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Expanding the Eurozone. The stage of economic convergence for Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania

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Abstract. *Before the economic crisis started in 2009, joining the Eurozone was mainly conditioned by meeting the nominal convergence criteria. Because of the problems faced by the Eurozone member states during the crisis, the European institutions implemented a series of measures aimed at increasing the resilience of the Eurozone, and thus the conditions for new candidates became more and more difficult. Gradually, they imposed conditions related to reaching a high level of real convergence, maintaining macroeconomic balance, and, more recently, joining the Banking Union, at the same time as joining the Exchange Rate Mechanism II. The sustainability of the nominal convergence criteria depends on a high level of real convergence and on sound macroeconomic indicators that would not generate macroeconomic imbalance. Based on the above, this paper touches on these aspects for the following six European Union member states, which stand to adopt the euro: Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania.*

Keywords: Convergence criteria, Euro area, GDP per capita, Romania, CESEE EU Member States.

JEL Classification: E60, F15, F36, F43, O40.

1. Introduction

The idea of using a single European currency by all European Economic Community countries and creating a European Central Bank was born in April 1989, by approving the Delors Plan. After the Madrid Summit in December 1995, it was established that the single European currency be named "euro".

In February 7, 1992, the Maastricht Treaty was approved, and it entered into force on November 1, 1993. The Treaty foresaw the creation of the European Union (EU), the Economic and Monetary Union, i.e. the Eurozone, by all member states using a single European currency, as well as the necessary convergence criteria for adopting the euro.

On January 1, 1999, 11 EU member states – Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain – adopted the euro, but it was used as a virtual currency for payment operations, while the national currencies were still being used for cash payments. Starting January 1, 2002, the euro was also introduced as bills and coins, thus replacing the old national currencies. Two European Union member states, Denmark and the United Kingdom went for an "opt-out clause" from adopting the euro.

Expanding the Eurozone started on January 1, 2001, with Greece joining, and it continued with the joining of Slovenia (2007), Malta (2008), Cyprus (2008), Slovakia (2009), Estonia (2011), Latvia (2014) and Lithuania (2015).

Currently, the euro is the national currency of 19 European states, and it stands to be adopted by the other seven states: Bulgaria, Czech Republic, Croatia, Hungary, Poland, Romania and Sweden.

This paper concentrates on the future expansion of the Eurozone, by analyzing the way in which the European Union member states who stand to adopt the euro meet the nominal, legal and real convergence criteria. The economic crisis was a cold shower for the Economic and Monetary Union, which determined its' strengthening, by new rules and supervisory mechanisms, and by coordinating the economic policies of the Eurozone.

2. The problems met by the Eurozone and the measures implemented for its consolidation

There are different opinions within the Eurozone about economic policies and future reforms. The Southern European countries, such as France, Italy, Greece, Spain, Portugal, Cyprus, Malta, want a more flexible budget policy and risk sharing by tax transfers between the Eurozone states. On the other hand, Central and Northern countries, Germany, Austria, the Netherlands, Finland, Slovakia, are relying on following tax regulations, promoting structural reforms and risk mitigation (Tokarski and Funk, 2019, p. 4).

The Eurozone benefitted from a favorable global economic context during the first decade of its existence, when most EU member states dearly wanted to adopt the euro, without considering the high differences between their national economic structures and their stages of development, compared to most Eurozone member states, which were highly developed. It was also during this time that many of the Eurozone founding member states, including

Germany, Italy and France, did not abide by some nominal convergence criteria. At the end of 2003, Germany had a budget deficit of 4.2% of the GDP, Italy had 3.3% of the GDP and France had a 4% of the GDP, which were over the threshold of 3% of GDP, provisioned in the Maastricht Treaty.

The economic crisis revealed these irregularities, which led to an explosion of public debt for some Eurozone member states, and an increase in unemployment rates, which imposed the adoption of new regulations and treaties for improving the institutional framework of the Economic and Monetary Union.

During the economic crisis, the European Union took a series of legislative measures which led to consolidating the *Stability and Growth Pact* and issuing the *Macroeconomic Imbalance Procedure*. The Macroeconomic Imbalance Procedure's purpose is the early detection and correction of excessive macroeconomic imbalance, and the analysis is made based on economic indicators included on a Scoreboard. Thus in the *Convergence Report* from May 2012, the European Central Bank has first analyzed and presented the situation of economic indicators on the Macroeconomic imbalance procedure scoreboard, for EU member states who are candidates for joining the Eurozone. The European Central Bank mentions that "EU Member States with a derogation that are subject to an Excessive Imbalance Procedure can hardly be considered as having achieved a high degree of sustainable convergence as stipulated by Article 140(1) of the Treaty" (European Central Bank, 2012, p. 18).

Finalizing the Banking Union represents one of the major reform projects for the Eurozone, in order to increase its resilience. This project began in 2012, as a response to the effects of the economic and financial crisis in Europe. The Single Supervisory Mechanism is one of the finalized pillars of the Banking Union, and participating in this mechanism is compulsory for all Eurozone member states.

Lately, the European Union institutions recommend Eurozone candidate states to participate in the Single Supervisory Mechanism at the same time as they enter the Exchange Rate Mechanism II, upon joining the Eurozone.

