenvalue (λ_{max}) and Trace Statistics (λ_{max}) tests are used to trace out the co-integration rank r (the number of independent co-integrating vector):

$$\lambda_{max}(r) = -T \sum_{i=r+1}^n \ln(1 - \lambda_i) \quad (2)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1}) \quad (3)$$

This method was used to know the direction of causality and cause and effect relationship between the variables in India.

Empirical results

Unit root test

Before we analyse the casual relationship between economic growth and saving, it is important to know the order of integration. This order is tested here by means of augmented Dickey and Fuller (1979, 1981) and Phillips and Perron (1988) tests. The results of unit root test are reported in Table 1.

Table 1. Stationary test based on Augmented Dickey-Fuller Test and Phillips-Perron Test

	Augmented Dickey-Fuller Test	Phillips-Perron Test
LGDP	-4.350843 (0.0009)*	-4.192187 (0.0015)*
DGDP	-7.465034 (0.0000)*	-34.37598 (0.0001)*
LGDS	-2.598519 (0.0990)	-2.369569 (0.1546)
DGDS	-7.988550 (0.0000)*	-17.81849 (0.0000)*

According to these results the null hypothesis is rejected both at level (denoted by L) and first difference in case of GDP. In case of savings the null hypothesis of non-stationary is accepted at level but can be rejected at first difference (denoted by D), indicating unit root at level.

Time series models are very sensitive to lag length. We employed the Schwarz information criterion to check the optimal lag length. On the basis of the Schwarz information criterion optimum lag length for this model is 2 as shown in Table 2.

Table 2. Optimum lag length

Number of lags	Schwarz information criterion
0	10.92178
1	9.936935*
2	10.09344
3	10.09177
4	10.23503

* Indicates lag order selected by the criterion.

Co-integration test

It has been observed that both the variables are integrated at first difference, we proceed to test co-integration between economic growth and saving. For this purpose Johansen co-integration test was used. The results of Johansen test are shown in Table 3.

Table 3. Johansen co-integration test results

H_0 – there does not exist co-integration

Variables in the system	Trace statistic	Maximum Eigen value statistic	Conclusion
GDP and GDS	26.19584 (15.4947)*	22.63546 (14.2646)*	Co-integrated
GDS and GDP	28.74866 (15.4947)*	26.84825 (14.2646)*	Co-integrated

Note: *indicate statistical significance at 5% level.

It can be seen from Table 3 that null hypothesis of no co-integration is rejected at 5% level of significance. Therefore accept the alternate one, which shows variables are co-integrated. Both the trace statistics and maximum Eigen value is above the 95% critical value.

Causality test

After getting confirmation that variables are co-integrated, it is obvious that the existence of granger causality is in at least one direction between economic growth and saving. Granger causality test was run and the results are presented in Table 4.

Table 4. Causality tests based on VECM/VAR F-statistic

Null hypothesis	F-Statistic	Prob.	Result
Gross Domestic Product does not granger cause Gross Domestic Saving	15.1221	0.0003	Reject
Gross Domestic Saving does not granger cause Gross Domestic Product	4.15096	0.0463	Reject

It indicates that the variables are mutually reinforcing to each other during the study period. Therefore the direction of causality is from both sides. Higher economic growth boosts savings and higher savings leads higher economic growth in India. These results are consistent with Schmidt et al. (1996), Singh (2010), Foul (2010), Bayer (2014), Najarzadeh et al. (2014), and Hashmi and Sedai (2016).

Conclusion

The savings in India play an important role in promoting economic growth. Saving is considered as real driving force of the economy and has shown an increasing trend since 1950 in India. Overall growth rate has shown an increasing trend but failed to match the extraordinary savings performance. In order to understand this phenomenon, this study was conducted under empirical lines to test the causality between economic growth and savings in India. The econometric evidence supports that savings do cause economic growth and economic growth causes savings. The bi-directional casual relationship was observed, which suggests that higher economic growth leads to higher savings and vice versa in India. The policy makers in India need to stimulate as well as effective mobilization of savings in productive sectors, which in turn lead to increase the capital formation and thus economic growth.

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Does exchange rate volatility affect financial depth? Evidence from BRICS countries

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Abstract. *Deepening of financial system in emerging market economies is crucial for economic development. Financial depth enhances the ability of financial system to supply funds to private sector. In this study, the impact of exchange rate volatility on financial depth in Brazil, Russia, China and South Africa is investigated in the short and long run. In this regard, annual data belonging to 1980-2018 period is used.*

The findings obtained from empirical analyses confirm that real exchange rate is not a factor that affects financial depth and so financial development. On the other hand, financial depth is a factor affecting exchange rate volatility in Brazil, Russia, China and South Africa. These results may be a reason of relatively enough size and development of financial systems. Moreover, dominancy of public sector in financial system may be another reason.

Keywords: financial depth, exchange rate volatility, BRICS economies.

JEL Classification: E44, F31, O42.

1. Introduction

The relation with economic growth and financial system is well investigated in the literature. In Aghion et al. (1999) study, it is presented in a well-established model. Their conclusion is that economies with less developed financial systems will tend to be more volatile and to grow slowly. This explains why macroeconomic volatility tends to be larger in related economies compare to economies with developed financial systems (Aghion et al., 1999: 1363).

In the empirical literature, there are numerous studies those find evidence supporting positive relation running from development of financial system to economic growth in both developed and developing economies via different methods (Jung, 1986; Roubini and Sala-i Martin, 1992; King and Levine, 1993; Kar et al., 2008; Ghali, 1999; Kar et al., 2011; Kar and Özşahin, 2016; Puatwoe and Piabuo, 2017). This uni-directional relation is also called supply leading hypothesis by Patrick (1966). In short, a well-functioning financial system affect steady-state growth by influencing the rate of capital formation and also by altering the rate of technological innovation (Öner, 2007: 138).

On the other hand, financial system is affected by economic growth without no doubt. Robinson (1952) claims that where enterprise leads, finance follows". Patrick (1966) calls the uni-directional causality running from economic growth to financial system development as demand following hypothesis. In this type of relation, creation of modern financial institutions and related financial products are a response to the demand for these services by investors and savers in the real economy (Patrick, 1966: 174). In this regard, growing economy would need more financial services. In response, financial system would expand. The empirical literature finds evidence supporting this type of relation (Kar and Pentecost, 2000; Boulika and Trabelisi, 2002; Güray et al., 2007). On the other hand, Levine (2004) suggests that economic growth negatively affect financial system due to increasing risk.

According to Sahay (2015), financial development has three components. They are depth, access and efficiency. While financial depth is measured via size and liquidity of financial markets, access is calculated via ability of persons to financial services. On the other hand, efficiency is more related to institutions and low costs, sustainable revenues increase efficiency of financial markets.

Among components of financial development, depth is more sensitive to economic conditions due to international financial flows in a liberalized financial structure. While access and efficiency are related to structure of the system, depth is more related to actual economic conditions. In this regard, Hajilee and Al Nasser (2017) indicate that financial depth is affected by main macroeconomic variables such as government policies, inflation rate, GDP, political stability and exchange rate.

One of the main macroeconomic indicators that affects not only financial system but also other economic variables such as inflation rate is exchange rate. A possible volatility in exchange rate affects financial system in different ways such as cost of capital imported from abroad. Also increasing exchange rate would reduce the value of domestic currency

and would induce liquidity in the banks. This might be the theoretical framework to explain why macroeconomic development have effect on financial system as Hajilee and Al Nasser (2017) explained.

The investigation of relation between financial depth and exchange rate is essential because determination of the possible relation could be useful for the choice of exchange rate strategy. According to Ehigiamusoe and Lean (2019), countries with less developed financial markets are more likely to adopt a fixed exchange rate, while countries with higher levels of financial development are more likely to adopt a flexible system. Fujiwara and Teranishi (2011) also states frictions in financial system induce responses of exchange rate persistently. All these explanations introduce that financial system's health and/or development is another important factor affecting exchange rate.

In this study, possible relation between economic growth and financial depth in Brazil, Russia, China and South Africa which are members of BRICS countries, except India between years 1994 and 2018. Although there is a vast literature investigating the interaction between exchange rate volatility and financial system/development even in BRICS economies, this study differs from them in three ways. First of them, employing financial depth instead of financial development would clarify the effect of volatility. Because by using depth only, it would possible to distill responses of financial system structure to a volatile exchange rate. Secondly, financial depth index developed by International Monetary Fund (IMF, hereafter) is employed. Lastly, advanced panel date methods are used to better understand the relation by clarifying effects of structural breaks. All these superiorities might increase possible contribution of the study to existing literature.

In the second section, a brief information about financial systems of BRICS countries. In this section, banking system and non-banking financial system will be investigated via IMF reports. In the third section international literature is investigated. In the fourth section, empirical model and analysis results will be presented. At last, results will be concluded, and policy implication will be presented.

2. Financial structure in BRICS

In the last decade of 20th century, structural changes are experienced in the world economy. Collapse of socialist system in especially Eastern Europe and liberalization of economy policies in emerging market economies have changed structure of financial systems in related economies. In this regard, Russia and China which are in a transition period from communism to capitalism and Brazil and South Africa which were subject to policy change are important actors of development in last twenty years.

In Brazil, financial system has been growing since 2012 (IMF, 2018: 5). According to IMF report (2018), although growth process, structure of the system is un-changed and the public sector is dominant in the system. While financial markets are liquid, concentration in banking system is very high and government securities play a key role in systemic

liquidity management. In the light of explanations above, there are a number of reforms in the banking system need to make in the near future in order to reduce dominance of government.

In Russia, after transition to free market economy, banking system has been experienced structural change. But, like Brazilian case, the dominance of a few federal banks is still present (Pushkareva et al., 2019: 29).

Allen et al. (2007) report that financial system of China is controlled by underdeveloped banking system and four largest of them is state controlled. Although it grows fast, two stock markets are still small compared to banking system of China. Resources are not used efficiently in the financial system. Lastly, nor banking system neither stock markets are the most effective parts of the Chinese financial system. Rather this binary, internal financing, trade credits and coalitions of various forms among firms, investors and local governments (Allen et al., 2007; 3).

In the South African case, financial sector is large and sophisticated (IMF, 2014: 10). Compare to other emerging market economies, financial system of the country is some different. Two thirds of financial assets are hold by non-banking financial institutions. Unit trusts, pension funds and insurance assets are some of products those constitute total financial assets. Banking system is dominated by only four banks. 90% of banking assets are hold by five banks. This is some similar with other BRICS economies. On the other hand, capital market is large, it is supported by non-banking financial institutions and foreign investor participation (IMF, 2014: 12).

As can be seen, financial systems of BRICS countries are similar, except South Africa. Three of four are dominated by government and although size of financial assets is big, dominance of a few large banks are the same in all of them. This situation brings a question into mind, how exchange rate fluctuations affect financial depth of these economies? As known, depth of a financial system is measured via liquidity and size, and both are enough for describing it as depth in the related countries. Moreover, dominance of public sector on banking system is might be a cause of size sufficiency, except South Africa.

In the light of explanations above, re-visiting financial depth and exchange rate fluctuations might have some important findings and conclusions. Existence of relation might give opinion what type of exchange rate strategy can be implemented in such a financial structure in the BRICS countries.

3. Literature review

In the light of theoretical explanations in the introduction section, it is possible to classify the relation in two groups. First is effect of exchange rate fluctuations on financial system and second is effect of financial system on exchange rate volatility. Moreover, parameter that used to measure financial system differentiates studies.

In the literature, stock market size, stock market price, financial depth index and various financial system indexes are employed to connote financial system development. In this regard, it is possible to classify existing literature according to different dimensions.

In one of recent studies, Ehigiamusoe and Lean (2019) investigate the relation for West African region. They employed banking data such as credit to private sector to measure financial development. According to panel data analysis results, financial development does not affect exchange rate volatility. On the other hand, increasing exchange rate volatility causes less financial growth.

Bahri and Sarmidi (2019) investigate the role of financial development in explaining how exchange rate volatility affects economic development in 41 developing countries. Authors connote financial development via domestic credit to private sector and liquid liabilities. Results imply that financial development mitigates the negative effects of exchange rate volatility on economic growth.

Martins (2015) investigates the relation between exchange rate volatility and foreign direct investments in Brazil between years 1976 and 2013. It can be thought that foreign direct investment is a measure of financial development. The author employs ARDL model to investigate the relation. According to results, real exchange rate volatility has negative impact on foreign direct investment of the Brazilian economy.

Zehan and Hamid (2017) analyze the relation in developing economies and employ capital inflows as a measure of financial system. They take 1980-2013 period into account and employ GMM estimation technique. According to results, exchange rate volatility has negative impact on capital inflows to developing countries. Agarwal (2012) analyzes Malaysian economy and investigates the effect of exchange rate on capital inflows. According to results, exchange rate volatility has an adverse effect on capital and foreign direct investment inflow in the Malaysian economy.

Hajilee and Al Nasser (2017) analyze 26 countries about possible interaction between exchange rate fluctuations and financial depth. They group the countries into three groups namely, developed, developing and emerging market economies. According to bounds test results, in 16 of 26 countries, financial depth responds to exchange rate fluctuations. More interestingly, direction of responses is different for each country.

Ergür and Özek (2020) analyze BRICS country in the context of relation between financial development and economic development. Different from this study, authors employ financial development index rather than financial depth. They use panel data approach and find that supply leading hypothesis is valid in the short run and feedback hypothesis in the long run.

In the literature, financial system and/or financial development is measured via different ways as said before. One of them is via stock market size. In earlier study of Nieh and Lee (2001), authors take stock markets as a part of financial system and exchange rate fluctuations in G-7 countries and find that there is no relation between variables. Kurihara

(2006) investigates possible effects of exchange rate on financial development in Japan by exploring the relation between exchange rate and stock prices. In the end, it is concluded that exchange rate is an effective variable on financial system. Diamandis and Drakos (2011) investigate the relation for Latin American countries and finds relation between variables in the short run. Interestingly, relation disappears in the long run in all countries. Another study which takes stock market into account to connote financial system belongs to Tsai (2012). The author analyzes six Asian economies to find possible interaction stock market and exchange rate fluctuation. Similarly, results imply no significance relation between variables.

Recent studies take capital inflows as an indicator of financial development. One of them belongs to Olusuyi (2018). Olusuyi (2018) investigates the effect of exchange rate volatility in Nigeria. The author employs GMM method and finds a possible interaction between capital inflows as a measure of financial development and exchange rate volatility. Another one belongs to Kraiche and Gaudette (2020). Different from existing studies, they investigate the effect of financial development on effect of exchange rate on foreign direct investments in 39 emerging market economies. According to results, exchange rate volatility is effective if financial development level is low and it is not effective if financial development level is high.

4. Data and empirical results

In this study, interaction between financial depth and real exchange rate in Brazilian, Chinese, Russian and South African economies is investigated. These countries are members of BRICS acronym. Because of lack of data belonging to India, Indian economy is excluded. That is why acronym is modified as BRICS. Data starts by 1994 and empirical analysis covers 1994-2018 period. In the analysis, annual data is employed. The data is obtained from International Monetary Fund's official database. In order to solve heteroscedasticity problem, natural logarithm of each variables is used in the analysis. Cross section dependency test, null hypothesis claims absence of cross section dependency and alternative one claims existence of cross section dependency.

Table 1. Cross section dependency test results

Constant	FD	REER
CD_{lm} (BP,1980)	26.608 (0.00)***	20.314 (0.00)***
CD_{lm} (Pesaran, 2004)	6.526 (0.00)***	4.132 (0.00)***
CD (Pesaran, 2004)	-3.543 (0.00)***	-3.274 (0.00)***
LM_{adj} (PUY, 2008)	5.114 (0.00)***	4.404 (0.00)***

When we take probability values into account, it is possible to conclude that alternative hypothesis which claims existence of cross section dependency is accepted. For this reason, we employ cross-sectionally augmented Dickey-Fuller (CADF, hereafter) which is among second generation unit root tests. In CADF test, null hypothesis claims series contain unit root and alternative hypothesis claims series does not contain unit root.

Table 2. *CADF unit root test results*

		Constant		Constant and Trend			Constant		Constant and Trend
	Lags	CADF-stat	Lags	CADF-stat		Lags	CADF-stat	Lags	CADF-stat
FD					REER				
Brazil	2	-2.398	2	-2.998	Brazil	1	-1.469	1	-2.455
Russia	3	-1.640	3	-0.468	Russia	1	-1.903	1	-2.095
China	1	-1.592	4	-3.122	China	1	-1.419	1	-1.457
South Africa	1	-1.310	1	-2.650	South Africa	3	-2.699	3	-5.600***
Panel CIPS		-1.735		-2.310	Panel CIPS		-1.872		-2.902**

Notes: Maximum lag length is determined as four. Optimal lag length is identified via Schwarz information criterion. CADF critical values are, in model with constant, -4.11 (%1), -3.36 (%5) and -2.97 (%10) (Pesaran, 2007, Table I(b), p. 275); in model with constant and trend, -4.67 (%1), -3.87 (%5) and -3.49 (%10) (Pesaran, 2007, Table I(c), p. 276). Critical values of panel statistics are, in model with constant, -2.57 (%1), -2.33 (%5) and -2.21 (%10) (Pesaran, 2007, Table II(b), p. 280); in model with constant and trend, -3.10 (%1), -2.86 (%5) and -2.73 (%10) (Pesaran, 2007, Table II(c), p. 281). Panel statistics are average of CADF statistics.

When test statistics are compared to critical values obtained by Pesaran (2007), it is concluded that real exchange rate series belonging to countries, except South Africa, contains unit roots in all models. In panel CIPS results, it is possible to conclude that group statistics contains unit root.

Table 3. *Cross section dependency and homogeneity test results*

Regression Model:		
$FD_{it} = \alpha_i + \beta_i REER_{it} + \varepsilon_{it}$	Statistic	p-value
Cross-section dependency tests:		
LM (BP, 1980)	37.972	0.00***
CD_{im} (Pesaran, 2004)	9.230	0.00***
CD (Pesaran, 2004)	5.393	0.00***
LM_{adj} (PUY, 2008)	11.910	0.00***
Homogeneity tests:		
$\hat{\lambda}^c$	10.314	0.00***
$\hat{\lambda}^o$	10.966	0.00***

Notes: The figures which is ***, **, * show 1%, 5% and 10% levels, respectively.

According to cross section dependency test results, it is seen that series are dependent to each other. That is why co-integration methods which take cross section dependency and heterogeneous predictive into account. In Table 4, it is seen that there is a long run co-integration relation between variables in the country group.

According both asymptotic and bootstrap probability test results, there is a co-integration relation between variables. All these positive results related to existence of co-integration allow to apply panel causality tests. In this regard, panel VECM causality method is employed.

Table 4. Panel co-integration test accounting cross section dependency

Tests	Constant			Constant and Trend		
	Statistic	Asymptotic p-value	Bootstrap p-value	Statistic	Asymptotic p-value	Bootstrap p-value
Error Correction						
Group_tau	-4.294	0.00***	0.021**	-7.429	0.00***	0.00***
Group_alpha	-7.446	0.00***	0.041**	-8.935	0.00***	0.057*
Panel_tau	-7.561	0.00***	0.00***	-9.690	0.00***	0.00***
Panel_alfa	-12.787	0.00***	0.00***	-11.316	0.00***	0.014**

Notes: The null hypothesis claims non - existence of co-integration. In error correction test, lag and antecedent are accepted as one. Bootstrap prob. value is obtained from 1.000 repeat. Asymptotic probability values are obtained from standard normal distribution. The figures which is ***, **, * show 1%, 5% and 10% levels, respectively.

In Table 5, panel vector error correction causality results are presented. According to results, there is no uni-directional causality running from real exchange rate to financial depth in the countries.

On the other hand, uni-directional causality running from financial depth to real exchange rate exists, but the significance level is low. In this regard, it is not possible to conclude that real exchange rate is not a cause of financial depthless. This causation linkage is valid in the short run.

Table 5. Panel VECM causality test results

		Short Run Causality	Long-run causality
	Δ (FD)	Δ (REER)	ECT(-1)
Δ (FD)	-	2.694 (0.097)*	-0.153540 [-1.975]**
Δ (REER)	0.036 (0.849)	-	5.833045 [0.647]

Notes: The figures which is ***, **, * show 1%, 5% and 10% levels, respectively.

In the long run, there is no causation linkage running from real exchange rate to financial depth for the panel group. But causation linkage running from financial depth to real exchange rate exists in the long run and significance level is 5%. This is consistent with short run causality findings. In this regard, neither in the short nor in the long run, real exchange rate does not affect financial depth. Interestingly, financial depth affects real exchange rate volatility in both short and long run.

Table 6. Emirmahmutoğlu and Köse (2011) panel causality test results

Country	Lag	FD#>REER	REER#>FD
Brazil	2	1.975 (0.372)	0.034 (0.983)
Russia	1	1.335 (0.247)	0.000 (0.986)
China	1	1.233 (0.266)	0.240 (0.623)
South Africa	2	8.269 (0.016)**	1.591 (0.451)
Fisher Stat.		15.677 (0.047)**	2.596 (0.957)

Notes: The figures which is ***, **, * show 1%, 5% and 10% levels, respectively.

Panel causality test method developed by Emirmahmutoğlu and Köse (2011) permits country-based causality analysis, besides group results. According to results, there is no causation linkage running from real exchange rate to financial depth in any country. Financial depth affects real exchange rate only in South Africa and significance level is low, 5%.

5. Conclusion

In this study, possible effects of exchange rate on financial depth in Russia, Brazil, China and South Africa between years 1994 and 2018. Because of absence of data belonging to the Indian economy, it is not possible to complete acronym BRICS and that is why acronym covers four of five.

The advanced panel data methods which take cross section dependency into account are employed. In the light of empirical findings obtained from these empirical methods, exchange rate volatility does not affect financial system in any economy. This may stem from public sector dominance in the banking sector, except South Africa. A possible volatility in exchange rate may not affect banking sector liquidity and size because of governments' persistency in the sector. Despite of all negative effects of exchange rate fluctuations, banks can provide liquidity and do not go to contractionary behaviors. This may be a kind of government policy.

In the South African case where, public banks are not dominant in the financial system, size of private banks are big enough to leaning against exchange rate fluctuations. So, it is possible to conclude that in financial systems, where dominance of public sector is high, it is possible to implement floating exchange without a fear of financial system's health. The policy makers can choose floating and/or fixed exchange rate.

The second finding of empirical analysis is uni-directional causality running from financial depth to exchange rate fluctuation. Financial depth affects exchange rate volatility in the short and long run. Despite of weak interaction, existence of causation linkage running from financial depth to exchange rate may be sight of relatively developed financial system in these economies. Especially, Emirmahmutoglu and Köse (2011) causality test results presents causation linkage in South Africa. This finding also supports a possible result of an advanced financial system.

When the results compared with existing literature, it is possible to emphasize that results of this study confirm the findings of Fujiware and Tenashi (2011). Also findings of Bahri and Sarmidi (2019). They have found that increasing level of development mitigates the effect of exchange rate volatility. In this regard, banking system that relatively developed and highly supported by public sector, mitigates the effects of exchange rate volatility.

In the light of explanations above, it is possible to conclude that level of financial development to reduce effects of exchange rate volatility on financial depth. To do this, it might be suitable to support of government on banking system till it is big enough to reduce external risks. This might be a government policy of developing and emerging market economies.

For the future studies, it is possible suggest that effect of exchange rate volatility on financial system can be measured not only via financial depth but also via financial access and financial efficiency measures. This would increase the robustness of findings of exchange rate volatility and financial system interaction.

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Debt-financed public investment in developing countries: Does the efficiency of public investment matter?

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Abstract. *Public investment is central to implementing the UN 2030 Agenda for Sustainable Development – but persistent levels of high public debt without sufficient debt-servicing capacity poses serious risks. This study examines whether government spending efficiency is associated with differential effects of public investment on debt-to-GDP ratio for a panel data consisting of 16 developing countries in Asia-Pacific region over the period 2007-2017. The empirical results indicate that public investment efficiency moderates debt-to-GDP ratio whereas public investment in the midst of public sector corruption accentuates debt-to-GDP ratio. The results have important policy implications.*

Keywords: public debt, government spending efficiency, public investment, public sector corruption.

JEL Classification: E62, H54, 043.

1. Introduction

Meeting the UN Sustainable Development Goals (SDGs) requires sustained mobilization of large-scale resources. Increased public spending in important areas like health, education and infrastructure is often cited in policy circles as a crucial avenue to close the gap – but this could undermine fiscal and debt sustainability. However, while debt-financed public investment could raise a country's debt ratios, it can also generate higher growth and revenues, leading to lower debt ratio, if debt is used productively.

The IMF and World Bank (IMF-WB) uses the debt sustainability analysis framework (DSA) to identify excessive borrowing that undermines macroeconomic stability. The DSA has helped countries to monitor their risks of debt distress, though it has been criticized for various reasons (Buffie et al., 2012). For example, the existing joint World Bank-IMF Debt Sustainability Framework (DSF) does not distinguish debt directed to productive investments. Wyplosz (2007) argued that the IMF-WB DSA analysis does not adequately consider the link between public investment and growth; it does not capture some key factors concerning the structure of a country's economy, such as the absorptive capacity of the country, efficiency of public investment, and the return on investment in infrastructure which have enormous impact on the outcome of public investments.

Increased public investment may result in reduced output gains if efficiency in the investment process is not enhanced. Public investment efficiency gains can contribute to achieving the Sustainable Development Goals (SDGs) – particularly in developing countries characterized by limited resources. According to a 2017 McKinsey report, there is ample room to improve the effectiveness and efficiency of infrastructure investment. For example, up to 38 percent of global infrastructure investment is not spent productively because of inefficiencies. The efficient provision of public infrastructure can reduce spending by more than \$1 trillion a year for the same amount of infrastructure delivered – and the savings can help in closing the SDG financing gap.

The link between efficiency and public investment is markedly important in the context of poor governance and rudimentary public investment systems. Public sector corruption is commonly considered as an innate characteristic of the developing world. Corruption alters the whole decision-making process connected with public investment projects. Tanzi and Davoodi (2000) assert that corruption can affect investment in different ways; corruption may affect (a) the size of public investment, and (b) the quality of investment decisions and investment projects.

Consequently, the purpose of this paper is to empirically investigate the following two hypotheses: 1) The interaction of public investment combined with government spending efficiency tends to decrease debt ratios. 2) The interaction of public investment combined with public sector corruption tends to increase debt ratios, *ceteris paribus*.

This paper is organized as follows. Section 2 introduces issues of public investment, growth and debt ratios. Section 3 discusses related research studies. Section 4 explores the debt composition. Section 5 explains the data and results. Section 6 presents the conclusions.

2. Public investment

Following the work of Delong and Summers (2012) and Abiad et al. (2017), this section presents theoretical framework for understanding the effect of public investment on output growth and public debt and how public investments can raise output and be self-financing in the long run.

An increase in public investment boosts aggregate demand through the short-term fiscal multiplier, and the magnitude varies with the state of the economy (Auerbach and Gorodnichenko, 2013). This, in turn, affects the debt-to-GDP ratio, which could increase or decrease depending on the magnitude of the fiscal multiplier and the elasticity of revenue with respect to output. As demonstrated in Abiad et al. (2017) and Delong and Summers (2012); in the short term, an increase in public investment as a share of potential GDP (Δi) (leads to a change in the debt-to-potential GDP ratio ($\Delta \delta$) given by:

$$\Delta \delta = (1 - \mu\tau)\Delta i. \quad (1)$$

In which μ is the fiscal multiplier and τ is the marginal tax rate

The efficiency of public investment is central to determining the size of the fiscal multiplier and the elasticity of revenue with respect to output. Inefficiencies in the public investment process, such as poor project selection, implementation, and monitoring, can result in a fraction of public investment turning into productive infrastructure, undermining the long-term output gains (Pritchett 2000).

Public investment efficiency contributes to higher output by increasing the stock of capital. The extent to which increases in public capital can raise output is a key factor in determining the sequence of public debt-to-GDP ratio. Over time, the increase in public capital will affect the debt-to-GDP ratio by affecting the annual debt-financing burden, which is equal to the difference between the real government borrowing rate (r) and the GDP growth rate (g) multiplied by the initial change in the debt-to-GDP ratio:

$$(r - g) \Delta \delta = (r - g) (1 - \mu\tau)\Delta i \quad (2)$$

How the financing burden will affect the debt-to-GDP ratio in the long term depends on the parameters of equation (2) and the elasticity of output to public capital, ε . In the long term, an increase in public investment may lead to an increase in output (Y), which will generate long-term future revenues:

$$\tau \Delta Y = \tau \varepsilon y_o \Delta i \quad (3)$$

Where ε is the long-term elasticity of output to public capital and is the initial output-to public capital ratio. Equations (2) and (3) jointly imply that if the returns to public capital (short-term multipliers and the elasticity of output to public capital) are large enough, such that:

$$(r - g) (1 - \mu\tau) - \tau \varepsilon y_o \Delta i \leq 0.$$

Then an increase in public investment will be self-financing.

3. Related literature and studies

A wide range of empirical literature has emerged over the last two decades showing that the quality of institutions matter for development. Such findings elevated governance as a determinant of economic development. Studies that are directly related to public debt are those that consider the effect of corruption on debt. Kaufmann (2010) points to a strong correlation between corruption and fiscal deficits in industrialized countries; it suggests that if Greece's levels of corruption was the same to Spain, its budget deficit over the last five years would be 2.5% of GDP rather than 6.5%. Grechyna (2012) builds a model that relates the level of government debt to the degree of corruptness of public officials in developed economies and finds that public corruption results in higher public debt levels. Gonzalez-Fernandez and Gonzalez-Velasco (2014) used panel data to analyze the relationship between the shadow economy and corruption as determinants of public debt and their results find that corruption has positive and significant impacts on regional public debt in Spain.

Debt burdens are of great concern to developed countries, but the developing country debt crises is of greater concern and a recurrent phenomenon. Jalles (2011) examined the role of corruption in the association of public debt with economic growth for a panel of developing countries over the 1970-2005 period. Their results conclude that countries with lower corruption are able to use and manage their debt better. Melecky (2012) points out that good public debt management can reduce borrowing costs and curb financial risks but are more likely to appear in countries with good quality institutions. Megersa and Cassimon (2015) studied a sample of 57 developing countries and found that debt is detrimental for growth, however, harm is reduced while controlling for the quality of public sector management. A comprehensive study by Cooray et al. (2017) examined the relationship between corruption and public debt in 106 countries over 1996-2012 and found that increased corruption leads to an increase in public debt.

A similar study by Kim et al. (2017) examined the relationship between public debt and growth across countries over the period 1990-2014 and conclude that the interaction term between public debt and corruption is statistically significant which implies that the effect of public debt on economic growth is influenced by corruption. A recent paper by Benfratello et al. (2018) used data from a large panel of countries over the period 1995-2015 to investigate the effect of corruption on public debt. Overall, the estimates show that corruption increases public debt. A regional study by Njangang (2018) examined the effects of corruption on public debt on a panel of 29 sub-Saharan African countries for the period 2000-2015 and the results show that corruption has a positive effect on public debt.

Less focus has been paid to possible interactions between government spending efficiency, public investment and public debt. This is important because public investment will continue to be fundamental in financing development goals which has the tendency to raise debt ratios. Therefore, addressing spending inefficiencies is critical – countries need to spend not only more, but better. We conjecture that countries could make significant savings through efficiency improvements.

In several countries, increased public investment does not lead to productive capital (Pritchett 1996). A significant proportion of the expected returns from spending on health,

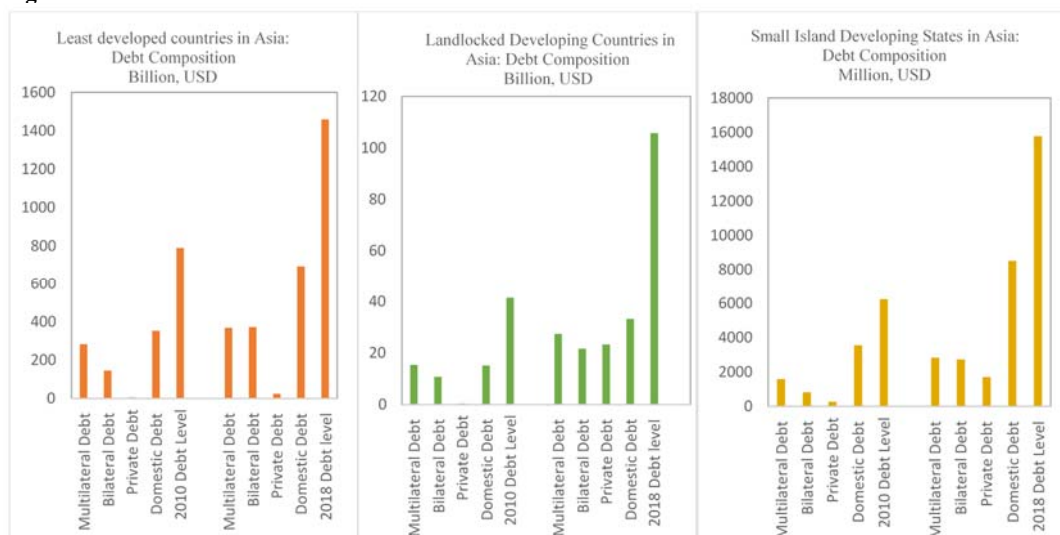
education, and infrastructure is lost due to spending inefficiencies. In the area of health, Grigoli and Kapsoli (2018) find that countries with low efficiency index could raise life expectancy by up to five years through addressing inefficiencies. In the area of education, Grigoli (2015) finds that addressing inefficiencies could help increase secondary school enrollment by 30 percentage points in developing countries. In the area of infrastructure, IMF (2015) finds that more than 30 percent of investment is lost through inefficiency with larger losses in developing countries. In addition, cross-country regressions by (IMF, 2015) suggests that the quality of institutions is the main determinant of public investment efficiency and the efficiency scores are a function of a set of explanatory variables such as the quality of institutions, measured by control of corruption and regulatory quality. Overall, the estimates show a positive relationship between public investment efficiency and the quality of institutions.

Efficiency refers to the case where public goods and services are provided at the minimum cost. High levels of corruption, for example, may be a cause of public investment inefficiency. This research study is novel attempt to examine the effect of public investment efficiency on debt-to-GDP ratios in selected developing countries in Asia-Pacific countries.

4. Debt composition

Developing countries mobilize part of their resources by borrowing from internal and external sources to finance their development activities. These sources gradually build up the debt stock of the country. Such debt stock demands regular debt servicing, that is, principal and interest payments, which consume scarce resources that can be used for financing development. Excessive borrowing to finance deficits drains the resources of the developing countries through higher cost of servicing debts.

Figure 1



Source: World Bank International Debt Statistics.

Figure 1 shows that in least developed countries (LDCs): multilateral debt increased marginally on aggregate; some countries increased their borrowing while others reduced their borrowing. However, bilateral debt doubled; it increased for all countries but in particular for Cambodia, Laos, and Myanmar. Private debt which is commercial borrowing from external private creditors (i.e. international capital market) saw a significant increase as a result of Laos whose outstanding loans jumped from USD 2.3 million in 2010 to 1.8 billion in 2018. Domestic borrowing recorded the highest increment; dominated by Bangladesh which saw its debt balloon from USD 16 billion to 56 billion. Domestic debt accounts for 50% of the total public debt. Overall, bilateral debt and domestic debt seem to be the increasingly major sources of financing.