3. Expanding the Eurozone

Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania are European Union member states with "derogation" from adopting the euro. According to the Treaty on the functioning of the European Union, these states will adopt the euro only after they sustainably meet the nominal convergence criteria as foreseen in article 140 and after they harmonize their national laws with the European ones, according to articles 130 and 131.

The nominal convergence criteria are price stability, soundness of public finances, long-term interest rates and exchange rate stability, by having the national currency participate in the Exchange Rate Mechanism II (ERM II) for a minimum of 2 years.

Legal convergence refers to the harmonization of law as regards the central bank activity, banning monetary financing and privileged access of the public sector to financial institutions.

Nominal convergence is evaluated by the European Commission and the European Central Bank once every two years (or faster, if the analyzed state requests it), by drawing up a convergence report to be presented to the Council.

Accessing the Eurozone will be more difficult for the seven EU states outside the euro area, compared to the states who adopted the euro before the economic crisis start in 2009, whose entrance was mainly based on meeting the nominal convergence criteria. During the last decade, the European Commission and the European Central Bank present and analyze not only the evolution of nominal convergence, but also real convergence, and economic indicators which can create macroeconomic imbalance.

Because of the financial problems of some of the Eurozone states, such as Greece, but also because of the corruption scandals within the Central Bank of Slovenia (Euobserver article from July 7, 2016), European institutions and Eurozone member states have become very precautious with regards to expanding the Eurozone. Moreover, the effects of the economic crisis have curbed the enthusiasm of the candidate states, and they set their target dates for adopting the euro as late as possible.

Czech Republic, Hungary and Poland have not yet set a date for adopting the euro. Through the *Substantiation report of the national plan to adopt the euro*, Romania has set 2024 as the target date. Bulgaria and Croatia have shown their intention to enter the Exchange Rate Mechanism II (ERM II) as soon as possible.

According to the Eurobarometer of the European Commission no. 465 of May 2018, the euro currency is highly appreciated by the Romanian citizens, as 69% agree to adopt the euro. In Hungary, 59% of the surveyed citizens agree to move to the euro, in Bulgaria 51%, in Poland 48%, in Croatia 47% and in Czech Republic, only 33%.

These wishes of the citizens play an important role in political decisions. Thus, Czech Republic, Hungary and Poland are in no hurry to adopt the euro any time soon.

The high support of the euro amongst the citizens of the majority of candidate states should represent an important factor in accelerating the reforms made by the national institutions, in order to successfully adopt the euro.

When it comes to adopting the euro, most citizens are concerned with a possible increase in the price of goods and services. According to Eurostat estimations, as a result of a adopting the euro, for the latest states to join the Eurozone (Slovenia, Slovakia, Estonia, Latvia and Lithuania), the increase in prices was under 0.3 percent points.

Adopting the euro will bring a series of advantages for new member states, such as eliminating exchange rate risk, a reduction in interest rates, a better financial and macroeconomic stability, etc. Based on the reduction in interest rates and introducing a more stable currency such as the euro, an increase in investments is expected, including direct foreign investments in the new euro states. In order to benefit from all of these advantages, it is necessary that the country reaches a high and sustainable nominal and real convergence before joining the Eurozone, and also maintaining them after accession.

Adopting the euro will increase the resilience of the national financial sector, and in the event of a national financial crisis, the new member states will have access to the European Stability Mechanism, through which they could receive financial assistance.

The costs of joining the Eurozone include a possible slight, negligible, increase in prices, logistics expenses related to changing the national currency, the financial contribution of new states to the European Stability Mechanism, the Single Resolution Fund, paying a participation fee at the European Central Bank subscribed capital etc.

4. The analysis of the nominal convergence criteria and of the economic situation of the six Eurozone candidate states

According to the European Central Bank 2018 Convergence Report, at the time of the analysis, the legislation of five out of the six states analyzed in this paper – Bulgaria, Czech Republic, Hungary, Poland and Romania – did not fully meet the requirements related to the independence of the central bank and of its integration in the Eurosystem, as well as the interdiction of monetary financing. Within the European Semester of 2018, of the European Commission, Croatia is mentioned as the only Eurozone candidate country whose legal framework is completely compatible with the European one.

By the end of 2018, none of the 6 states analyzed had met the nominal convergence criteria. The criterion related to the stability of the exchange rate is not met by any of these states, because they have to yet enter the Exchange Rate Mechanism II.

The criterion related to maintaining the budget deficit under 3% of the GDP was met by all six states, Croatia, Czech Republic and Bulgaria even registering budget surplus. Croatia and Hungary have public debt of 74.6% and 70.8% of GDP respectively, and they are the only Eurozone candidate states with a public debt of over 60% of GDP. The criterion regarding price stability has not been met by Bulgaria, Hungary and Romania; the criterion regarding long-term interest rates has not been met by Poland and Romania.