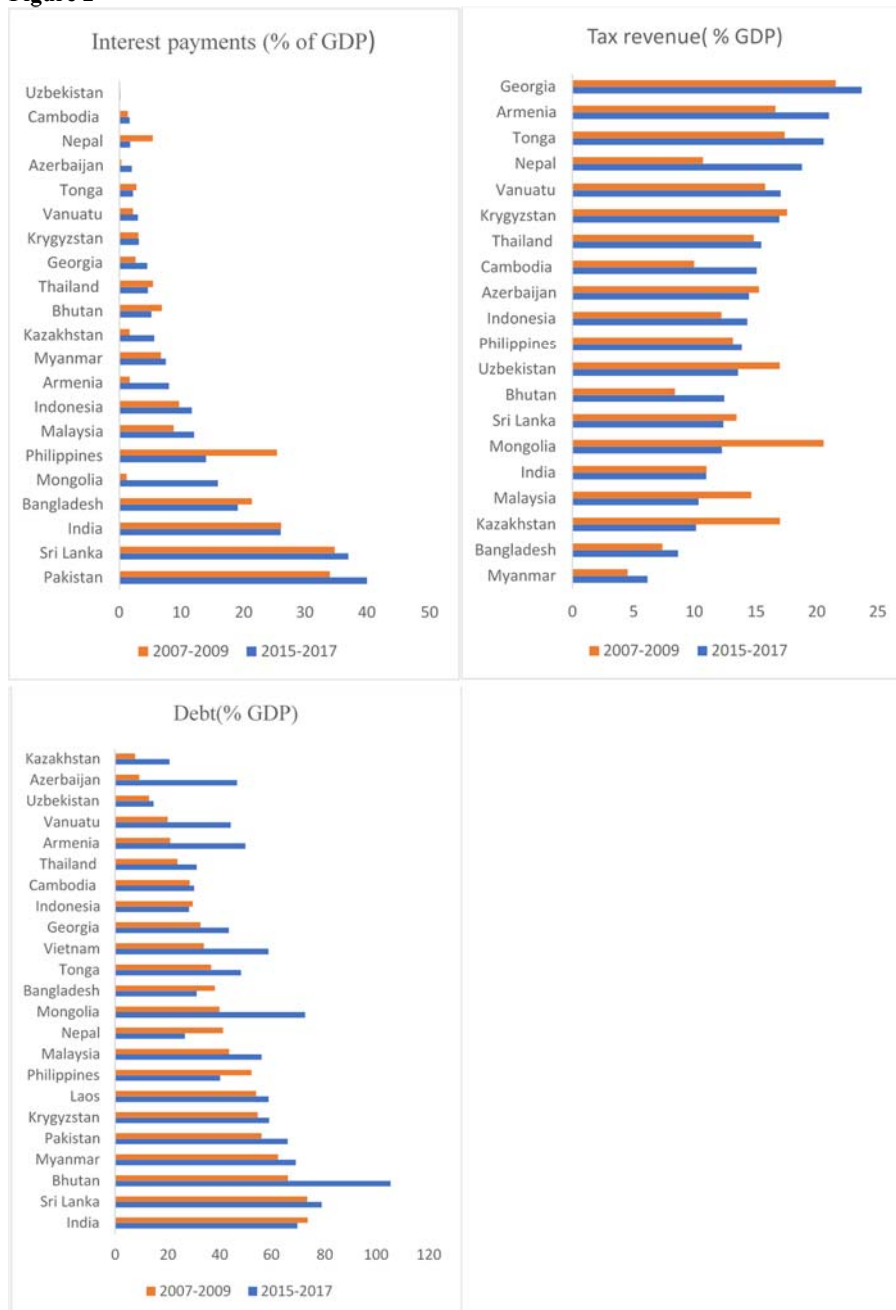
In landlocked developing countries (LLDC): multilateral debt increased for all countries except in Laos. Bilateral debt more than doubled on aggregate; only Turkmenistan saw a decrease in bilateral debt. Private debt went up from almost non-existent in 2010 to USD 23 billion in 2018, thanks to Laos, Kazakhstan and Mongolia. Domestic debt increased in all countries dominated by Turkmenistan and Kazakhstan, while Kyrgyzstan and Afghanistan have no domestic debt. External private debt and domestic debt now account for over 50% of the total public debt.

In small island developing states (SIDS): multilateral debt increased on aggregate – Papua New Guinea took the lead from USD 712 million to 1.6 billion. Fiji doubled its multilateral debt to USD 131 million. Bilateral debt increased in all countries and PNG accumulated the largest debt stock at USD 1.2 billion. Samoa, Solomon Islands, Timor Leste, Tonga, and Vanuatu have no external private borrowing; again, PNG recorded the biggest increment from USD 33 million to 1 billion. Domestic debt increased in almost all the countries; Solomon Islands reduced its domestic debt while PNG reported the largest increase with a debt stock of USD 4.9 billion. Domestic debt now accounts for more than 50% of the total public debt.

On average, multilateral debt seems to be running out of steam as bilateral debt fills the void. However, developing Asia Pacific countries have raised their appetite for commercial debt; not only is debt growing, its structure is changing. The share of commercial – and more costly – debt has increased.

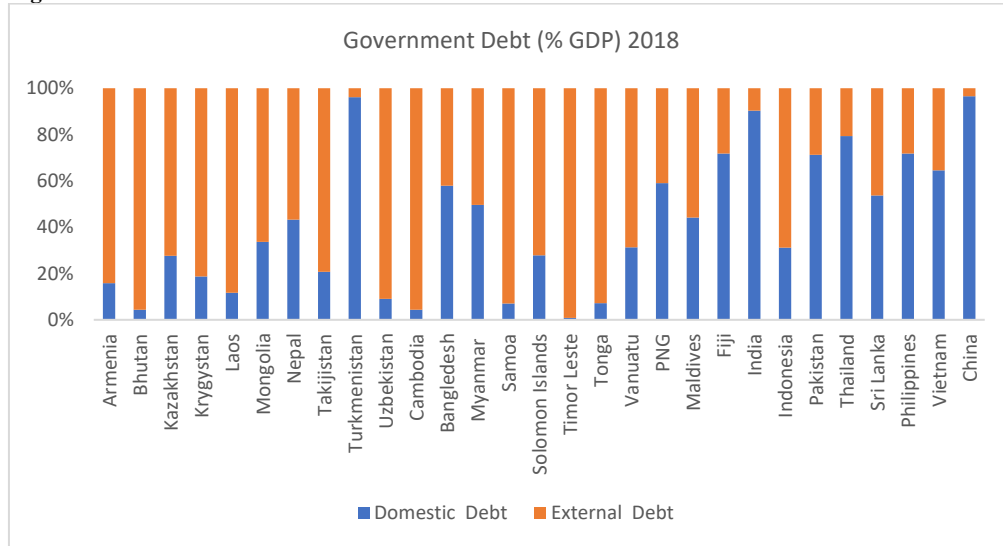
Figure 2 shows debt-to-GDP ratio varies across countries. Bhutan, India, Mongolia, and Sri Lanka have all surpassed the 60% threshold, while others such as Uzbekistan, Kazakhstan, Indonesia and Nepal have more fiscal space. Countries can have high debt-to-GDP ratio and not be in debt distress or at high risk of debt distress. Composition of debt matters. For example, Bhutan has a debt-to-GDP ratio above 100%. Bhutan's interest payment as a percentage of revenue is relatively low at 5% – mainly because its public debt are largely concessional loans. However, interest payments in Sri Lanka is significantly higher at 36% than Bhutan despite similar tax revenue and higher debt-to-GDP ratio. Sri Lanka's debt composition is markedly different; non-concessional loans in 2006 as % of GDP was 7% and increased to 55% in 2018. Concessional loans exert far less pressure on debt service obligations than commercial loans, and it is the major reason (among others) why interest payment is high in Sri Lanka.

Figure 2



Source: World Bank Development Indicators.

Figure 3

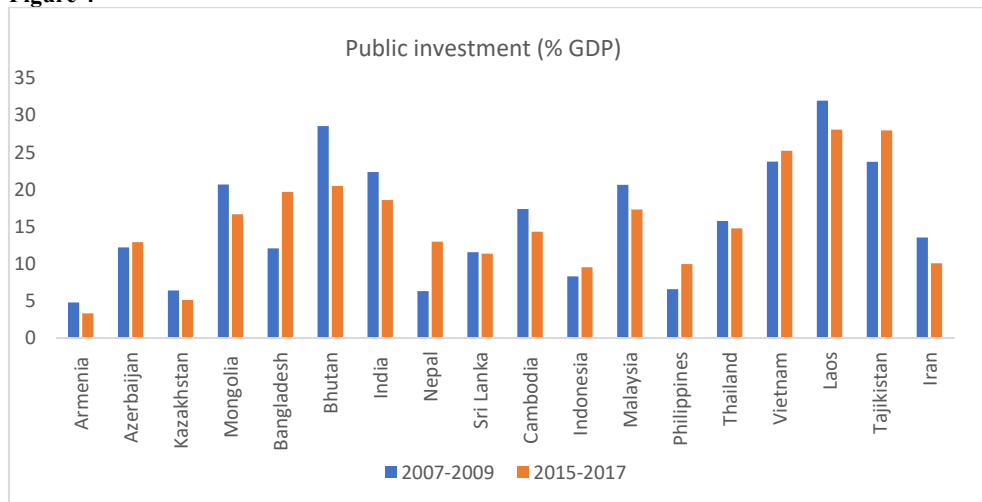


Source: World Bank International Debt Statistics.

Debt composition indeed matters for debt sustainability.

Figure 3 shows China, Turkmenistan and India have the lowest external debt as a percentage of total government debt while Bhutan, Cambodia and Timor Leste have the highest external debt. The choice between external and domestic financing is not the focus of this research. However, in low-income countries, highly concessional external debt is usually a better choice to domestic debt in terms of financial risks and costs, even in the face of a probable devaluation, subject to some caveats.

Figure 4



Source: IMF Investment Dataset.

Figure 4 shows public investment ranges from 3.3% to 32% with an overall average of 15.5 per cent. Armenia, Kazakhstan, Nepal, Philippine and Indonesia recorded the lowest values in the period 2007-2009 while Bhutan, Laos, Vietnam, and Tajikistan recorded the highest values. Public investment fell or remained the same in most of the countries except the case of Bangladesh, Nepal and Philippines – Nepal doubled its public investment. However, it is a good idea to look at public investment in relation to government debt. Armenia's debt to GDP ratio jumped from 21% to 45% and within the same period, public investment shrank from 5% to 3%. Kazakhstan's debt to GDP ratio went from 9% to 20% and within the same period, public investment reduced from 6% to 5%. Sri Lanka's debt to GDP ratio is almost 80% but public investment is 12%.

In comparison, Laos has a smaller debt to GDP ratio of 59% but public investment is 28%. The same goes for Vietnam with debt to GDP ratio of 58% but public investment is 25%. Some countries have low debt to GDP ratio and also low public investment for example Indonesia and Kazakhstan which means there is ample room to scale up public investment. Nonetheless, public investment has generally not been scaled up commensurately with the increase in public debt, and where this is significantly the case, public debt went into government consumption and/or debt repayments.

5. Data and estimation results

The data covers the 2007-2017 period for 16 Asia-Pacific countries: Armenia, Azerbaijan, Bangladesh, Bhutan Cambodia, Indonesia, India, Kazakhstan, Malaysia, Mongolia, Nepal, Philippines, Sri Lanka, Thailand, Uzbekistan, and Vietnam. The estimation is carried out using panel fixed effects regression⁽²⁾. The countries are chosen due to data availability. Time frame is chosen due to limited data for government spending efficiency measure. The dependent variable is the ratio of public debt to GDP, which is measured as the central government debt, total (% of GDP). Central government debt refers to the debt by the federal government, while general government debt refers to overall debt, including states and municipalities. The independent variables of interest are the interactions between public investment, government spending efficiency and public sector corruption.

We measure public investment as general government investment (% of GDP). We measure government spending efficiency as how efficient is the government in spending public revenue (1 – extremely inefficient; 7 – extremely efficient). We measure public sector corruption using the Corruption Perceptions Index (CPI): an index published annually by Transparency International which ranks countries by their perceived levels of public sector corruption, as determined by expert assessments and opinion surveys. The CPI generally defines corruption as the misuse of public power for private benefit. Here the estimate of corruption ranges from 0 (totally corrupt) to 100 (totally not corrupt). The control variables are: GDP per capita growth (annual %), GDP growth may not translate into growth in GDP per capita due to population growth; trade openness, the sum of imports and exports by GDP; inflation, the percentage change in the GDP deflator; and interest payments, (% of revenue).

Table 1 shows the regression results. The effect of public investment on debt to GDP ratio is ambiguous; however, it has no significant effect on the ratio of public debt to GDP in both regressions. More importantly, public investment x government efficiency has a statistically significant negative effect on the ratio of public debt to GDP. On the other hand, public investment x public sector corruption has a statistically significant positive effect on the ratio of public debt to GDP. The results imply that the multiplier effect of increased public investment in more corrupt countries is relatively lower whereas the multiplier effect of increased public investment in countries with more efficient public spending is relatively higher. This is somewhat similar to Abiad et al. (2015) results that found public investment shocks lead to significant medium-term reduction in the debt-to-GDP ratio of countries with high public investment efficiency but increase debt-to-GDP ratio in countries with low public investment efficiency in a sample of developed countries. However, our research focused on a sample of developing countries which have relatively weak public investment management institutions – and introduced public corruption index as a robustness check.

The growth of GDP per capita as expected has a statistically significant negative effect on the ratio of public debt to GDP in both regressions. Higher growth lowers the overall debt-to-GDP percentage. Conversely, declines in the long-run economic growth rate drive increases in the debt-to-GDP ratios. The higher the inflation, the lower the ratio of public debt to GDP; inflation can rise and decrease the real value of the domestic debt if debt is denominated in its own currency; however, inflation can also rise and increase the real value of the external debt through exchange rate depreciation. The net effect depends on the debt composition. The higher the interest payments, the higher is the ratio of public debt to GDP; higher interest payments increase the cost of refinancing the stock of existing debt. The more open an economy becomes, the higher the ratio of public debt because changes in a country's export and import prices affects the decision to issue new debt. In addition, capital account openness facilitates capital inflows which results in higher debt levels. The regression estimates should be interpreted with caution due to the sample size. However, the central message remains the same: public investment efficiency indeed matters in moderating or accentuating public debt ratios.

Table 1

Dependent Variable:	Debt to GDP ratio		Debt to GDP ratio
Independent Variables	Fixed effect (1)	Independent Variables	Fixed effect (2)
Lag Debt ratio to GDP	0.766*** (0.5216)	Lag GDP PerCapita Growth	0.817*** (0.0828)
Public Investment*Efficiency	-0.0408* (0.0228)	Public Investment*Corruption	0.0181* (0.0099)
Government Efficiency	0.6904 (0.3468)	Corruption	0.0168 (0.0645)
Public Investment	1.323 (0.9184)	Public Investment	-0.746 (0.491)
GDP Per Capita Growth	-0.7233*** (0.1346)	GDP Per Capita Growth	-0.571*** (0.0507)
Trade Openness	0.0581 (0.0639)	Trade Openness	0.0323 (0.2445)
Inflation	-0.295*** (0.0749)	Inflation	-0.257** (0.0621)
Interest Payment	0.4188*** (0.142)	Interest Payment	0.154* (0.0916)
Constant	-15.84 (15.51)	Constant	8.67 (9.99)
Time effects	Yes	Time effects	Yes
Country fixed effects	Yes	Country fixed effects	Yes
Observations	149	Observations	150
R-sq	0.91	R-sq	0.95
No. of countries	16	No. of countries	16

Note: Robust standard errors reported in parenthesis. ***, **, * Denotes significance level at 1%, 5%, 10%, respectively

6. Conclusion

This study examined the effects of public investment efficiency on debt ratios. The empirical results show that public investment efficiency has a statistically significant negative effect on public debt which implies that public investment efficiency moderates the positive effect of public investment on debt to GDP ratio. However, when public investment interacts with public sector corruption, the variable becomes positive and statistically significant which supports the claim that public investment in the midst of corruption worsens debt ratios. The research study has important policy implications: improving actions against public sector corruption or raising the efficiency of public investment could help moderate debt ratios.

Notes

- (1) Anyanwu was a Consultant with the Macroeconomic Policy and Financing for Development Division, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand.
- (2) The Hausman test lends support to fixed effect over random effect.

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Appendix A

Definition and sources of variables used in the regression analysis

Variable	Definition	Source
Government debt	Central government debt (% of GDP)	IMF's Global Debt Database
Public investment	General government investment (% of GDP) in constant 2005 international dollars	IMF Investment and Capital Stock Dataset
Corruption Perceptions Index	The CPI measures public sector corruption.	Transparency International
GDP per capita growth	Annual percentage growth rate of GDP per capita based on constant local currency	World Bank's World Development Indicators
Government efficiency	Government spending efficiency	World Economic Forum
Trade openness	Exports plus imports as percent of GDP	World Bank's World Development Indicators
Inflation	GDP deflator (annual %)	World Bank's World Development Indicators
Interest payment	Interest payments (% of revenue)	World Bank's World Development Indicators

Appendix B

Sample of countries used in the regression analysis

Asia-Pacific countries	
Armenia	Malaysia
Azerbaijan	Mongolia
Bangladesh	Nepal
Bhutan	Iran
Cambodia	Philippines
Indonesia	Sri Lanka
India	Thailand
Kazakhstan	Vietnam

Appendix C

Summary statistics of variables used in the regression analysis

VARIABLES	Obs.	Mean	Std. Dev	Min	Max
Debt % of GDP	220	41.83	20.46	5.87	114
Public investment as % GDP	220	15.9	7.9	2.35	37.8
Public sector corruption	220	32	10	18	67
GDP per capita growth	220	4.29	3.54	-13.5	24
Trade openness	220	84.6	37	35	200
Inflation	220	7.03	7.06	-18.9	39.2
Interest payment as % revenue	165	10.4	10.4	0.165	42.6
Government efficiency	211	3.39	0.67	1.63	5.07

Dynamic connection between macroeconomic variables and sectoral stock returns: Evidence from India

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Abstract. *The present study attempts to assess the impact of institutional investments, foreign direct investment, index of industrial production, interest rate, inflation rate, exchange rate, gold rates and oil prices on the sectoral indices of NSE using monthly data from 01/01/2009 to 30/12/2019. The study is covering four sectoral indices financial services, FMCG, IT and oil and gas which cover almost 78% of market capitalisation of NSE. An autoregressive distributed lag (ARDL) model is used to examine the short run and long run method co-integration between macroeconomic variables and stock market performance as the variables are integrated of different order. The outcomes of the study find that in the long run institutional investment and index of industrial production are the major determinants and in the short run, the major determinants are index of industrial production, wholesale price index and exchange rate. Government must focus on these areas to efficiently run the stock market.*

Keywords: co-integration, ARDL, financial services, FMCG, IT, oil and gas.

JEL Classification: C32, C53, C58, E44, G1.

Introduction

Capital market plays an imperative role in the monetary intermediation of any economy of the world as it can lift the economic growth and prosperity by stabilising the financial sector and providing a vital investment channel that contributes in attracting domestic and foreign capital (Ahmad et al., 2015). Formerly a country was considered strong and capable if it demonstrated a sustained growth of Gross Domestic Product (GDP) and per capita income. But, of late it has been recognised that stock market exerts greater influence on national economy. Market capitalisation, savings, investment, performance of stock market, sound banking and insurance system are considered to be key indicators of economic growth (Tripathi and Seth, 2014).

Over the past few decades, the interaction of share returns and the macroeconomic variables has been a subject of interest among academics and practitioners (Gan et al., 2006; Zakaria and Shamsuddin, 2012). The theoretical motivation for this connection lies in dividend discount model (DDM), capital asset pricing model (CAPM) and arbitrage pricing theory (APT). These models provide the sound basis of associations between macroeconomic environment and stock prices (Ashwani and Sheera, 2018). Moreover, these models also helps in forecasting the changes in stock prices after the arrival of anticipated or unanticipated new information about expected future dividends, GDP, production, inflation, interest rates, and exchange rates etc.

For investors, ascertaining the macroeconomic variables volatility could help them to accurately forecast stock prices movements. If the volatility of macroeconomics variables can be used as reliable indicators for the stock market volatility, it can also help them in managing their investment portfolios. Meanwhile, from the macroeconomic point of view, it is crucial for policymakers to be able to recognize interactions between stock market volatility and macroeconomic volatility. If stock market volatility leads macroeconomic volatility, policymakers could use stock market volatility as a leading indicator to forecast future macroeconomic volatility. On the other hand, if stock market volatility does not lead macroeconomic volatility, it is not wise for a policy maker to focus on stock market volatility in order to reduce macroeconomic volatility. Therefore, it is worthwhile to determine whether macroeconomic volatility can explain stock market volatility, or vice versa (Zakaria and Shamsuddin, 2012).

Even though there are numerous studies available on the impact of macroeconomic fundamentals on stock market indices, but most of these studies usually focused on developed economies and also ignored the impact of these macroeconomic variables on sector specific stock market indices in developing Asian countries. The present study is going to consider the effect of major macroeconomic variables on the sectoral stock prices of Indian stock market. It is necessary for an investor to have a good knowledge on the relationship between the macroeconomic variables and sector specific stock market performance as it would enhance the ability of investors to make optimal decision in the diversification of their business investments.

Literature review

A number of studies have shown the influence of macroeconomic variables on stock market performance and also on sectoral stock indices in different countries. In a study conducted by Wasserfallen (1989) revealed that changes in interest rates and price levels have negative impact on stock market returns.

Another study conducted by Maysami et al. (2004) on Singapore's stock market index (STI) and Singapore Exchange Sectoral indices clinched that stock market index and property index formed association interest rates, industrial production, price levels, money supply and exchange rate in long as well as in short run. Filis (2010) used Hodrick-Prescott (HP) and Baxter and King (BK) series filters to remove cyclical components of time series and found suggested Greek stock market is negatively influenced by oil prices and inflation whereas industrial production affects the stock market in a positive way and suggested Greece should pay more attention to oil price shocks as these shocks influence its stock market and also to inflation.

Another study on stock price movements in Cote d'Ivoire by Herve and Chanmalai (2011) confirmed the existence of strong bi-directional liaison between stock price index and domestic interest rate. The study also suggested that variations in the domestic interest rate might be used to predict the future stock price movement whereas other macroeconomic factors are not appropriate indicators to forecast the future behaviour of the stock index movements. Singh et al. (2011) also conducted a study on Taiwan stock market using stock portfolio consisting of market capitalisation, P/E ratio, Price to Book ratio, yield and five crucial macroeconomic variables employment rate, exchange rate, GDP, inflation rate and money supply and revealed that exchange rate and GDP had significant relationship with all the portfolios but inflation rate, exchange rate and money supply were having negative relationship with returns for portfolios of big and medium companies.

In a study conducted by Hosseini et al. (2011) on macroeconomic variables and stock market indices of India and China found that, in the long-run, increase in crude oil price and money supply has a positive impact in China but the effect is negative for India while in the short run, the effect of crude oil prices is positive in India but for China it is negative and insignificant. The effect of industrial production is negative in China and the impact of money supply and inflation is positive on Chinese market but for Indian market, the effect is negative. More so, Kibria et al. (2014) concluded that macroeconomic variables have significant positive impact on KSE 100 index of Pakistan.

Furthermore, Tripathi and Seth (2014) studied the casual relationship between macroeconomic variables and stock market indicators namely BSE India Sensex, BSE India market capitalization and BSE India market turnover and found significant correlation among the explanatory variable and also identified three principal factors through factor analysis viz Inflation, interest rate and exchange rate. The study finally concluded that it is not the real economic variables that precede stock market movements but stock market precedes the real economy more.

Wongbangpo and Sharma (2002) demonstrated the presence of long run and short run relationships between stock prices and macroeconomic variables. Tripathi et al. (2015) also found a long term relationship between FDI and six macroeconomic variables i.e. exchange rate, inflation, GDP/IIP, interest rate, trade openness and S&P CNX 500 equity index. Ahmad et al. (2015) found that foreign direct investment, consumer price index, interest rate and oil price have a significant positive influence on stock market development in the long-run while Money supply has a significant negative influence on the stock market development.

Adebayo (2016) in a study on Nigerian stock exchange negative effect of interest rate, inflation rate, lending rate and unemployment on market capitalization however there was positive but insignificant relationship between market capitalization and GDP. Mehrara et al. (2016) in a study Tehran's stock exchange found that inflation, exchange rate and GDP had significant impact on stock market volatility and also concluded that the effect of fiscal policies such as tax revenues and government expenditure is more than monetary policy factors on stock prices. Bahloul et al. (2017) examined the Islamic stock market return and volatility for twenty developed and emerging markets using Markov switching regression models and found that conventional stock returns and changes in money supply had significant impact on Islamic index returns in both low and high volatility regimes for developed and developing markets while the estimated coefficients of other variables were significant in low volatility regime.

Mohammad et al. (2017) examined the significance of macroeconomic variables in effecting the performance of selected SAARC using OLS multiple regression model and found that macroeconomic variables i.e. exchange rate, foreign currency reserve and interest rate are all statistically significant in affecting stock market performance of SAARC countries. But inflation rate and money supply do not have a significant relationship in affecting the stock market performance. Mwaanga and Njebele (2017) in a study on Zambia stock market found the existence of long-run integration and as a result of these co-integrating relationships, there are possibilities for investors to earn excess returns. But, if the markets are efficient, the investors would not be able to earn any abnormal returns because the security prices will adjust rapidly to the arrival of new information, then the current prices will reflect all information about the security.

Megaravalli and Sampagnaro (2018) examined the long-run and the short-run relationship between India, China and Japanese stock markets and key macroeconomic variables such as exchange rates and inflation by using pooled mean group estimates and showed that exchange rate had a positive and significant long-run effect on stock markets while the inflation had negative and insignificant long-run effect. In the short run, no statistically significant relationship exists between macroeconomic variables and stock markets returns. Ashwani and Sheera (2018) used ARDL model and MIDAS (Mixed Data Sampling) GARCH approach to examine the role of macroeconomic variables and concluded that all the variables had significant impact on stock market volatility. However, the level of exchange rate and inflation are negatively associated with the stock market volatility.

Natchimuthu and Chellaswamy (2018) investigated the dynamic relationship between foreign and domestic institutional investments with NIFTY returns in India and found that net FII investment in India is influencing the net DII investment but net DII investment was not influencing the net FII investment. NIFTY returns were influencing both DII and FII investment but both DII and FII were not causing NIFTY returns. So, the study finally concluded that NIFTY returns are the cause for FII and DII not the effect.

Amudha and Muthukamu (2018) examined the volatility and leverage effect among the Auto sectorial indices of NSE stocks. The study revealed that majority of the selected stocks experienced high volatility during the study period and leverage effect also exists in the Indian equity market where negative shock cause more volatility than the positive one of the same magnitude.

Sutrisno (2017) found that macroeconomic variables such as interest rate, inflation rate and exchange rate have significant impact on the sectorial indices in Indonesia. The interest rate had a significant but negative influence on all sectors except basic industry and chemical, finance, infrastructure, utilities, and transportation, and miscellaneous industry sectors. The inflation rate partially had no significant effect on the sectorial indices whereas exchange rate partially had a significant negative impact on all industries.

Jambotkar and Raju (2018) analyzed the impact of Macroeconomic variables on the selected NSE sectorial indices series and concluded that the relationship between banking sector and financial services sector is very high but it is moderate between other sectors. From the OLS method, it was revealed that exchange rate had a significant but negative impact on all the sectorial indices share prices. The value of R square was very less which means the other factors which bring changes in the sectorial share prices were not considered in the study.

Joshi and Giri (2015) examines the relationship of sectoral GDP by using manufacturing sector, electricity, gas and water supply sector and service sector with their sectoral stock indices by using various econometrics techniques and suggested sectorial indices are affected significantly by changes in sectoral GDP in the long run and in the short run all the indices are sensitive to the changes in crude oil price. The study also found long run causality running from manufacturing index and electricity, gas and water supply index but no such causality found from service sector index. The study also suggested crude oil price is a common variable which plays an important role in all the indices and reflect maximum information about all the indices.

Chandrashekar et al. (2018) explored the role of macroeconomic variables and stock market index of India and Brazil with the help of panel analysis and concluded that IIP and exchange rate have positive impact on the stock market whereas interest rate and inflation negatively affected the stock market index.

A study conducted by Menike (2006) on stock prices in Colombo stock exchange concluded that stock prices have negative relation with exchange rate, interest rate, money supply and direct relation with interest rate. Hunjra et al. (2014); Zakaria and Shamsuddin

(2012) examined the association between the stock market volatility and macroeconomic variables and found that there is no short run but a long run relationship exists between the stock prices and macroeconomic variables. In an another study concluded by Ilahi et al. (2015) found exchange rate, inflation rate and interest rate have insignificant relation with stock market returns.

Data sources and estimation techniques

The present study has tried to appraise the impact of selected macroeconomic determinants on selected sectoral indices of NSE by using ARDL bound testing approach by using monthly time series data of 11 years from 01/01/2009 to 30/12/2019. The study is using four sectoral indices namely financial services, FMCG, IT and oil and gas which cover almost 78% of market capitalisation of NSE on March 2020. The macroeconomic determinants which are used in the study includes institutional investments (IINVs), foreign direct investment (FDI), index of industrial production (IIP), interest rate (INT), inflation rate (INF), exchange rate (EXR), gold rates (GOL) and oil prices (OIL).

All the variables are used in logarithmic form. Monthly returns of sectoral closing prices are computed using logarithmic price relatives:

$$R_t = \log\left(\frac{P_t}{P_{t-1}}\right),$$

where:

R_t is the logarithmic monthly return at time t.

P_{t-1} and P_t are monthly closing prices of the indices at two successive months. t-1 and t respectively.

Data pertaining to all the indicators has been collected from secondary sources. The various sources used are official website of national stock exchange, official website of department for promotion of industry and internal trade, handbook of statistics on Indian economy, moneycontrol.com and indexmundi.com. Institutional investment includes net investment made by foreign institutional investors and domestic institutional investors. Index of industrial production is taken as a proxy of gross domestic product, which is a measure of economic growth. Interest rate represents 91 days Treasury bill rate. Wholesale price index is used as a measure of inflation. US dollar to Indian rupee is taken as exchange rate. Gold prices are taken as rupee per 10 grams rate. Crude oil price is Dated Brent Price (US Dollars per Barrel).

The study is using descriptive statistics tools like mean, median, standard deviation, Skewness, Kurtosis and Jarque-Bera values to get an initial impression from the data.

An essential feature of time series data is that they mostly contain a unit root. This means that the data is non-stationary. A series is said to be non-stationary if it's mean, variance and auto co variances depend on the time factor and is said to be stationary if its mean, variance and auto-covariance remains the same over the entire series such that it satisfies

the mean reversion criterion. Therefore, present study applied Augmented Dickey-Fuller (1979) test to check the stationarity of comprised variables.

The dependent variable of time series model depends not only on the current value of the explanatory variable but also on its past or 'lagged' values. This kind of model which considers the effects of both current and past values of variables on the dependent variable are called distributed lag models. It is necessary to determine the appropriate lag length so as avoid the problem of multicollinearity. For the selection of appropriate lag length, present study has used Akaike information criterion (Akaike, 1974). The guideline for this is lowers the AIC value, better the model. So, the study uses 2 lag as directed by VAR lag length selection method.

In order to test the co-integration between the variables, Auto-Regressive Distributed Lag (ARDL) bounds testing approach is used. The Auto-Regressive Distributed Lag (ARDL) bounds testing approach was developed by (Pesaran et al., 2001). In this approach, all the variables are assumed to be endogenous and the long run and short run parameters of the model are estimated simultaneously. The Auto-Regressive Distributed Lag (ARDL) framework can be applied with the presence of mixture of I(0) and I(1) regressors. But the procedure will crash in the presence of I(2) series. The implementation of the ARDL approach involves two stages. First, the presence of the long-run nexus (co-integration) among the variables under investigation is verified by computing the F-statistics. Secondly, if the co-integration between variables is recognised, then one can commence further analysis of long-run and short-run (error correction) association between the variables. The stability of ARDL model estimates is tested by applying cumulative sum (CUSUM) and cumulative sum of squares (CUSUMsq) tests. For further diagnoses, the study used Breusch-Godfrey serial correlation test, Breusch-Pagan-Godfrey heteroskedasticity test, Ramsey Reset test and Jarque Bera test for normality.

Interpretation of results

This section deals with all the research techniques and tools that will be employed in this study. Before conducting co-integration test, the study firstly perform preliminary analysis using descriptive statistics, correlation analysis and ADF unit root test.

Descriptive statistics

The preliminary analysis of the data using descriptive analysis is shown in Table 1. Mean returns are very low in case of oil and gas sector. Standard deviation is a measure of dispersion or spread in the series which reveals that variation is high in case of institutional investment. Skewness denotes the degree of departure of a distribution from symmetry (mean) and reveals the direction of scatterness of the items. Returns from IT sector and oil and gas sector, IINV, FDI and IIP are positively skewed whereas the values of returns of financial service sector, returns from FMCG, INT, WPI, EXR, GOL and OIL are negatively skewed. The kurtosis value reveals that IINV, INT and GOL are leptokurtic i.e. they are too much concentrated around the center whereas all the sectoral returns and other macroeconomic variables i.e. FDI, IIP, WPI, EXR and GOL are

platykurtic i.e. these items are less concentrated near the center. The outcomes of Jarque-Bera test indicates that except FMCG, IT and oil and gas sector returns all the variables are normally distributed.

Table 1. Descriptive statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
R_FIN	0.013116	0.046938	-0.28222	2.202789	5.24778	0.07252*
R_FMCG	0.013849	0.033123	-0.12222	2.190422	3.933396	0.139918
R_IT	0.013822	0.093084	0.055289	2.270243	2.996254	0.223549
R_OIL	0.008688	0.041499	0.04226	2.40255	2.002497	0.36742
IINV	3134.446	4249.017	0.79745	3.138139	14.09533	0.000869*
FDI	9.582405	0.547546	0.012305	1.787448	8.089879	0.017511*
IIP	5.187336	0.104849	0.130041	2.082721	4.99974	0.082096*
INT	1.894582	0.260389	-1.16789	3.840037	33.88863	0*
WPI	5.129373	0.124968	-0.95255	2.605344	20.81847	0.00003*
EXR	4.0669	0.155367	-0.466	1.724351	13.72749	0.001045*
GOL	10.16543	0.22988	-1.25972	3.276258	35.33154	0*
OIL	4.306234	0.324582	-0.04701	1.623881	10.46399	0.005343*

The results of ADF unit root test are shown in Table 2. It is evident that all sectoral returns, IINV, FDI, INT and WPI are stationary at level, whereas the other variables like IIP, EXR, GOL and OIL are stationary at first difference. Hence, none of the variables is integrated of order second order.

Table 2. Augmented Dickey-Fuller unit root test

Variables	Null Hypothesis: Variable is non stationary			
	LEVEL		FIRST DIFFERENCE	
	Intercept	Trend and intercept	Intercept	Trend and intercept
R_FIN	-8.351270 (0.0000)*	-8.322202 (0.0000)*	-7.054288 (0.0000)*	-7.071252 (0.0000)*
R_FMCG	-10.36082 (0.0000)*	-10.67182 (0.0000)*	-8.442255 (0.0000)*	-8.415641 (0.0000)*
R_IT	-3.436367 (0.0115)*	-3.275334 (0.0754)*	-6.668912 (0.0000)*	-6.740749 (0.0000)*
R_OIL	-5.539706 (0.0000)*	-5.515613 (0.0000)*	-9.561179 (0.0000)*	-9.570542 (0.0000)*
IINV	-10.34014 (0.0000)*	-10.35173 (0.0000)*	-6.628549 (0.0000)*	-6.674696 (0.0000)*
FDI	-0.508425 (0.8847)	-9.265836 (0.0000)*	-7.832585 (0.0000)*	-7.839650 (0.0000)*
IIP	-0.541561 (0.8779)	-1.539470 (0.8104)	-3.540898 (0.0085)*	-3.525430 (0.0412)*
INT	-4.025363 (0.0018)*	-0.907182 (0.9513)	-2.879376 (0.0508)	-3.408642 (0.0551)*
WPI	-3.473291 (0.0103)*	-1.952860 (0.6208)	-3.481795 (0.0100)	-4.553972 (0.0019)*
EXR	-0.790992 (0.8181)	-2.439114 (0.3579)	-11.90322 (0.0000)*	-11.86544 (0.0000)*
GOL	-2.281545 (0.1795)	-1.745394 (0.7253)	-10.02115 (0.0000)*	-10.15362 (0.0000)*
OIL	-1.910185 (0.3268)	-2.748661 (0.2193)	-9.384476 (0.0000)*	-9.462419 (0.0000)*

When the variables are mixture of $I(0)$ and $I(1)$ and no variable is integrated of order 2, then the most appropriate statistical technique to test the co-integration between variables is ARDL approach. So, in order to test the co-integration between the variables, Auto-

Regressive Distributed Lag (ARDL) bound testing approach will be used. The results are depicted in the Table 3.