Table 1. *The level of meeting nominal convergence criteria, except the criterion on the stability of the exchange rate, for Bulgaria, Czech Republic, Croatia, Hungary and Romania in 2018*

Country/Indicators	Inflation Rate HICP (%, annual average)	Long-term interest rates (% per year, annual average)	General Budget Deficit/Surplus (ESA, % of GDP)	Public Debt (ESA, % of GDP)
Bulgaria	2.6 criterion: < 2.2	0.89 criterion: < 3.19	+2.0 criterion: ≥ -3	22.6 criterion: ≤ 60
Czech Republic	2.0 criterion: < 2.2	1.98 criterion: < 3.19	+0.9 criterion: ≥ -3	32.7 criterion: ≤ 60
Croatia	1.6 criterion: < 2.2	2.17 criterion: < 3.19	+0.2 criterion: ≥ -3	74.6 criterion: ≤ 60
Hungary	2.9 criterion: < 2.2	3.06 criterion < 3.19	-2.2 criterion: ≥ -3	70.8 criterion: ≤ 60
Poland	1.2 criterion: < 2.2	3.20 criterion: < 3.19	-0.4 criterion: ≥ -3	48.9 criterion: ≤ 60
Romania	4.1 criterion: < 2.2	4.69 criterion: < 3.19	-3.0 criterion: ≥ -3	35.0 criterion: ≤ 60

Note: The average annual inflation rate of the top 3 highest performing EU states as regards price stability (Ireland, Denmark, Cyprus) is 0.7% for 2018, and the average long-term interest rate in the 3 states is 3.19%.
Source: Eurostat.

Hungary and Romania did not meet their medium-term budgetary objective, as they registered an estimated structural deficit of 2.3% and 2.7% of GDP respectively, which is a lot over the threshold of 1% from the Stability and Growth Pact.

In order to coordinate the economic processes of the member states, the Macroeconomic Imbalance Procedure (MIB) was introduced. Its purpose is the early detection of macroeconomic imbalance within one member state, which may have negative effects on the economies of other member states. In order to detect the generating factors, the MIB Scoreboard is used – it contains a set of economic indicators.

Bulgaria and Croatia are dealing with macroeconomic imbalance, and they are subjected to a new analysis by the European Commission, within the Alert Mechanism Report of 2018.

Czech Republic, Poland, Romania and Hungary are not facing major macroeconomic imbalance, and they are not the object of an analysis within the Alert Mechanism Report of 2018.

Table 2. *The Scoreboard for the supervision of macroeconomic imbalance in Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania in 2017 and 2018*

	Indicator Criterion	Years	Bulgaria	Czech Republic	Croatia	Hungary	Poland	Romania
Current account balance - 3 year average (% of GDP)	between -4% and 6%	2017	1.9	1.2	3.6	3.9	-0.3	-2.2
		2018	3.4	1.2	3.0	3.1	-0.4	-3.3
Net international investment position - annual data (% of GDP)	minimum -35%	2017	-44.7	-25.0	-62.4	-53.0	-61.0	-47.8
		2018	-36.8	-23.6	-54.1	-46.8	-55.6	-44.7
Real effective exchange rate based on HICP - Percentage change (t/t-3)	±5% (EA); ±11% (non-EA)	2017	-3.3	5.3	-0.1	0.0	-3.5	-5.6
		2018	4.1	11.0	4.1	2.0	0.1	-0.6
Export market shares - 5 years % change	minimum -6%	2017	19.0	8.7	19.6	11.1	28.1	36.6
		2018	10.5	12.1	18.5	9.2	25.4	23.1
Nominal unit labour cost - 3 years % change	maximum +9% (EA); +12% (non-EA)	2017	13.6	5.9	-4.3	6.7	4.2	13.5
		2018	13.5	13.4	:	16.8	7.8	33.5
House price index, deflated - annual average rate of change (%)	maximum 6%	2017	6.2	9.1	2.8	3.3	1.7	3.3
		2018	3.9	5.3	4.8	6.2	4.9	1.8
Unemployment rate - 3 year average (%)	maximum 10%	2017	7.7	4.0	13.5	5.4	6.2	5.9
		2018	6.3	3.0	11.0	4.3	5.0	5.0
General government gross deb - annual data (% of GDP)	maximum 60%	2017	100.1	67.4	98.2	71.6	76.4	51.0
		2018	:	:	:	70.8	76.0	48.1
Private sector debt - annual data (% of GDP)	maximum 133%	2017	25.6	34.7	77.8	73.4	50.6	35.2
		2018	22.6	32.7	74.6	70.8	48.9	35.0

: – unavailable data.
Source: Eurostat.

With the exception of Czech Republic, the indicator regarding the net international investment position is under the reference threshold of -35% of GDP, recommended within the *Macroeconomic Imbalance Procedure*.

In 2018, out of the six Eurozone candidate states, the Czech Republic had the lowest unemployment rate, 3%, while Croatia had the highest, 11%. It is worth mentioning that

there are several Eurozone states who have high unemployment rates at the end of 2018, Greece having a level of 18.6%, Spain 14.5% and Italy 10.8%.

In 2018, the highest employment rate of the population aged between 15 and 64 years old was that of Czech Republic, with 75.4%, while Croatia was the lowest, at 60.6%.

In order for the European Central Bank's policy to act in the same way for all economies in the Eurozone, it is necessary that the national economy structures be as similar as possible and there should also be a synchronicity of the economic cycles.

The economic structures of the six states are different from the ones in the strong Eurozone states; for instance, the Czech industry weighs more in the GDP than the Eurozone average, and the Romanian agriculture has a larger weight than that of Eurozone states. There is also an improper alignment of economic cycles in candidate states with the economic cycles of Eurozone states, which may lead to asymmetric shocks.