Table 3. Long-run bound test

F-Bounds Test		Null Hypothesis: No level relationship			
Test Statistic	Sector	Value	Significance level	I(0)	I(1)
Asymptotic n=1000					
F-statistic	r_FIN	15.27576	10%	1.95	3.06
	r_FMCG	14.55669	5%	2.22	3.39
	r_IT	15.14895	2.5%	2.48	3.7
	r_OIL	14.33449	1%	2.79	4.1
K = 8					
t-Bounds Test		Null Hypothesis: No level relationship			
Test Statistic	Sector	Value	Significance level	I(0)	I(1)
t-statistic	r_FIN	-11.36737	10%	-2.57	-4.4
	r_FMCG	-11.05325	5%	-2.86	-4.72
	r_IT	-11.47723	2.5%	-3.13	-5.02
	r_OIL	-10.33867	1%	-3.43	-5.37

The outcome of Table 3 reveals that the computed F-value of all sectoral indices is more than the upper bound critical value at 5% level of significance (Pesaran, Shin and Smith, 2001). Thus, the null hypothesis cannot be accepted, meaning that dependent variable has a long run relationship with the independent variables. Moreover, the absolute t value of all sectoral indices is also more than the upper bound critical value at 5% level of significance; it also specified the same result as depicted by F-value. So, there is long run association between variables which is depicted in the following Table 4.

Table 4. Long-run coefficients using ARDL bounds test

Variable	Coeff. (r_fin)	Coeff. (r_fmccg)	Coeff. (r_it)	Coeff. (r_oil)
IINV	3.88E-06***	1.78E-06***	-2.71E-07	2.18E-06***
FDI	-0.020271**	-0.002206	0.017680	-0.007187
IIP	-0.128968**	-0.081719	-0.038114	-0.184498***
INT	-0.041075*	-0.030074	-0.037019	-0.032301
WPI	0.222051	0.181194	-0.052819	0.182373
EXR	-0.013214	-0.109646	0.188942*	0.011168
GOL	-0.010363	-0.007216	-0.119651*	-0.006090
OIL	0.006014	0.001456	0.074136***	-0.005161

*, ** and *** means significant at 10%, 5% level and 1% level respectively.

The outcomes of Table 4 show that institutional investment, index of industrial production, interest rates and inflation are the main determinants of stock market in the long run. Financial service sector returns are positively and significantly influences by IINV whereas negatively and significantly by FDI IIP and INT. FMCG sector returns are positively and significantly influenced by IINV. IT sector returns are positively and significantly influences by exchange rate and oil prices whereas it is negatively and significantly influenced by gold prices. Oil and gas sector returns are also positively and significantly influences by IINV whereas it is negatively and significantly influenced by IIP. WPI has no long run association with any of the sectoral stock returns.

The short run behaviour of the variables has been estimated by the error correction model. The results are depicted in following Table 5.

Table 5. Error correction representation – Dependent variable *D(NIFT)*

Variable	Coeff. (r_fin)	Coeff. (r_fmccg)	Coeff. (r_it)	Coeff. (r_oil)
C	0.004387	0.002423	-0.000441	0.003189
$\Delta(R_SECTOR)_{t-1}$	0.116084	0.071542	-0.383328***	0.011890
$\Delta(FDI)_{t-1}$	-0.014027	-0.011026	0.010103	-0.016882*
$\Delta(IIP)_{t-1}$	-0.135456	-0.119644	-0.596445***	-0.169422*
$\Delta(IIP)_{t-2}$	-0.126865	-0.174233**	0.432756**	-0.183781**
$\Delta(INT)_{t-2}$	0.201335*	0.023101	-0.171780	0.076645
$\Delta(WPI)_{t-2}$	-1.063658*	-0.551855	0.849698	-1.365066***
$\Delta(EXR)_{t-1}$	-0.557572**	-0.270235*	-0.073563	-0.289505
$\Delta(EXR)_{t-2}$	0.749246***	0.511489***	0.264381	0.509015***
$\Delta(GOL)_{t-2}$	-0.157408	-0.201712*	0.349684	-0.168670
$\Delta(OIL)_{t-2}$	0.085215	0.119955**	0.006583	0.037270
ECM_{t-1}	-1.058868***	-1.035285***	-1.061505***	-0.911104***
R-squared	0.535770	0.564747	0.785088	0.573651
Adjusted R-squared	0.454849	0.488877	0.747626	0.499333
S.E. of regression	0.042680	0.032041	0.078394	0.037996
Durbin-Watson stat	1.925462	1.945843	1.961848	1.922490
F-statistic	6.620909	7.443621	20.95707	7.718901
Prob(F-statistic)	0.000000	0.000000	0.000000	0.000000

*, ** and *** means significant at 10%, 5% level and 1% level respectively and Δ means differenced variables.

Table 5 depicts the results of ECM by inspecting the short run relationship between Nifty sectoral returns and independent variables. Financial service returns are positively and significantly influenced interest rate and two month lagged exchange and negatively by one month lagged WPI and exchange rate. FMCG sector returns are positively and significantly influenced by two month lagged exchange rate and oil prices whereas negatively by two month lagged IIP, gold prices and one month lagged exchange rate. IT sector returns are positively and significantly influenced by two month lagged IIP whereas negatively by one month lagged IT returns and IIP. Oil and gas sector returns are positively and significantly influenced by two month lagged exchange rate and negatively by FDI, IIP, WPI and exchange rate.

Finally the speed of adjustment (ECT) exhibit a negative sign and is statistically significant at 1% level which indicates that there is convergence to long run equilibrium when there is any deviance from long run equilibrium in the short run which means any deviation in stock returns from the long run equilibrium level is corrected in the next month; inferring endogenous variable adjusts with a very high speed.

Coefficient of determination (R^2) measures the proportion of variation in dependent variable that can be attributed to the independent variables. Its value ranges from 0 to 1. In the above model, the value of R^2 is quite high which indicates that high amount of the variation in stock returns can be explained by independent variables, which is a good sign. The standard error of regression in all the sectors is quite low, which is desirable, it indicates that all the observed data points fall exactly on the regression line. The p-value of the F-test is significant at 1% level in all the cases which implies that model fit is good. The value of Durbin-Watson statistics is near to 2 in all the cases, implying there is no autocorrelation in residuals.

Tests of stability

The robustness of the ARDL model is examined through the diagnostic tests and stability tests. Table 6 shows the result of Breusch-Godfrey Serial Correlation Langrage Multiplier test (BG test), Breusch-Pagan-Godfrey Heteroskedasticity Test, Jarque-Bera’s test and Ramsey RESET test.

Table 6. Other diagnostic tests after ARDL model

Test Statistics	R_fin	R_fmcg	R_it	R_oil	Interpretation
Breusch-Godfrey Serial Correlation LM test	0.4025	0.9193	0.4957	0.4015	No serial correlation
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.1718	0.3890	0.0944	0.6364	No Heteroskedasticity
Jarque-Bera’s test	0.3106	0.2665	0.2373	0.6974	Normal distribution
Ramsey RESET test					
t-statistics (114)	0.0506	0.6811	0.2833	0.5356	Dependent and independent variables relationship is correctly specified.
F-statistics (1, 114)	0.0506	0.6811	0.2833	0.5356	

The outcomes of Table 6 suggest that there is no serial correlation, no heteroskedasticity and data is also normally distributed. The result of Ramsey’s RESET test also suggests that the relationship between dependent and independent variables is correctly specified.

Figure 1. Graphical representation of CUSUM and CUSUM of square test in case of financial services sector

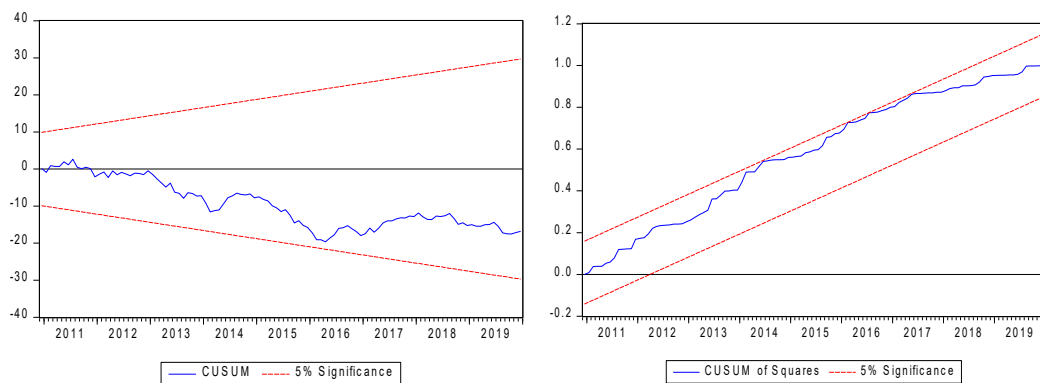


Figure 2. Graphical representation of CUSUM and CUSUM of square test in case of FMCG sector

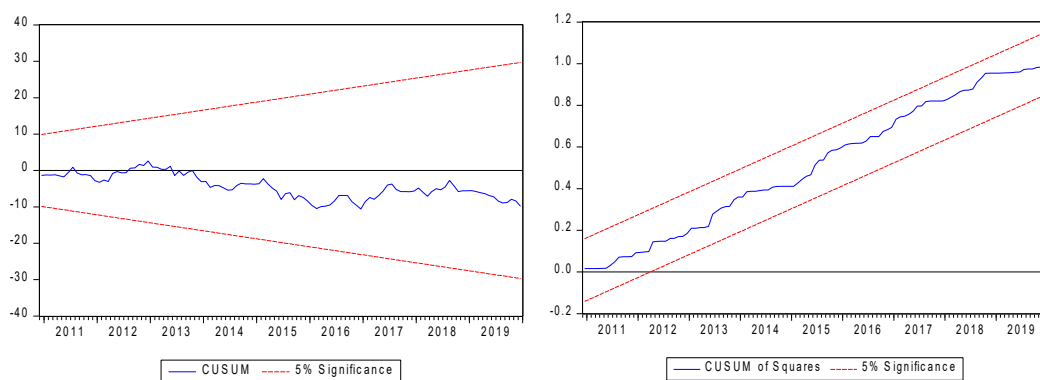
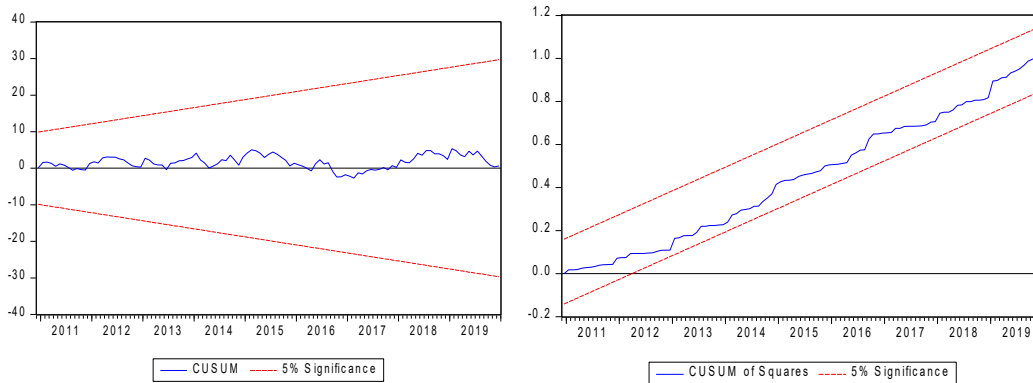
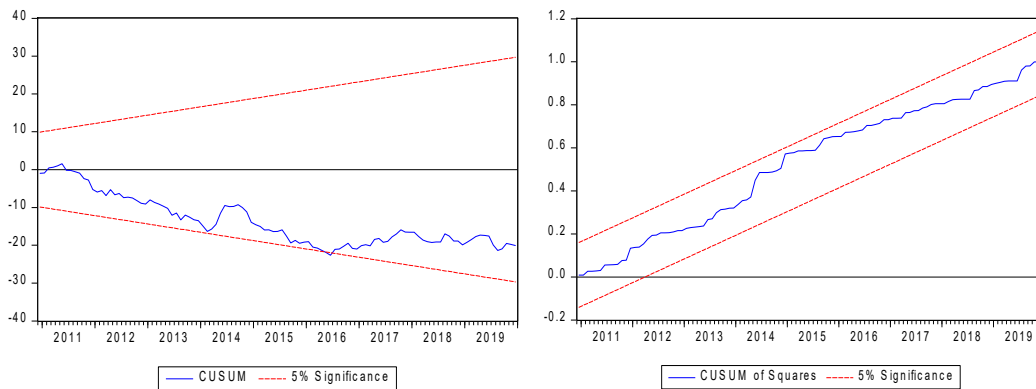


Figure 3. Graphical representation of CUSUM and CUSUM of square test in case of IT sector**Figure 4.** Graphical representation of CUSUM and CUSUM of square test in case of oil and gas sector

Thereafter, using CUSUM test, the long run stability in the parameters is confirmed. It is clear from the above figure of CUSUM and CUSUMQ test, that all the parameters together exhibit long run stability at 5% level of significance in all the cases. As the plots are between the critical boundaries of 5% level of significance, it implies that model is stable and well specified. It indicates that the long run and short run parameters have a significant impact on the sectoral stock returns in India.

Conclusion

The results of ARDL model suggests that there exists a long run relationship between all sectoral indices and macroeconomic variables as indicated by bound test. It is found that institutional investment is having long run relationship with most of the sectoral indices such as financial services, FMCG sector and oil sector. Index of industrial production is also influencing financial services and oil sector. Foreign direct investment and interest rates are also affecting financial services in the long run. In case of IT sector, major

influential sectors are exchange rate, gold prices and oil prices. In the short run, financial service returns are influenced interest rate, exchange rate and by WPI. FMCG sector returns are positively and significantly influenced by exchange rate, oil prices, IIP, gold prices and exchange. IT sector returns are influenced by IIP.

Oil and gas sector returns are influenced by exchange rate, FDI, IIP and WPI. The diagnosis testing also reveals that there is no serial correlation, no heteroskedasticity and data is also normally distributed. Moreover, the relationship between dependent and independent variables is also correctly specified. Using CUSUM test, the long run stability in the parameters is confirmed which indicates that the long run and short run parameters have a significant impact on the sectoral stock returns in India.

So, in the long run, the major determinants are institutional investments and index of industrial production. Hence, government should design his policies in such a way to attract more institutional investment in stock market for the growth of respective sectors. In the short run, the major determinants are index of industrial production, wholesale price index and exchange rate.

So, government should focus more on industrial growth, inflation and exchange rate stability to efficiently run the stock market. Index of industrial production is the only sector which is influential in long as well as in short run so industry should be the key concern of the government and government should give more industrial benefits to industries in order to efficiently run the stock market.

Limitations for the study and scope for future research

Although the study provides better insights into various macroeconomic variables and their impact on various sectors but it definitely has some limitations.

Firstly, the study is based on monthly secondary data of only 11 years which is not appropriate for other periods.

Moreover, the results are based on the impact of eight macroeconomic variables; there can be some other key variables which can affect the stock market.

Furthermore, only four sectors are considered as dependent variables, other sectoral indices can also be used for further analysis.

So, longer time period, additional macroeconomic variables and more sectoral indices can be added to improve the model.

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A pragmatic evaluation of the interconnection between currency futures return volatility, open interest and volume

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Abstract. *In an efficiently functioning market, the exchange rate and return from the currency futures contract should be perfectly contemporaneously correlated. In this article, the authors investigated the interconnection between volatility and trading activity (open interest and volume) during January 2012 to March 2020 in Indian currency futures market. Data on three variables are used: trade settlement rates, open interest, and trading volumes for each one of the currency futures contracts. The paper found the corroboration of time-varying volatility, which exhibits high persistence and predictability in the Indian futures market. The results imply that the speculative activities, as proxied by the volumes, tend to increase the futures volatility from the GARCH (1,1) model and trading volumes have a positive relationship with volatility, while open interests have a negative relationship with volatility. The ramifications imply that futures volatility from the GARCH (1,1) model increases based on speculative activities which are proxied by the volume. Thus, Open interests have a negative impact with volatility, but trading volumes have the exact opposite relationship.*

Keywords: currency futures, volatility, volume, and open interest.

JEL Classification: C58, G12, G13.

Introduction

For a long time, the edifying role of trading activity in futures exchanges on price volatility has created a lot of interest. Especially, in emerging exchanges, where the trading activity is comparatively low with high price volatility; the relationship between trading activity and price changes are crucial. Relatedness is formed between volatility, trading volume and the quality of information flow based on the trading volume received by traders. Positive interdependence between trading volume and price volatility is comprehensively documented, including Karpoff (1987) citing 18 studies leading to the same volatility-volume relationship. A hedger's expectations, his demands, differences in trader's opinions and market depth impact the Futures trading volume and open interest. It is pertinent to explore the interdependence of volatility with liquidity variables such as open interest and trading volume.

The competence and development of price discovery is determined by the subtle change in volume and volatility tie-ins. The traditionally developed financial markets have been the subject of numerous empirical studies on this relationship. Hardly a few studies have focused on the emerging markets, predominately using commodity futures and index data and never really concentrated on currency futures. The current study will contribute to the fledging literature on price discovery in emerging capital markets, with focal point at firm level.

The study investigates the correlation between volatility in return and trading activity during 2012 to 2020 in Indian currency futures market. The remainder of the article is organised as follows: Section 2 discusses review of literature. Section 3 presents the methodology used to analyse the relationships between volatility, open interest, and trading volume and describes the dataset. Section 4 discusses the empirical results for the combined relationships between volatility in return, opens interest and trading volume. Finally, section 5 summarises and concludes the study.