For Croatia, according to the information included in its own euro adopting strategy, losing their monetary policy will not have a very high cost, due to the high level of deposits and loans granted in euros; Croatia also has an economic cycle which is synchronized with the Eurozone states. As a small country, with a large economic opening, Croatia will find it easier to give up its own monetary policy, because its financial conditions are mainly influenced by external factors.

As regards banking, Croatia has the highest degree of euroisation of the six Eurozone candidate states. At the end of 2016, 58.1% of Croatian banking loans were granted in euros, while 59.4% of all banking deposits were in euros.

Table 3. *The weight of loans and deposits granted in euros out of the total number of loans and deposits in Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania, at the end of 2016*

	Outstanding amounts of euro- denominated loans (in EUR millions)	As percentage of total Loans (%)	Outstanding amounts of euro-denominated deposits (in EUR millions)	As percentage of total Deposits (%)
Bulgaria	11,159	42.9	11,109	31.9
Croatia	15,974	58.1	19,876	56.7
Czech Republic	11,957	12.3	8,930	7.2
Hungary	8,159	19.8	9,725	18.3
Poland	25,644	10.8	17,346	7.1
Romania	18,816	38.8	16,006	26,5

Source: European Central Bank (2017), The International role of the euro, July 2017.

5. The Exchange Rate Mechanism II and participating in the Banking Union

Before joining the Eurozone, a candidate state will have to participate in the Exchange Rate Mechanism II (ERM II) for at least 2 years, and the euro exchange rate will have to fluctuate within a margin of maximum ±15% or even within a smaller interval, if the responsible parties establish it.

Before joining ERM II, the respective state will have to reach not only a high level of sustainable nominal convergence, but also a high degree of real convergence, of GDP per capita in purchasing power standards. There will be a negotiation process between the state

who requests participation in ERM II, who will be represented by its Government and its Central Bank, and the European institutions and the Eurozone member states. The negotiations will be conducted based on setting the central parity of the national currency against the euro, the fluctuation margins, as well as on the participation of the candidate state in the Banking Union, by joining the Single Supervisory Mechanism. From the experience of the most recent states, we could observe that the negotiation process can last from several days to several months.

The states will have to undergo preparation for joining the Banking Union and to sign an agreement taking it upon themselves to update their legal framework with new tax regulations (Government of the Republic of Croatia; Croatian National Bank, 2018, p. 10).

Before joining the Single Supervisory Mechanism, ECB will request an evaluation of all commercial banks in the candidate states, which will include an inspection of bank assets and their shock resilience.

As a result of participating in the Single Supervisory Mechanism, certain commercial banks considered of systemic importance (a minimum of 3 commercial banks) will be supervised directly by the ECB. The rest of commercial banks will continue to be supervised by competent national authorities.

On June 29, 2018, Bulgaria sent a common letter from the Bulgarian Ministry of Finance and the Bulgarian National Bank to express their intention to participate in Exchange Rate Mechanism II and the Banking Union starting July 2019. On July 24, 2018, the President of the Eurogroup issued an answer mentioning that approximately a year after Bulgaria submitted their request, the ECB would finalize their evaluation of the cooperation with the National Bank of Bulgaria, of Bulgaria's participation in the Single Supervisory Mechanism, and the Single Resolution Mechanism (including the Single Resolution Fund). Also, the recommendation is for Bulgaria to improve their legal framework on the corporate governance of state owned enterprises. Bulgaria should also apply the recommendations of the Commission of the Cooperation and Verification Mechanism for judicial reform and the fight against corruption, which would lead to the stability and integrity of the financial system.

According to Bulgaria's Convergence Program 2019-2022, in order to participate in ERM II and in the Banking Union implicitly, in 2018, the National Bank of Bulgaria started preparing the modification of the legal framework.

The legal changes include establishing a close cooperation between the European Central Bank and the National Bank of Bulgaria, delegating certain competences to the ECB and extending the National Bank of Bulgaria's competences as regards macro prudential supervision of credit institutions. In view of joining the Single Supervisory Mechanism (part of the Banking Union), as Bulgaria joined the ERM II, they modified the Credit Institutions Law and the Law of the National Bank of Bulgaria (Ministry of Finance of Bulgaria, 2019, p. 21).

On July 4th, 2019, it was Croatia's turn to send a letter to the European institutions and to the ministries of finance of the Eurozone states and of Denmark, to request their accord to participate in the Exchange Rate Mechanism II.

Through the document titled "The Euro Adoption Strategy of the Republic of Croatia", Croatia manifests their availability to participate in the Exchange Rate Mechanism II, in view of adopting the euro.

"Strategy for the adoption of the euro in the Republic of Croatia" presents the economic and political determining factors in order to meet the criteria for joining the Eurozone, but it does not mention a target date for Croatia's adoption of the euro.

The document titled "Assessment of the Fulfilment of the Maastricht Convergence Criteria and the Degree of Economic Alignment of the Czech Republic with the Euro Area", elaborated by the Czech Ministry of Finance and the Czech National Bank, recommends that Czech Republic does not yet set a target date for joining the Eurozone and does not yet participate in the ERM II. The reasons shown are the necessity for finalizing Czech Republic's process of real convergence with the Eurozone average, the existence of a large gap between prices and wages in Czech Republic and the average levels of the Eurozone, the differences between the Czech economy structure and the Eurozone economies. Moreover, the ongoing changes in Eurozone institutions and regulations make it so that the Czech Republic cannot currently evaluate the obligations they will have to undertake after joining the Eurozone.