A review: Volatility, volume and open interest

For any market in a single trading day the numbers of contract changing hands or amount of trading activity is "Volume". Substantial amount of trading during a market session leads to higher trading volume. Volume is linearly and positively related to absolute value of price change. Outstanding contracts that are held by traders at the end of each day determine the open interest. The volume measures the intensity behind a price trend and the open interest measures the flow of money into the futures market.

Parallels between price variability and the trading volume for futures and equities have been investigated extensively. A large number of empirical studies show that there is a positive correlation between trading volume and price variability in equities and futures markets. Epps and Epps (1976), Clark (1973), Cornell (1981), and Tauchen and Pitts (1983) find a positive relationship between price variability and trading volume. Karpoff (1987) finds a positive relationship between an absolute price change and volume in both

equities and futures markets. The relationship between open interest and volatility on the futures market had always been of experimental attentiveness. Kamara (1993) and Bessembider and Seguin (1993) both considered open interest as a vital parameter for the purpose of market depth and hedging. Fung and Patterson (1999) based on developed market, reveals that open interest reduces volatility while volume increases volatility in currency futures markets.

Girma and Mougoue (2002) found that contemporaneous (lagged) volume and open interest provide a significant explanation for futures spreads volatility when entered separately. The lagged volume and lagged open interest have a greater effect on volatility and substantially reduce the persistence of volatility. Gagnon and Karolyi (2003) findings reveal a significant short-run dependence in returns and volatility and the return spillovers are very sensitive to interactions with trading volume.

Omran (2009) found that the persistence in volatility is not eliminated when contemporaneous trading volume is incorporated and anticipated information shocks can have a negative impact on the volatility of return. It documented that, when the volume is further broken down into its expected and unexpected components, volatility persistence decreases. Eaves and Valero (2009) states the volume–volatility link is positive and stays constant or strengthens as traders' beliefs about value become more precise. Ferris et al. (2002) found that index futures market volatility increases when investors sell off their futures positions with relatively larger drops in futures prices. Pati and Rajib (2010) results indicate that inclusion of both contemporaneous and lagged trading volume reduces the persistence in volatility, but contemporaneous volume provides a greater reduction than lagged volume.

Kumar and Pandey (2010) found positive relationship between volatility and volume. It reveals open interest does not proxy for information. Overall, most literature confirmed the positive relationship between volume and volatility, while the relationship between volatility and open interest is still ambiguous. Salvador (2016) proved open interest helps explain futures market volatility and trading volume contributes positively and significantly in explaining the conditional volatility of futures markets. Desai and Joshi (2018) reported futures market volatility influenced by depth of the market but the influence depends on the type of contract.

Research methodology

In this study, we measure volatility using a time-series model, GARCH specifications which have been very apt (Engle, 2001). The volume and open interest provide information that accounts for liquidity characteristics of futures contracts. Volume is usually measured as the total number of contracts traded during a day. Further, one can obtain the volatilities of futures returns and we analyse the relationships between three variables (open interest, trading volume and return volatility).

Data

For the empirical analysis, data on three variables are used: trade settlement rate, open interest and trading volumes for the currency futures contracts. For the present analysis, we have collected data on the currency futures of USD-INR (United States Dollar-Indian Rupee), EUR-INR (Euro-Indian Rupee), JPY-INR (Japanese Yen- Indian Rupee), and GBP-INR (Great Britain Pound-Indian Rupee). We use data from the nearby month contracts, i.e. the contracts with the closest settlement date. Trading is usually most active for these contracts as compared to deferred contracts. All contracts cover a time span from January 2012 to March 2020 (1,812 observations). The data was obtained from NSE. For empirical analysis all the collected data have been converted into natural logarithm.

Estimating conditional volatility

For estimating the conditional volatility, we applied Autoregressive Conditional Heteroskedasticity (ARCH) model. This model was introduced by Engle (1982) and modelled as GARCH (Generalized ARCH). GARCH models and its applications are widely used in time series analysis (Bollerslev et al. (1992), Bollerslev et al. (1994)). The GARCH (p,q) model captures the tendency in financial data for volatility clustering and heteroskedasticity into the estimation procedure.

Firstly, returns for currency were calculated as following:

$$R_t = \ln(P_t / P_{t-1})$$

To identify the model return series and lag length, the Schwarz information criterion (SIC) were calculated for lags one to six and lag order of 1 was found appropriate. In this study the researcher used GARCH formulation:

$$R_t = b_0 + b_1 \text{return}_{t-1} + \varepsilon_t \sim (0, \sigma_t)$$

$$\sigma_t^2 = \delta + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$$

Result and discussions

The empirical results begin with the descriptive statistics of the currencies (open interest, trade volume, and futures return) selected for the study as shown in Table 1. The mean return for EURFR and GBPFR is almost zero percent. The highest mean return is observed in case of GBPFR followed by EURFR. The standard deviation as a measure of volatility is highest for GBPFR followed by EURFR, USDFR, and JPYFR. So, the risk and return relationship is positive for the four currency pairs. The volatility measures are larger than the mean values. The results show that the return series of the currency futures have positive skewness for all currencies and all return series are leptokurtic. Also, Jarque-Bera (JB) statistics rejects the null hypothesis of normality. The result reveals that the currency futures market is not informationally efficient for the currency pairs.

Table 1. Descriptive statistics for open interest trading volume and futures return

Variable	Mean	Std. dev	Skewness	Kurtosis	Jarque-Bera
EUROI	48264.34	23975.02	1.027402	4.634005	509.7351
EURFR	0.000168	0.000249	12.14617	212.6889	3301119
EURVOL	66600.82	34774.12	1.298244	7.036996	1703.932
GBPOI	32801.24	18650.05	0.716112	3.354422	160.9985
GBPFR	0.144380	0.311041	4.527662	26.40038	46641.15
GBPVOL	74658.17	57982.37	3.219459	30.29491	58166.15
JPYOI	19330.37	12408.93	0.968882	3.359389	287.2608
JPYFR	6.19E-05	8.24E-05	9.353829	121.4685	1065671.
JPYVOL	31712.79	20095.22	1.935884	10.90359	5728.611
USDOI	1420375	603282.5	0.527453	3.692834	117.8042
USDFR	2.15E-05	2.04E-05	4.235291	26.14558	45003.32
USD VOL	1891525	942539.5	1.097098	4.409842	503.0755

Source: Authors estimation.

Test of stationarity and price discovery process

The currency futures data series are indicated in logarithm form and tested by using augmented Dickey Fuller (ADF). ADF test confirms the presence of unit root and shows stationarity at first difference. There is high volatility in the currency futures return it's proved by the low mean and high standard error. The researcher tested autocorrelation to know the impact of past value which affects the future returns and the result shown in Table 2.

Table 2. Autoregressive result

Variable	AR(1)	SIGMASQ	R-squared	Schwarz criterion	Durbin-Watson stat
EURVOL	-0.40047	0.176775	0.160402	1.117723	2.219129
EUROI	-0.27823	0.183661	0.077365	1.155886	2.111352
EURFR	-0.09108	0.000174	0.008303	-5.80721	2.059463
JPYVOL	-0.40207	0.201653	0.161807	1.249397	2.227275
JPYOI	-0.25339	0.14261	0.064151	0.902896	2.087962
JPYFR	-0.19879	8.57E-05	0.03956	-6.5146	2.016163
USDVOL	-0.34492	0.153706	0.11899	0.97786	2.172811
USDOI	-0.1255	0.04776	0.015751	-0.19106	2.036744
USDFR	0.007896	.21E-05	0.000062	-7.88031	1.999355
GBPVOL	-0.42184	0.162478	0.176433	1.0334	2.226616
GBPOI	-0.27075	0.181865	0.072326	1.146057	2.089877
GBPFR	-0.20196	7.03E-05	0.040734	-6.71264	2.007995

Source: Authors estimation.

To investigate whether a GARCH model is appropriate for modelling, several tests are carried out. To check the presence of ARCH effect in the data series the researcher considered Ljung-Box (LB) Q-stat of the squared residual obtained. LB Q-stat for the various lags is significant, suggesting the presence of ARCH effect. A more formal test for the presence of the ARCH effect is done using the ARCH LM test. To capture this time varying heteroskedasticity we proceed to run the model using the most suitable ARCH model. After all these tests; heteroskedasticity needs to be modelled. GARCH (1,1) models, it is able to model the time varying heteroskedasticity parsimoniously.

Table 3. Generalized autoregressive conditional heteroskedasticity result

Variable	RESID(-1)^2	GARCH(-1)	R-squared	Durbin-Watson stat	p-value
EURVOL	0.311165	0.116639	0.160034	2.245557	0.015
EUROI	2.971618	-0.00178	0.029388	2.464522	0.1342
EURFR	0.218826	0.357416	5.97E-03	1.9984	0.0001
JPYVOL	0.1204	0.305275	0.161349	2.241404	0.0001
JPYOI	1.570908	-0.00434	0.047754	2.300908	0.5001
JPYFR	0.199639	-0.04664	0.022016	2.272159	0.415
USDVOL	0.134414	0.185463	0.117051	2.23398	0.0001
USDOI	2.307521	-0.00072	0.009571	2.168539	0.4480
USDFR	0.037491	0.954017	0.000016	2.006219	0.0001
GBPVOL	0.191847	0.330005	0.175549	2.26403	0.0001
GBPOI	0.566027	-0.02269	0.070314	2.144483	0.003
GBPFR	0.210976	-0.07568	0.017338	2.307571	0.382

Source: Authors estimation.

The relationship between open interest and the trading volume for currency futures market was investigated. And the effect of trading volume and open interest on volatility in return was observed in futures markets. Table 3 presents the estimate of the GARCH (1, 1) model for currency futures return with current open interest and trading volume. Return is the dependent variable, while open interest and trading volume are used as explanatory variables in the conditional variance function. The futures return volatility shows a high level of persistence. The findings show that current open interest and trade volume has marginal explanatory power for the currency future return volatility. The coefficient of the contemporaneous open interest in the conditional variance equation, is statistically significant at 1 percent level. Investors emphasize the information of open interest for various objectives and motives. It had been observed that an increasing or upward trend is confirmed when the open interest increases with an increase in price. Moreover, open interest is a crucial parameter in technical analysis. The open interest measures market depth. The researcher's present time series plots of variables along with the distribution plots in Figures 1-4. The data series show that the most volatile series is GBP and it shows fluctuations throughout the study period.

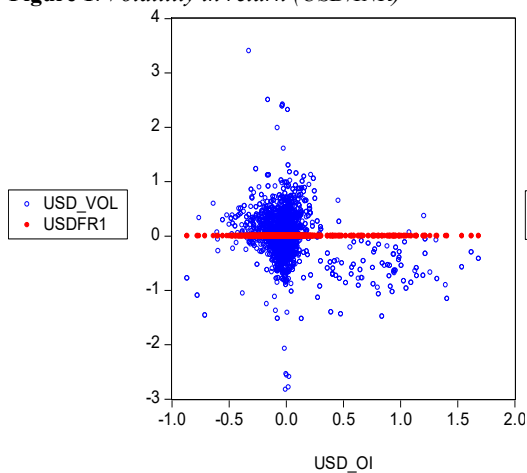
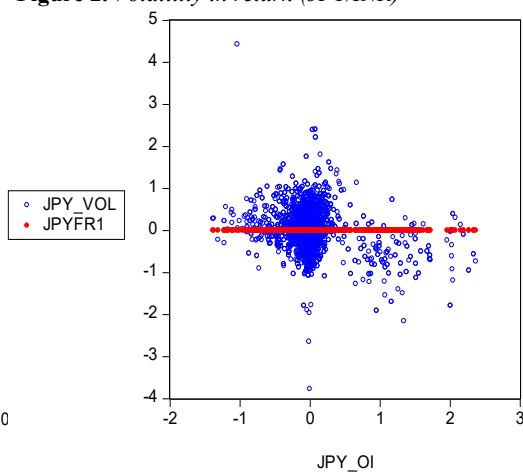
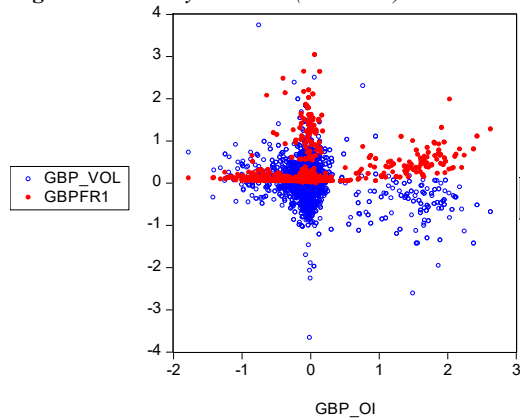
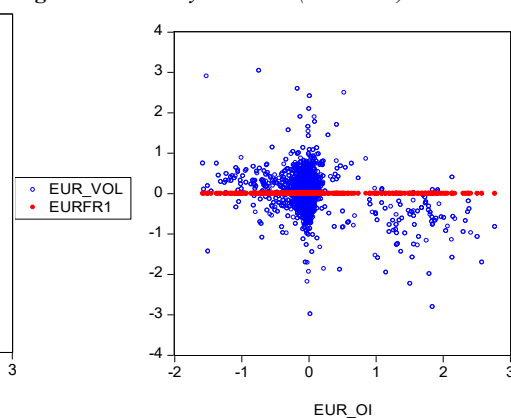
Figure 1. Volatility in return (USD/INR)**Figure 2.** Volatility in return (JPY/INR)

Figure 3. Volatility in return (GBP/INR)**Figure 4.** Volatility in return (EUR/INR)

Conclusion

This paper analysed trading activity implications by considering open interest and trading volume on return volatility in Indian currency futures markets. The open interest and trading volume effects on price volatility, it reflects market information for investors. The researchers applied GARCH (1,1) model study on the impact of open interest and trading volume on volatility. We found the evidence of time-varying volatility, which exhibits high persistence, and predictability in the Indian futures market. The result imply that the speculative activities, as proxied by the volumes, tend to increase the futures volatility. From the GARCH (1,1) model, trading volumes have a positive relationship with volatility, while open interests have a negative relationship with volatility. Open interest can mitigate price volatility in Indian currency futures exchanges. The results of this study would be of economic significance and have important implications for the traders, regulatory bodies, and practitioners. If the volume-price volatility relationship is positive, it implies that the futures contract will be successful only to the extent that there is enough price uncertainty associated with the underlying asset. Increased trading volume causing increased volatility may suggest the need for greater regulatory restrictions.

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Fiscal policy and growth-inequality tradeoffs: Bayesian evidence from Cote d'Ivoire

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Abstract. *The growing within-country income inequality has brought to the forefront of the economic policy agenda the question of the role of fiscal policy in income redistribution. However, there may be a tradeoff between the objectives of addressing income inequality and promoting economic growth vis-à-vis fiscal policies. This study investigates the potential growth-inequality tradeoffs in the design of fiscal policy in Cote d'Ivoire. Using a Bayesian VAR framework which is more suitable to deal with possible issues that may appear in small data sample, the results show that a positive shock in government current expenditure undermine economic growth but reduce income inequality. Also, we find that public investment and direct taxes promote growth and reduce income inequality while indirect taxes decelerate growth with a marginal effect on income inequality. Overall, our findings reveal that government current expenditure is the fiscal policy instrument that generates growth-inequality tradeoff in Cote d'Ivoire.*

Keywords: fiscal policy, income inequality, economic growth, Bayesian VAR, Cote d'Ivoire.

JEL Classification: C5, E6, H3.

1. Introduction

The rapid growth of emerging economies such as China and India has brought down the overall global inequality over the last decade. At the same time, however, the within-country income inequality has experienced a sharp increase in almost every country (Bastali et al., 2012; Bourguignon, 2015; Gordón and Resosudarmo, 2018). This growing within-country income inequality has brought to the forefront of the economic policy agenda the question of the role of fiscal policy in income redistribution. Fiscal policy is seen as one of the main tools for effectively tackling income inequality. It can affect household consumption directly through taxes and transfers and indirectly through work and production incentives as well as the provision of public goods and services such as education and health.

Bourguignon (2003) argues that high-income inequality reduces the elasticity of poverty to economic growth. Policymakers should, therefore, be concerned with high and persistent income inequality as this can be a major obstacle in reducing poverty. However, income inequality-reducing fiscal policies may have adverse effects on economic growth. In other words, there may be a tradeoff between the objectives of addressing income inequality and promoting economic growth through fiscal policies. For instance, direct taxes, which are usually composed of personal income tax and corporate income tax, are believed to decelerate economic growth because they distort resource allocation and discourage the effort to work and investment. At the same time, these taxes, in particular, the progressive personal and corporate income tax, are considered to be very effective in combating income inequality. Thus, the design of fiscal policy needs careful consideration of its potential effect on the growth- inequality tradeoff.

Cote d'Ivoire is the leading economy in the West African Economic and Monetary Union (WAEMU)⁽¹⁾, and one of the largest economies in West Africa; it has also become one of the world's fastest-growing economies since 2012. The average economic growth over the period 2012-2018 is around 9%. However, this impressive economic growth seems not to have contributed significantly to reduce income inequality in the country. The level of market income inequality (income inequality before tax and transfers) measured by the Gini index experienced only a marginal decline from 46.2 in 2008 to 45.7 in 2016. This is in line with the 2019 report by United Nations Economic Commission for Africa (UNECA) which points out that "despite the remarkable economic growth, income inequality in Africa fell only slightly". Since tackling inequality will be a key to achieving the UN 2030 Agenda for the Sustainable Development Goals, it is highly important to find the combinations of fiscal policies that can reduce effectively income inequality without disrupting the current growth dynamics in the country.