As the other Eurozone candidate states, the Czech Republic have established a Single Resolution Fund, whose capital is formed of the contributions of all commercial banks in Czech Republic. Thus, upon joining the Eurozone, or maybe even upon participating in the Exchange Rate Mechanism II, the contributions will be transferred in the Single Resolution Fund, as part of the Banking Union established at Eurozone level.

It is expected that in 2022, Romania will request to participate in the Exchange Rate Mechanism II, since the *Substantiation report of the national plan to adopt the euro* sets 2024 as Romania's target date for adopting the euro.

Poland and Hungary aren't going to adopt the euro in the foreseeable future, as neither has yet set a target date for joining the Eurozone, nor have they announced their intention to take part in the Exchange Rate Mechanism II.

Currently, none of the six analyzed states participate in the ERM II. Thus, we have made a simulation of the fluctuations of the national currencies of Czech Republic, Croatia, Hungary, Poland and Romania, from January 2017 to December 2018 (the minimum 2 year period for participating in ERM II), against the central parity of national currencies, which we have hypothetically considered as the arithmetic average of the national exchange rate for the euro in December 2016, the month preceding the analyzed period. This analysis does not include the *leva* (Bulgaria's national currency), as Bulgaria has a fixed exchange rate with the euro, set at 1.95583 BGN/EUR.

Table 4. *The exchange rate for the euro in Czech Republic, Croatia, Poland, Hungary and Romania, from January 2017 to December 2018, compared to the average registered in December 2016 (%)*

	Czech Republic	Croatia	Hungary	Poland	Romania
Euro exchange rate (percentage appreciation(+)/depreciation(-) over 2 years)	+7.30/-0.10 criterion: ±15%	+2.19/-0.50 criterion: ±15%	+2.93/-5.33 criterion: ±15%	+7.09/+0.53 criterion: ±15%	+0.61/-3.34 criterion: ±15%

Note: the deviation of the national currencies/euro exchange rates during 2017-2018, compared to the average of December 2016; Bulgaria's currency has not been included, because it has a fixed euro exchange rate.
Source: European Central Bank.

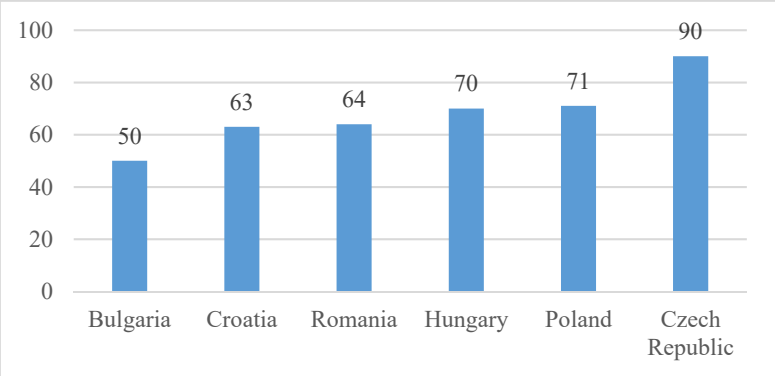
According to the data presented in Table 4, the national currencies/euro exchange rates fit in the fluctuation margin of ±15% against "central parity".

6. Real convergence and intra-national disparities

The Maastricht Treaty for the functioning of the European Union contains no article referring to the necessity of having a high degree of real convergence before adopting the euro. The idea was that the Eurozone will automatically lead to an increase in real convergence.

When talking about real convergence, we mainly refer to the indicator GDP per capita in purchasing power standards (PPS).

Figure 1. *GDP per capita in PPS in 2018 (% of EU 28 average)*



Source: Eurostat (latest update: 17.06.2019).

Figure 1 shows that Czech Republic's economy is a sound one, as its GDP per capita in purchasing power standards is 90% of the European Union average (EU28). The other five candidate states still have a series of economic measures to implement in order to reach real convergence to an as high as possible degree.

When joining the Eurozone in 2015, Lithuania had a GDP per capita in PPS at 75% of European Union average (EU28). The Czech Republic is far above this level, but official Czech documents show that the Czech authorities intend to adopt the euro only after their GDP per capita in PPS reaches the European Union average.

Table 5. *GDP per capita in PPS in Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania, on regional level (NUTS 2016) in 2017*