Most of the empirical studies focus either on the effect of fiscal policy on economic growth or the effects of fiscal policy on income inequality. Despite its relevance in terms of economic policy, the joint response of economic growth and income inequality to different instruments of fiscal policy has received little attention in the literature except for a few recent empirical studies such as Roca-Sagalés and Sala (2011), Muinelo-Gallo and Roca-

Sagalés (2013), and Liu and Martinez-Vazquez (2015). Also, the existing scarce evidence on this issue is generally based on a large sample made up of developed and developing countries. However, as argued by Castelló-Climent (2010) and others, the empirical analysis of the relationships between growth, income inequality and fiscal policies should be based on countries with similar levels of development, because the political implications may differ considerably depending on the level of development of the economies.

Against this backdrop, this study aims to investigate how income inequality and economic growth respond simultaneously to various types of fiscal policies in Cote d'Ivoire. The study is organized as follows: Section 2 presents a brief survey of the literature. Section 3 highlights the methodology; Section 4 presents the results and discussions while section 5 concludes.

2. Fiscal policy, growth and income inequality: A brief survey of evidence

The empirical literature on the impact of fiscal policy on economic growth and income inequality has examined separately the link between “fiscal policy and economic growth” and the link between “fiscal policy and income inequality”. The joint response of economic growth and income inequality to fiscal policies has been largely under-researched. Table 1 presents a list of selected empirical studies.

Table 1. Selected empirical studies

Authors	Country	Methodology	Findings
<i>1. Impact of fiscal policies on economic growth</i>			
Barro (1991)	98 countries	Pooled cross-section time series regression	Negative effect of government consumption expenditure on economic growth and statistically insignificant effect of public investment on economic growth
Easterly and Rebelo (1993)	100 countries	Pooled cross-section time series regression	Public investment in transportation and communication affect positively economic growth
Kneller et al. (1999)	22 OECD countries	Two-way panel fixed effects regression	Distortionary taxation and unproductive government expenditure undermines economic growth while non-distortionary taxation and productive government expenditure promotes growth
Kamps (2005)	22 OECD countries	Vector Autoregressive (VAR)	Public capital has a positive effect on output
Fedderke et al. (2006)	South Africa	Error Correction Model	Public expenditure on infrastructure affects positively economic growth
Tun (2019)	Myanmar	Ordinary Least Square (OLS)	Fiscal deficit has a positive effect on economic growth
<i>2. Impact of fiscal policies on income inequality</i>			
Caterina et al. (2018)	EU countries	System GMM	Education, health spending, sickness, disability, family and child benefits, significantly reduce income inequality
Woo et al. (2013)	38 advanced and Emerging countries	Panel fixed-effects regression with Driscoll-Kraay standard errors	Fiscal consolidations tend to increase income inequality

Authors	Country	Methodology	Findings
Martinez-Vazquez et al. (2012)	150 countries	Generalized Method of Moments (GMM)	Indirect taxes increase inequality while education, health, and housing expenditures reduce inequality
Gemmell and Morrissey (2005)	Six African countries	Concentration curves.	Taxes on exports and goods consumed by the poor increase inequality. Taxes on 'luxury' items reduce inequality.
<i>3. The Joint response of economic growth and income inequality to fiscal policies</i>			
Liu and Martinez-Vazquez (2015)	150 developed and developing countries	Structural equations, three-stage least squares (3SLS)	Growth-inequality tradeoff: direct taxes retard growth and reduce income inequality while indirect taxes promote growth and increase income inequality.
Muinel-Gallo and Roca-Sagalés (2014)	Uruguay	Vector Autoregressive (VAR)	Growth-inequality tradeoffs: Government current expenditure increases growth and worsens income inequality. Public investment breaks such a tradeoff
Muinel-Gallo and Roca-Sagalés (2013)	21 high-income OCDE countries	Structural equations, three-stage least squares (3SLS)	Distributive expenditures and direct taxes undermine growth and reduce net income inequality.
Roca-Sagalés and Sala (2011)	Sweden	Vector Autoregressive (VAR)	Growth-inequality tradeoffs: government current expenditure decelerates growth and reduces income inequality. Public investment promotes growth and increases income inequality. Indirect taxes stimulate growth and worsen income inequality.

3. Data and methodology

3.1. Data

To achieve the aim of the study, we use annual data for the period 1985-2016. The choice of the study period is dictated by data availability, especially income inequality indicator. The relatively small size of our sample is not uncommon in the empirical literature related to our study (see, for example, Kamps, 2005; Roca-Sagalés and Sala, 2011; Muinel-Gallo and Roca-Sagalés, 2014, among others).

Regarding the variables used, we have income inequality (net income inequality) measured by the Gini index, and it is sourced from the Standardized World Income Inequality Database (SWIID) by Solt (2019). This database has been widely used in the literature (see, Acemoglu et al., 2013; Anyanwu et al., 2016, among others). It is important to remind that the Gini coefficient is not the only way of measuring income inequality; our choice is purely motivated by its availability as compared to other indicators of inequality. Another variable is the real gross domestic product (GDP) used as a proxy for economic growth. The raw data is collected from the World Development Indicators (WDI). Concerning the fiscal policy variables, we have government current expenditure and public investment on the spending side, and direct taxes, and indirect taxes on the tax side. Government current expenditure comprises mainly wages and salaries, expenditure on goods and services, and subsidies and transfers. Direct taxes include taxes on income and profits while indirect taxes include mainly tax on goods and services (VAT), and import and export duties⁽²⁾. All the variables related to fiscal policy are measured in percentage of GDP, and the raw data is extracted from the Central Bank of West African States online Database⁽³⁾, World Bank (WDI), and African Development Bank Online Database.

Table 2 shows some descriptive statistics about the selected variables. The average level of government current expenditure is 11.7% of GDP while the average level of public investment is roughly 4.4% of GDP. On the tax side, the average level of direct taxes is 4.8% of GDP while the average level of indirect taxes is 10.8% of GDP. The average level of net income inequality (Gini Index) is around 41%.

Table 2. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Gini net	32	40.89	0.432	40.3	41.5
Current spending	32	11.71	3.751	7.226	18.254
Public investment	32	4.399	1.894	1.565	9.913
Direct taxes	32	4.873	1.598	2.738	9.232
Indirect taxes	32	10.845	2.025	8.079	16.534
GDP ^a	32	9.22	0.181	8.972	9.678

Note: a. Included as the logarithm of GDP.

3.2. Methodology

To investigate the response of economic growth and income inequality to fiscal policies in Cote d'Ivoire, a Vector Auto-Regressive (VAR) modeling strategy is a useful choice. However, in small samples as the case at hand in this study, the rich parametrization of VAR models may come at the cost of overfitting the data, possibly leading to imprecise inference. To avoid such overfitting, we estimate a Bayesian Vector Autoregression model (BVAR). Bayesian estimation method have a better estimation performance than alternative methods in small samples (Rabanal and Rubio-Ramirez, 2005; Karagöz and Keskin, 2016). In the BVAR model, the parameters are regarded as random variables with prior probabilities; it provides parameter estimates where the model includes many variables and relatively little data. Bayesian techniques may also be used to provide unbiased coefficient estimates when the variables contain unit roots (see, for example, Koop and Korobolis, 2010, Kotzé, 2017).

A typical VAR model can be expressed as follows:

$$Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \dots + B_p Y_{t-p} + D z_t + \varepsilon_t \quad (1)$$

Where Y_t is a $n \times 1$ vector of endogenous variables; B are $n \times n$ and $n \times d$ matrices of parameters respectively; z_t is a $d \times 1$ vector of exogenous variables while ε_t is a $n \times 1$ vector of error terms independently, identically and normally distributed with variance-covariance matrix Σ ;

$$\varepsilon_t \sim IIN(0, \Sigma), B_t (t = 1, \dots, p).$$

To introduce the Bayesian estimation techniques, equation (1) is rewritten in a more compact form as follows:

$$Y_t = X_t B + \varepsilon_t \quad (2)$$

where

$$X_t = (I_n \otimes W_{t-1}) \text{ is } n \times nk \text{ matrix; } W_{t-1} = (Y'_{t-1}, \dots, Y'_{t-p}, z'_t)' \text{ is } k \times 1, \beta = \text{vec}(B_1, B_2, \dots, B_p, D) \text{ is } nk \times 1.$$

The unknown parameters of the model are β and Σ . The Bayesian estimation techniques consist of combining the likelihood function of the VAR model with prior information

regarding the distributions of the parameters. Assuming a prior $p(\beta, \Sigma)$ and the likelihood function $L(Y/\beta, \Sigma) \propto |\Sigma|^{-T/2} \exp\{-\frac{1}{2} \sum_t (Y_t - X_t \beta)' \Sigma^{-1} (Y_t - X_t \beta)\}$, the posterior distribution of the coefficients can be obtained by using the following Bayes rule:

$$p(\beta, \Sigma / Y) = \frac{p(\beta, \Sigma) L(Y/\beta, \Sigma)}{p(Y)} \propto p(\beta, \Sigma) L(Y/\beta, \Sigma) \quad (3)$$

Where \propto represents “proportional to” (see Cicarelli and Rebucci, 2003).

In the literature, there is a wide range of priors but the commonly used prior distribution is the “Minnesota prior” propounded by Litterman (1980). This prior transforms the VAR model into random walk process for each variable (Luetkepohl, 2011). At the same time, imposing Minnesota priors is the simplest way of dealing with the variance-covariance matrix of the VAR coefficients (Bobasu, 2016).

Minnesota method is composed of the following priors: $\mu_1, \lambda_1, \lambda_2$, and λ_3 . μ_1 is the prior mean; λ_1 is the overall tightness on the variance (first lag) and controls the relative importance of sample and prior information. λ_2 represents the relative tightness of the variance of other variables while λ_3 represents the lag decay (Moreira et al., 2015). In this study, we used the standard values of these hyper-parameters recommended by Sims and Zha (1998) as they are applicable and works well in practice even if the length of periods and system size vary (Wind, 2015; Gemechu, 2019). Hence, the value of μ_1 (prior mean values) is set to 1 to account for the non-stationary variables (random-walk priors), λ_1 ($lamda1$)= 0.2, λ_2 ($lamda2$)=1, and λ_3 ($lamda3$)=1 (lag decay). In sum, this study employs a Bayesian VAR model with Litterman/Minnesota prior to estimate the impact of fiscal policy shock on growth and income inequality in Cote d’Ivoire.

The fiscal shocks are identified using a recursive scheme (Cholesky decomposition). The ordering of the variables in the model is based on economic theory and economic intuition. Thus the variables are ordered from the most exogenous one to the most endogenous. Following Roca-Sagalés and Sala (2011), and Blanchard and Perotti (2002), among others, we assume that public spending affects contemporaneously economic growth and income inequality while economic growth and income inequality affect public spending with lag.

Output changes are not usually distributionally neutral, thus affecting income inequality. On the other hand, output is most likely to respond to changes in inequality only in the longer term, since the transmission mechanisms identified in the literature, such as human capital accumulation with imperfect financial markets, or the joint education–fertility decision, need time to operate (Benabou, 1996; Perotti, 1996).

We also assume that economic growth affects tax revenues contemporaneously. Keho (2010) finds that tax revenues in Cote d’Ivoire depend highly on the changes in economic activity. However, it is assumed that output does not respond contemporaneously to changes in tax policy. The underlying reason is that there may be some delays between the decisions and the implementation of changes in the tax rates (Roca-Sagalés and Sala, 2011). We assume also that changes in tax policy affect contemporaneously income inequality, however, the reverse may be also true. Thus we interchange the positions of income inequality variable and tax variables in the ordering for robustness check.

Regarding the disaggregated fiscal variables, we assume that government current expenditure affects contemporaneously public investment because the amount of public investment is usually conditioned by the level current expenditure but the reverse is not true. We equally assume that direct tax revenues affect contemporaneously indirect tax revenues but the reverse is not true. Overall, based on the aforementioned arguments, the main causal ordering adopted for the estimation of the Bayesian VAR model is as follows: government current expenditure, public investment, economic growth, direct taxes, indirect taxes, income inequality.

We start the empirical estimation by determining the order of the BVAR using Schwarz information (SC) and the Hannan-Quinn (HQ) information criterion. These selection criteria indicate that the optimal lag is one. All the variables are taken in logarithmic (log) form before the test and estimations. Before proceeding to the analysis of the impulse-response functions (IRF), we checked the properties of the residuals of the estimated BVAR model. The diagnostic tests concerning the properties of the residuals reveal that the estimated BVAR model satisfies the stability condition and it is free from serial correlation and heteroscedasticity problems.

4. Results and discussions

Figure 1 shows the responses of economic growth and income inequality to one standard deviation shock in fiscal policy variables using BVAR with Minnesota prior; it shows the joint response of economic growth and income inequality to fiscal policies.

The results show that a positive shock in government current expenditure has a negative effect on economic growth. Similarly, a positive shock in government current expenditure has a negative effect on income inequality. In other words, government current expenditure reduces income inequality and undermines economic growth. We were expecting government current spending to reduce income inequality given the fact that it includes some social spending with distributive implications, especially subsidies and transfers. The key message from this finding is that government current spending such as transfers and subsidies, and other current expenditure may reduce inequality but at the expense of growth as it creates distortion in the economy, and hence, crowd out private investment. In sum, government current spending has the potential to create growth-inequality tradeoff in the context of Cote d'Ivoire. These findings, however, differ from Muinelo-Gallo and Roca-Sagalés (2014) but in line with Roca-Sagalés and Sala (2011).

A positive shock in public investment has a positive and statistically significant effect on economic growth and a negative effect on income inequality. In other words, public investment stimulates economic growth and reduces income inequality in Cote d'Ivoire. This shows that, in the case of Cote d'Ivoire, public investment-driven fiscal policy does not give rise to a growth-inequality tradeoff. This is an interesting finding as it indicates that public investment can be used to promote inclusive growth in Cote d'Ivoire. Our finding is consistent with López (2003) and Calderón and Servén (2004, 2010). The importance of public investment in stimulating economic growth is acknowledged in endogenous growth models. Specifically, public investment in education, health,

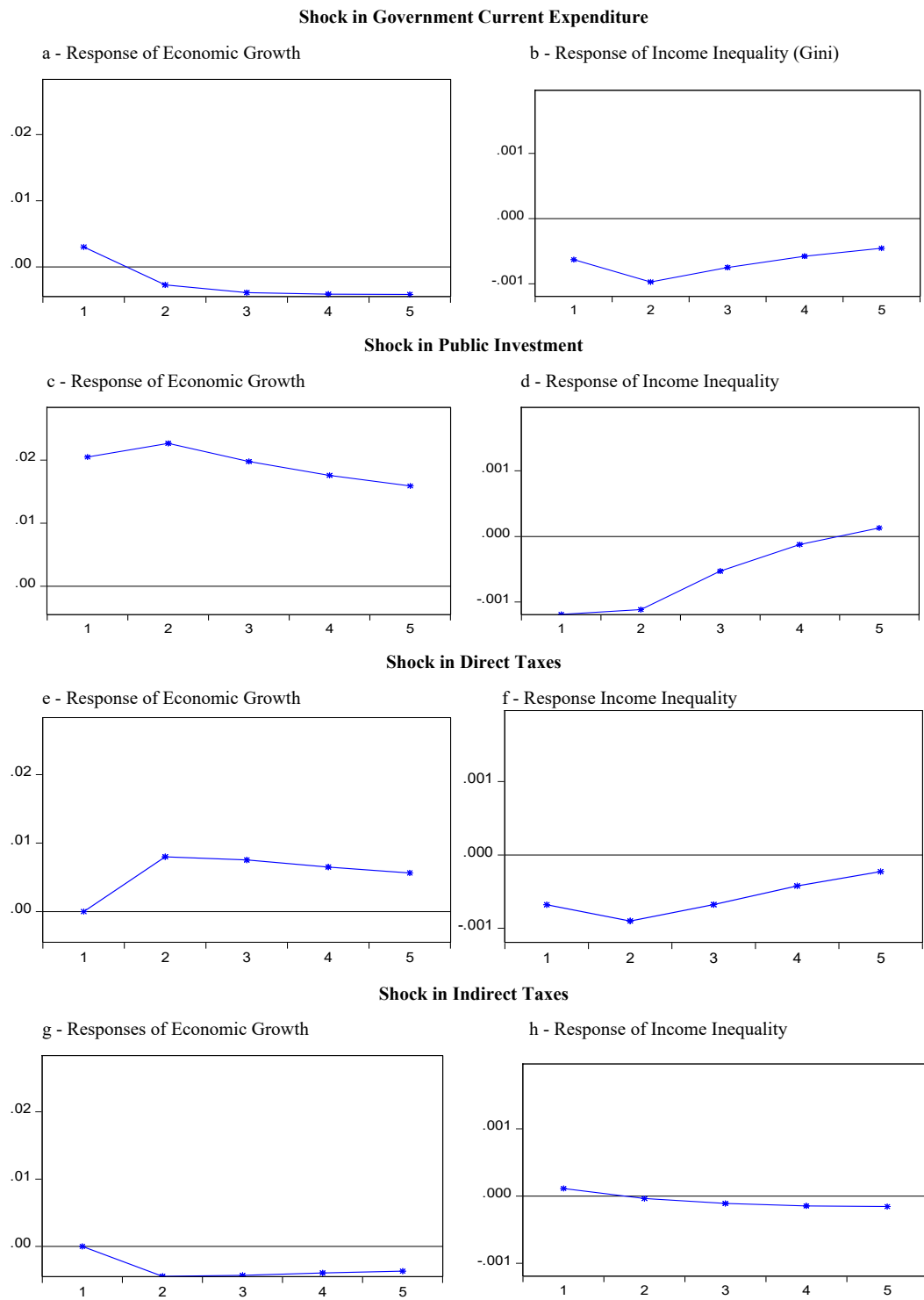
infrastructure, and research development is considered as the engine of economic growth. Lucas (1988) argues that investment in education increases the level of human capital, which in turn, increases the output. Other authors emphasize the importance of public investment in infrastructure (Barro, 1990), research and development (Romer, 1990), and health (Bloom et al., 2001) in economic growth. Also, public investment in socio-economic infrastructure impacts positively on the human capital of the poor segment of the society, which in turn, improve their job opportunities and income prospects (Brennenman and Kerf, 2002; Calderón and Chong, 2004).

A positive shock in direct taxes affects positively economic growth and negatively income inequality. In other words, direct taxes increase economic growth and reduce income inequality at the same time in Cote d'Ivoire. Our finding is consistent with Roca-Sagalés and Sala (2011). The inequality-reducing effect of direct taxes found in this study is in line with the theoretical predictions. Because of their progressivity feature, direct taxes, which comprise the personal income tax and corporate tax, are expected to reduce income inequality. However, the growth-enhancing effect of direct taxes found is contrary to the belief that direct taxes are harmful to economic growth because they tend to lessen economic incentives for work effort and investment, with a negative effect on output. However, our finding is consistent with Keho (2010) for the case of Cote d'Ivoire.

One of the possible explanations is that direct taxes in Cote d'Ivoire might have not yet reached the saturation point beyond which they could affect significantly investors' decisions, and hence, there is still a room for manoeuvre in terms of increasing direct taxes revenue. Also, as argued by Helms (1985), these taxes can lead to economic growth when they are used to finance public spending that has positive effects on investment and the productivity of private capital.

These are generally economic infrastructures such as roads, bridges, airports, railways, telecommunications, etc. and social infrastructures such as health, education, and electricity, etc. In Barro's (1990) model, the positive effects generated by this spending can offset the negative effects generated by distortions from taxation.

Figure 1. Impulse-response functions based on BVAR (1) with Minnesota prior



Another result found in this study is that a positive shock in indirect taxes affects negatively economic growth with almost no impact on income inequality. The negative effect of indirect taxes on economic growth can be explained by the fact that higher taxes on goods and services may affect negatively consumption and reduce aggregate demand in the economy, especially in a country like Cote d'Ivoire where the majority of the population belong to the low-income group. Also, in Cote d'Ivoire, import and export duties constitute a large share of indirect taxes, thus higher tax on international trade is more likely to reduce economic growth because of the role of trade as one of the engines of economic growth. Based on a sample made up of 45 African countries, including Cote d'Ivoire, UNECA (2019) reports that trade tax affects negatively economic growth.

Public investment and direct taxes reduce income inequality while promoting economic growth in Cote d'Ivoire. How important are public investments and direct taxes in explaining variations in economic growth and income inequality in Cote d'Ivoire? Table 3 shows the variance of economic growth (GDP) and income inequality (GINI) from shock in each fiscal policy variable.

Table 3. *Variance decomposition of GDP and Gini index (in %)*

Variance decomposition of GDP						
Period	Current Expenditure	Public Investment	GDP	Direct taxes	Indirect taxes	GINI
1	0.73	34.14	65.12	0	0	0
2	0.70	39.70	55.43	2.72	0.84	0.59
3	0.96	40.55	52.62	3.70	1.17	0.98
4	1.21	40.55	51.55	4.04	1.33	1.29
5	1.41	40.34	51.08	4.16	1.34	1.55
Variance decomposition of GINI index						
Period	Current Expenditure	Public Investment	GDP	Direct taxes	Indirect taxes	GINI
1	6.42	22.93	0.30	7.52	0.20	62.60
2	12.74	25.28	0.92	12.13	0.13	48.78
3	14.98	23.15	2.53	13.68	0.20	45.43
4	16.03	21.20	4.67	13.74	0.34	43.99
5	16.44	20.00	7.02	13.24	0.48	42.78

Table 3 shows that public investment is the fiscal policy that explains the large share of changes in economic growth in Cote d'Ivoire. For instance, the results show that in the second year after the initial shock, about 40% of the variance of GDP is explained by public investment, while 55% is explained by its lag. Public investment, government current expenditure and direct taxes are the fiscal policies that account for the large share of changes in income inequality in Cote d'Ivoire. In the second year after the initial shock, about 25% of the changes in income inequality is explained by public investment, 12% by direct taxes and government current expenditure, and 48% by its lag. The relative importance of government current expenditure in explaining the fluctuations of income inequality increases constantly over time to reach nearly 16.5% in the 5th year after the initial shock⁽⁴⁾.

5. Conclusion

As pointed out by the United Nations Economic Commission for Africa (UNECA) in its 2019 report, “despite the remarkable economic growth, income inequality in Africa fell only slightly”. This observation applies to Cote d'Ivoire where the recent impressive economic growth since the year 2012 coexists with a high level of market income inequality. This situation calls for a careful design of fiscal policy to reduce significantly income inequality, and hence, to make economic growth more inclusive in Cote d'Ivoire. However, fiscal policy aiming at reducing income inequality may undermine economic growth. In other words, there may be a tradeoff between the objectives of addressing income inequality and promoting economic growth via fiscal policy. Most of the existing studies usually examine separately the macroeconomic and redistributive effects of fiscal policy looking either at the impact of fiscal policy on growth or the effect of fiscal policy on income inequality. Only a few studies have investigated the joint responses of economic growth and income inequality to fiscal policy instruments.

We contribute to the rare existing evidence on this issue by investigating the case of Cote d'Ivoire. To this end, we use annual data over the period 1985-2016 and employ a Bayesian Vector Autoregressive (VAR) framework where prior beliefs combine with data information to draw a posterior probability distribution on parameters. The important results are that a positive shock in public investment and direct taxes affect positively economic growth and negatively income inequality. In other words, public investment and direct taxes promote growth and reduce income inequality at the same time, and hence, no growth-inequality tradeoff regarding these fiscal policy tools in the context of Cote d'Ivoire.

Also, the results show that a positive shock in government current expenditure reduces income inequality and undermines economic growth. In sum, government current spending has the potential to create growth-inequality tradeoff in the context of Cote d'Ivoire. We find also that a positive shock in indirect taxes impacts negatively on economic growth with a marginal effect on income inequality. Overall, our results show that government current expenditure is the only fiscal policy instrument that creates a significant tradeoff between growth and income inequality in the design of fiscal policy in Cote d'Ivoire.

Given the positive effect of direct taxes on economic growth found in this study, one could argue that the saturation point of the tax burden has not yet been reached, however, this is not to suggest an increase of direct tax rates. Although an increase in these taxes will reduce income inequality, it may undermine economic growth in the long-run. A complementary study should be conducted to determine the optimum level of direct taxes beyond which they could affect investors' decision and undermine economic growth. Efforts should also focus on improving the tax collection system which is very weak and plagued with corruption in Cote d'Ivoire. This can be done, for example, by the dematerialization of the taxes collection process. An efficient tax collecting system will increase government revenue which is needed to spend on investments in socio-economic infrastructures. The government should also increase the share of social spending such as transfers and subsidies in the total government current expenditure. This should be done carefully in such a way that it does not create distortion in the economy by paying attention, for example, to their efficiency and effectiveness.

Notes

- (1) West African Economic and Monetary Union comprises eight countries, namely Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, and Togo.
- (2) We would like to disaggregate further the fiscal measures; however, we are prevented from doing so due to data constraints.
- (3) Central Bank of West African States is the common Central bank for the country members of the West African Economic and Monetary Union.
- (4) For robustness check, we use alternative ordering by assuming that income inequality affects contemporaneously direct taxes and indirect taxes while income inequality gets affected by these variables with lag. We find similar results and they are available from the author upon request.

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My colleague is corrupt: Information disclosure to control corruption

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Abstract. *The paper argues that the co-workers of a corrupt public official are in the best position to provide proof of corruption. It, with the help of a game-theoretic model, discusses the incentive structure that will allow a co-worker to disclose the information on a corrupt public servant. The study argues that incentives for the co-worker may work best if they are based on the cost of disclosing the information and are contingent upon successfully proving corruption.*

Keywords: corruption; co-worker; information disclosure.

JEL Classification: D73.

1. Introduction

The main obstacle in controlling corruption is that the probability of being punished for corruption is often low. This low probability cannot be substituted with heavy punishments. In a democratic country, it is often not possible to impose a very heavy punishment for corruption. Even when such a punishment is possible, its effectiveness is doubtful (Wedeman, 2005; Zhu, 2012).

The studies have suggested increasing competition among public servants (Shleifer and Vishny, 1993), asymmetric punishment (Basu et al., 2016), increasing transparency (Lindstedt and Naurin, 2010; Kolstad and Wiig, 2009) and providing higher incentives to change the cultural equilibrium (Barr and Serra, 2010; Kaushik Basu, 2011) to tackle this problem. Though these policy measures may lower the corruption to some extent, they may not increase the probability of punishing the corrupt. The effect of competition is found to be ambiguous (Bliss and Di Tella, 1997). Asymmetric punishment proposed by Basu et al. (2016) may prove effective only in a small number of cases where the victim may have an incentive to report corruption to the authorities.

There are three major weaknesses of these proposals. First, the bribe that most people pay in their daily lives is much smaller than the cost of approaching higher authorities or court to avoid it. Paying bribe often makes availing public services relatively hassle-free which encourage people to bribe rather than completing the formalities. Second, the bribe payment by businesses in many cases is a repeated game. It considerably increases a business person's cost of reporting it. The cost of reporting is especially high if there is policy uncertainty and the businesses require additional time to adjust to the new law. In such a scenario, the businesses may prefer the public officials to turn a blind eye towards their operations for some time. Third, having a competing department is not possible in several cases due to the nature of service such as policing or the high cost of having multiple providers of public service such as schooling in rural areas. These drawbacks mean that despite the usefulness of these policies, we need an effective strategy to increase the probability of a corrupt public servant being punished. The present paper discusses one such possibility.

The probability of being found guilty of corruption is a function of the information available to the court or authorities. Thus, corruption can be analyzed as an information problem. The people, who often have the maximum information on the corruption, are the co-workers of a corrupt public official. A significant share of public officials does not benefit from the corruption of other public officials. In most of such cases, their interest is not aligned with that of the bribe payers. Therefore, they are less susceptible to policy uncertainties or bribe payer's incentives.

Many of these public officials can provide detailed information on their corrupt colleagues. They are also in the most suitable position to keep a record of the corruption that happened on multiple occasions, especially if the corrupt official has broken a law. Proving corruption becomes much easier when there is proof that the public official has accepted a bribe on multiple instances.

There are many instances when the authors asked a public official about the working of their departments. These public officials could always provide detailed information on the corrupt acts of their colleagues. They could even tell the ways the money is exchanged or how rules are manipulated. In several instances, they even knew the bribe payers.

Despite this, the reporting by a co-worker is rare. Honest public officials find it costly to testify against their colleagues. The corruption inquiries are lengthy and stressful for witnesses. They may face harassment at the hands of other colleagues for providing information. If the corrupt official is a senior, then the informant may find herself at the receiving end. On the other hand, co-workers hardly ever have any incentive to provide this information to the authorities. The governments do provide incentives to whistle-blowers in a few situations such as reporting tax evasion. However, such a policy is largely absent in majority of corruption cases. Hence, co-workers usually prefer not to disclose this information.

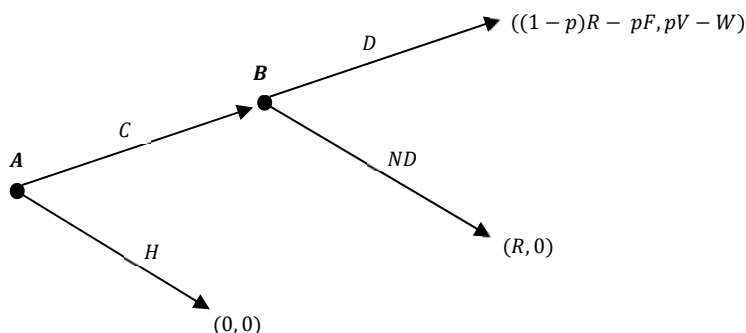
This whole situation can be analyzed as a game. Like the rest of the literature, the paper considers corruption as a public servant using his/her position for personal gains.

The paper is divided into four sections. The next section develops a simple model of corruption and information. It provides the conditions under which a co-worker will disclose the information about corruption of a public servant. The third section discusses the right amount of incentives that should be paid to the informant. The last section concludes the study.

2. The model

Let us assume a game with two players, A & B (Figure 1). Player A is a public official who may use her position for corruption. Player B is A 's co-worker who has information that can be used to prove A 's corruption. We shall assume that B does not benefit from corruption in any way. Both the players are assumed to be risk-neutral.

Figure 1. Corruption game



A plays first. She has two strategies available to her. She can choose corruption (C) or honesty (H). If she chooses H , then the game will end with a payoff vector of $(0, 0)$. In case, A engages in corruption, player B has two choices, either to disclose (D) or not to

disclose (*ND*) the information to the authorities. If *B* chooses *D*, then she must bear a cost W for disclosing the information and may gain V where $W > 0$ and $V \geq 0$. Player *B* may gain if she is competing with the corrupt official for promotion or it could be a reward by the government for disclosing the information. Here, the reward may be given in form of monetary benefits or extra points in promotion which are valued at V by the informant. We shall assume that the realization of V depends on *A* being proved guilty. This assumption ensures that people cannot gain by spreading rumors.

For simplicity, we shall consider that player *B* is the only one who can provide the information. If *B* discloses information, then *A* is found guilty with probability $p > 0$. *A*'s probability of being fined is zero (that is, $p = 0$) if *B* choose *ND*. Let R be *A*'s gains from corruption. If found guilty, *A* will lose R and has to pay a fine F . We shall assume that $R > 0$ and $F > 0$. Thus, *B*'s payoffs of choosing *D* are $pV - W$ and *A* gets payoffs $(1 - p)R - pF$. If *B* chooses *ND*, then she does not have to bear the cost W and *A* will not pay any fine. Thus, the game will end with a payoff vector $(R, 0)$.

Before analyzing the game, let us assume that *A* will choose *H* whenever choosing *C* or *H* give equal payoffs and *B* will choose *D* whenever her payoffs from *D* and *ND* are the same. Analyzing the game using backward induction, player *B* will choose *D* if $pV - W \geq 0$. This condition can be rewritten as $pV \geq W$. If $pV < W$, she will choose *ND*. If *B* chooses *ND*, then *A* will choose *C* as $R > 0$. If *B* chooses *D*, then *A* will choose *C* only if $(1 - p)R - pF > 0$ or $(1 - p)R > pF$. If $(1 - p)R \leq pF$, *A* will choose *H*. Now we shall discuss two simple propositions to understand how incentives to disclose information matter.

Proposition 1. If $V = 0$, then *A* will choose *C*.

Proof: *B* will choose *ND* if $pV < W$. Given $V = 0$, this condition requires $0 < W$. Since $W > 0$ as per the assumption, *B* will choose *ND*. Given that there is a complete information and $R > 0$, *A* will choose *C*. ■

Proposition 2. If $pV \geq W$ and $(1 - p)R \leq pF$, then *A* will choose *H*.

Proof. We know that *B* will choose *D* only if $pV \geq W$. With complete information and *B* choosing *D*, *A* will choose *H* as $(1 - p)R \leq pF$. ■

Proposition 1 represents the present regime that governs almost all cases of corruption. There may be a few situations in which a co-worker may benefit by providing information to the authorities. For example, *B* may benefit from disclosing information if she is competing with *A* for promotion. Even in such cases, the benefits often come too early and the co-worker may not have any incentive to keep cooperating with the authorities till the end. As a result, the probability of a corrupt official getting punished is often low in such cases too.

Proposition 2 provides conditions required for a public official to choose honesty. First, the fine must be set at a level so that expected gains from corruption are less than or equal to the expected fine, that is $(1 - p)R \leq pF$. Note that an increase in p has two effects. It increases the expected fine and lowers the expected gains from corruption. Second, the co-worker who can provide information about the corruption must have large enough benefits

from proving the corruption that her expected benefits must be equal to or higher so than her cost of disclosing information.

3. Finding the right value of V

Determining the right value of V is crucial for an efficient incentive mechanism. A higher value of V means that the condition, $pV \geq W$, can be fulfilled even for a low p . It will lead to a high number of disclosures most of which may have a very low probability of successful prosecution. It may result in the authorities spending too much time on cases with a meager chance of success.

This problem can be solved by deciding the value of p that the authorities find acceptable to start an investigation. Assume that this value is p^* . Let $V = W + Z$ so that it covers the cost of disclosing information. Here, Z is the incentive over and above W for revealing information. It will change B 's payoffs from disclosing the information to $p(W + Z) - W$ or $pZ - (1 - p)W$. Thus, she will choose D if $pZ \geq (1 - p)W$. Since the authorities would want all cases with probability equal to or higher than p^* to be reported, Z can be determined by equating $pZ - (1 - p)W$ to zero at p^* , that is

$$p^*Z - (1 - p^*)W = 0.$$

Solving this problem will give us

$$Z = \frac{(1 - p^*)}{p^*}W = kW \tag{1}$$

where $k = (1 - p^*)/p^*$.

Thus, the informant can be paid $(1 + k)W$ for disclosing the information. Even though each informant will be paid using the same formula, the different probability of success in each case means that each one of them will have different expected returns from disclosing the information. The advantage of paying the informant according to her cost is that condition $pZ \geq (1 - p)W$ will always be fulfilled whenever $p \geq p^*$. To see this, replace Z in $pZ \geq (1 - p)W$ with its value in equation 1. This will give us,

$$p \frac{(1 - p^*)}{p^*}W \geq (1 - p)W \Rightarrow \frac{(1 - p^*)}{p^*}pW \geq W - pW$$

Adding pW both sides, we can write this as

$$\begin{aligned} \frac{(1 - p^*)}{p^*}pW + pW &\geq W \Rightarrow \left[\frac{1 - p^*}{p^*} + 1 \right] pW \geq W \\ \Rightarrow \frac{p}{p^*}W &\geq W \end{aligned} \tag{2}$$

Equation 2 means that the condition $pZ \geq (1 - p)W$ will be met if and only if $p \geq p^*$. Thus, all corruption cases with the probability of successful prosecution equal to or more than p^* shall be reported to the authorities, but not those where probability is less than p^* .

If we consider an informant as a monopolist who is the sole producer of information, this condition is equivalent to first-degree price discrimination.

The model presented in the paper is highly simplified and has ignored many possibilities that may exist in real life. However, it does point out that incentive structure may become an effective tool in corruption control.

4. Conclusion

The co-workers of a corrupt public servant are often in the most suitable position to provide information on corruption. Since disclosing the information is costly, they will disclose the information only if their expected benefits are higher than their cost. The paper suggests that an incentive mechanism based on the cost of disclosing the information may be the most suitable.

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