Region (NUTS 2016)	GDP per capita (PPS)	GDP per capita PPS (%,UE28=100)	Region (NUTS 2016)	GDP per capita (PPS)	GDP per capita PPS (%,UE28=100)
BULGARIA	14,800	49	CZECH REPUBLIC	26,900	89
Yugozapaden	23,700	79	Prague	56,200	187
Yugoiztochen	13,000	43	Střední Čechy	25,100	84
Severoiztochen	11,800	39	Jihovýchod	24,400	81
Yuzhen tsentralen	10,400	35	Jihozápad	23,300	77
Severen tsentralen	10,200	34	Severovýchod	22,600	75
Severozapaden	9,300	31	Moravskoslezsko	22,100	74
CROATIA	18,500	62	Střední Morava	22,000	73
Kontinentalna Hrvatska	18,900	63	Severozápad	19,000	63
Jadranska Hrvatska	17,800	59	HUNGARY	20,300	68
POLAND	20,900	70	Budapest	41,900	139
Warszawski stołeczny	45,700	152	Nyugat Dunántúl	21,500	72
Dolnośląskie	23,100	77	Közép Dunántúl	18,800	63
Wielkopolskie	22,800	76	Pest	16,000	53
Śląskie	21,600	72	Dél-Alföld	14,500	48
Pomorskie	20,200	67	Észak Magyaroszág	13,700	46
Łódzkie	19,500	65	Dél Dunántúl	13,500	45
Małopolskie	19,100	63	Észak-Alföld	12,900	43
Mazowiecki regionalny	17,800	59	ROMANIA	18,800	63
Zachodniopomorskie	17,400	58	Bucharest - Ilfov	43,200	144
Lubuskie	17,300	57	Center	17,900	60
Kujawsko-Pomorskie	16,900	56	North-West	16,900	56
Opolskie	16,600	55	South-East	15,800	53
Podlaskie	15,000	50	South Muntenia	15,100	50
Świętokrzyskie	14,900	50	South-West Oltenia	13,600	45
Warmińsko-Mazurskie	14,700	49	North-East	11,600	39
Podkarpackie	14,600	49			
Lubelskie	14,400	48			

Source: Eurostat.

There is a very large economic gap between the national regions of Czech Republic, Hungary, Poland and Romania. On the one hand, there are those regions that include their capitals, Prague, Budapest, Warsaw and Bucharest, which have a GDP per capita in PPS far above EU average (the Prague region has an almost double level compared to the EU average), while on the other hand there are regions (except in Czech Republic) with a GDP per capita in PPS below 50% of European Union average (Table 5).

It is recommended that the states who stand to adopt the euro first reach a high level of GDP per capita in PPS compared to European Union average, together with a sustainable fulfillment of nominal convergence criteria, but that they also reduce the economic gaps between their own regions.

7. Conclusions

A strong Eurozone needs strict rules, that may not be broken by some of the member states. It is also necessary to finalize the Banking Union, to create the Capital Markets Union and a common Eurozone Treasury, as it emerges from the "The Five Presidents' Report: Completing Europe's Economic and Monetary Union".

Economic growth will still be possible after joining the Eurozone in the six analyzed states, under the condition that they continue their structural reforms, maintain their nominal convergence, while the institutions and mechanisms of the Eurozone continue their consolidation.

In order for the ECB's monetary policy to have the desired impact on the new states, it is recommended that before joining the Eurozone, they have a high alignment between their national economies and the economies of the Eurozone, but that they also align their economic cycles.

The competitivity of companies in the EU states outside the Eurozone has been maintained by the existence of national currencies which were weaker than the euro, which led to an increase in exports, but also by smaller wages costs. After adopting the euro, an increase in wages is expected, while the exchange rate advantage will disappear. Consequently, the new Eurozone member states will have to implement a set of structural reforms and measures to increase competitivity, especially by increasing labour productivity, offering good quality products and services, delivering goods on time etc.

In the 2018 Convergence Report by the European Central Bank, Croatia and Romania are recommended to improve the EU fund absorption and to take measures to improve the business environment, the institutional environment and corporate governance. Also, Hungary is advised to eliminate excessive taxation and bureaucracy, consolidating the institutional environment, in order to increase the competitivity of the private sector.

All in all, it is worth mentioning one recommendation from the 2018 Convergence Report by the European Central Bank, addressed to all six candidate states – Bulgaria, Croatia, Czech Republic, Hungary, Poland and Romania: "In order to further bolster confidence in the financial system, the national competent authorities should continue to improve their supervisory practices, among other things, by following the applicable recommendations from the relevant international and European bodies, and by collaborating closely with other national supervisors of EU Member States within the supervisory colleges" (European Central Bank, 2018, p. 69).

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Business R&D investments in the EU: Main dynamics and economic effects

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Abstract. *Research and development expenditures are known as drivers of innovation and productivity. This paper aims at investigating two interrelated aspects of business R&D investments in the EU: the main features and trends in business R&D investments and their impact on company's performance. The results from preceding descriptive analysis on the most recent dynamics in the EU's R&D investments indicate the persistence of several characteristics highlighted also in the literature, such as an increasing business R&D intensity gap between the EU and its main competitors, large differences registered in the total R&D investment intensity across EU countries, sectors and firms and industrial R&D concentration at the level of a few players. The positive impact of R&D investments on company's performance in terms of net sales and operating profit is shown by conducting several econometric models. We also investigate whether the size has an effect on the R&D investments performed by companies exploiting data from the EU industrial R&D investment Scoreboard.*

Keywords: company, research and development, EU Scoreboard, innovation, performance.

JEL Classification: O12, O16.

1. Introduction

Research and development (R&D) expenditure has been intense used in innovation analysis as a proxy for innovation inputs and viewed as a determinant of economic growth and productivity. Investments in research and other intangible assets (education, ICT, skills development, management capacity etc.) are essential to support knowledge creation and that can be transformed to higher-value-added innovations.

Being identified as source of innovation and performance, one of the pillars of the European Union's policy agenda states that the EU should move towards a stronger public research and to make it more attractive to private investment in research and innovation. This would allow the EU to bridge the growing gap in the levels of research investment between Europe and its main trading partners (European Commission, 2003). Also, the Innovation Union is one of the 7 flagship initiatives of the *Europe 2020 strategy* for smart, sustainable and inclusive growth. The Innovation Union plan aims to make Europe into a world-class science performer, to remove obstacles to innovation like expensive patenting, market fragmentation, slow standard-setting and skills shortages, and to revolutionize the way public and private sectors work together, notably through innovation partnerships between the European institutions, national and regional authorities and business.

The comparative analysis of innovation performance in the EU countries that aim at assessing relative strengths and weaknesses of national innovation systems, as well as industrial research monitoring activity were set up as parts of the action plan. In this context, scoreboards were building to evaluate trends in R&D investment. The EU Scoreboard of top R&D-investing companies is published annually and monitors the top 1000 R&D investors financed by company's funds, regardless the place where the R&D is performed. R&D investments allow firms to develop new products, processes or services. For this reason, the EU Scoreboard allows the inputs to this process to be monitored and facilitates comparisons with other companies operating in the USA, Japan or other parts of the world.

This paper aims at investigating the main features and trends of business R&D investments in the EU and their impact on company′s performance. Firstly, we conduct a descriptive analysis on the most recent trends in R&D investments in the EU and third countries. While overall average European R&D intensity (ratio of R&D investment to GDP) lags behind the one registered by its competitors, the top EU industrial companies invest annually more in R&D and are among the most important players on the world market. Exploiting the latest micro-data from the EU Industrial R&D Investment Scoreboard, we investigate R&D investment patterns by examining the distribution of R&D investments among sectors and countries. R&D concentration at the level of a few countries, sectors and companies creates analysis opportunities regarding the impact of R&D on company's performance. The positive impact of R&D investments on company's performance in terms of net sales and operating profit is shown by conducting several econometric models. We also investigate whether the size has an effect on R&D investments of the companies.

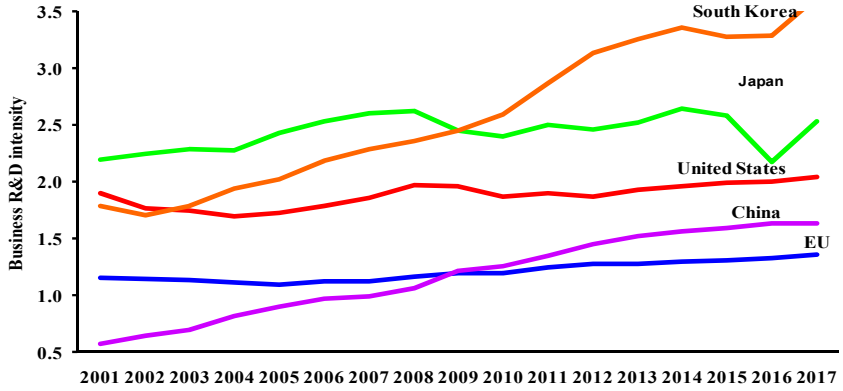
2. Dynamics in the EU's business R&D investments

Europe is a global player in research and innovation activity, leading in public investment in R&D and in its stock of researchers. It is also a front runner in scientific production, including high-quality of scientific publications. The EU accounts for less than one fifth of the world's R&D investment, but a quarter of global public R&D investment and one third of all high-quality scientific publications (European Commission, 2018a).

However, several factors can explain Europe's difficulty to transform its scientific leadership into leadership in innovation, mainly related to underinvestment in research activities.

Europe's *investment in business R&D* is less than one fifth of global business R&D investment. Although there is a slightly upward trend in business R&D intensity registered in the last decade, Europe's business R&D intensity has been shrinking over time due to the rising share of other economies, notably China. One quarter of global business R&D expenditure is performed in China and its business R&D intensity has nearly tripled since 2000, progress that is rivaled only by South Korea. In fact, business R&D intensity stood at 1.36% in 2017 in the EU, in comparison to 2.04 in the United States and 3.62% in South Korea (Figure 1), reflecting an increasing business R&D intensity gap between the EU and its main competitors.

Figure 1. *Business R&D intensity by region (R&D as % of GDP)*



Source: Eurostat.

The EU is not on track to reach the Europe 2020 strategy target of 3% of GDP invested in R&D. By 2020, the EU aims to reach an overall R&D intensity of 3% (2% for business R&D intensity) through different national targets. While R&D expenditures have increased in most member states over the last decade, it is unlikely that the EU target of 3% of GDP will be met by 2020. EU R&D intensity only increased from 1.83% of GDP in 2008 to 2.06% in 2017 and it is considerably behind that of South Korea, Japan and United States. There are various national targets of R&D intensity (as it is shown by European Commission – Eurostat; EIB, 2018 etc.). As of 2017, Denmark, Germany, Czech Republic and Cyprus were the EU countries to have reached their national Europe 2020 strategy target.

Large differences are registered in the total R&D investment intensity across EU countries, especially between those in the EU's core and periphery. For instance, in 2017 Romania allotted 0.5% of the GDP to R&D, which was below the EU average of 2.06% and it was the lowest share among the member states. This puts Romania in a group of countries where the R&D expenditure was below 1% of the GDP in 2017, namely Latvia (0.51%), Malta (0.55%), Cyprus (0.56%), Bulgaria (0.75%), Croatia (0.86%), Lithuania (0.88%) and Slovakia (0.88%). The countries that spent the most on R&D were Sweden (3.33%) and Austria (3.16%), followed by Denmark (3.06%) and Germany (3.02%).

The large dispersion of R&D intensity and its dynamics is mainly driven by business R&D expenditures and reflect several low investors stagnating and some high investors accelerating as well as some Central and Eastern European countries increasing their R&D levels. The highest EU business R&D intensity growth rates over 2007-2017 are registered in Bulgaria, Poland, Greece, Slovakia, Cyprus and Hungary, all of which had growth rates at least four times higher than the EU average. Although the business R&D intensities of all of these member states were below the EU average in 2017, the gap with the EU average has narrowed considerably since 2007.

Business R&D expenditures registered 54.8% of the gross domestic expenditure on R&D in 2008 in the EU, but the situation has not improved much almost a decade later. The share of business R&D expenditures in 2017 in the EU was lower than that in the United Sates (63.6%) and in South Korea (74.7%) as we show in Table 1. This indicates that, to catch up with its main competitors, the EU will need to create a better framework and provide the right incentives for supporting more R&D activities by the business sector.

Table 1. *Gross domestic expenditure on R&D by source of funds in the EU-28 and competing economies (as % of total)*

Region/country	Business enterprise sector		Government sector		Higher education sector		Private non-profit sector	
	2008	2017	2008	2017	2008	2017	2008	2017
EU-28	54.8	56.6	33.8	29.5	1.0	0.9	1.6	1.6
China	71.7	76.5	23.6	19.8	n.a.	n.a.	n.a.	n.a.
United States	62.5	63.6	30.4	22.8	2.9	3.6	3.2	3.9
Japan	78.2	78.3	15.5	19.8	5.1	5.3	0.7	0.8
South Korea	72.9	74.7	25.4	21.6	1.0	0.6	0.4	0.3

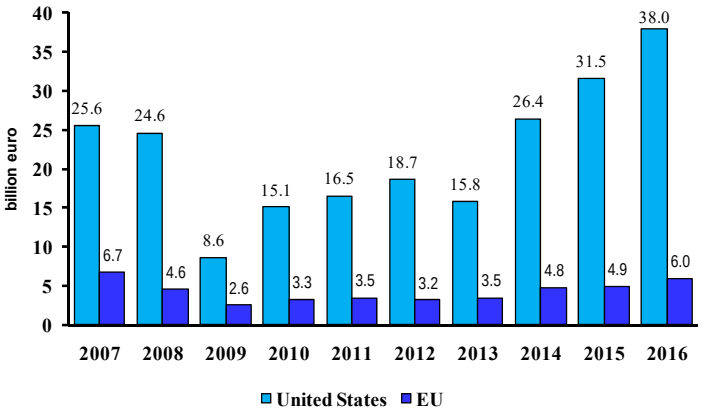
Source: Eurostat.

Table 1 also illustrates that the percentage of R&D expenditure financed by government sector is much higher than the corresponding shares for the United States (22.8%), South Korea (21.6%), China and Japan (19.8%). This reflects a higher reliance and a stronger role of public research in many EU countries (European Commission, 208a*)*. The highest share of R&D expenditures in the government sector was recorded in Latvia (47.7%), followed by Greece and Portugal (42.6%) in 2016.

The differences in business R&D investment across EU member states are only partly driven by the industry specialization of each country. The variation is also due to differences in the business environment, access to finance, human capital and the skills of the labor force (EIB, 2018).

There is a *low access to risk-taking capital* in the EU. Venture capital companies play an important role in providing financing to start-up and risky projects. However, Europe's venture capital market remains largely underdeveloped in comparison to the United States at all phases of the innovation process: from inception, to development and scale-up, from seed-capital, early- and later-stage development funds to mezzanine bridges. Figure 2 shows that the EU's venture capital market lags far behind that in the United Sates in terms of venture capital raised. In addition, the EU's market is largely dominated by Unaided Kingdom, which remained far away Europe's leading venture capital magnet, followed by Germany and France. Also, there is a large dispersion in terms of venture capital investment levels in Europe, as well as in their dynamics with low investments stagnating registered in several CEE countries (Diaconu, 2017).

Figure 2. *Venture capital raised (billion euro) in the EU and the United States*



Note: Data from HR, CY, MT, SI, SK were not included.
Source: Invest Europe, NVCA / Pitchbook.

Business R&D investment is characterized by high concentration, with a small number of countries, sectors and companies accounting for a large share of R&D expenditures. The 1000 EU firms that invest the most in R&D together account for more than 90 % of total business expenditure on R&D in the EU. In addition, major European companies are among the most important players on the world market, while the overall average EU R&D intensity lags behind the one registered in its main competitors.

3. Investment trends and economic effects in companies that invest the most in R&D in the EU

3.1 Main characteristics of major R&D investors in the EU

The EU Industrial R&D Investment Scoreboard comprises information on R&D investment made by each company included in the 1000 top companies registered in the EU ranked by their investment in R&D. According to European Commission (218b), the 1000 companies have invested more than €8 million in R&D in 2017/2018, and of these 1000, 577 appear in the world top 2500. The total R&D for the EU 1000 is shown in

Table 2, alongside other indicators of business performance. The EU 1000 companies have a total R&D of €206.3 bn in 2017/2018 and they raised most of financial indicators over time, not only R&D investments, but also net sales, capital expenditures, R&D intensity and capital intensity. Profitability also increased mainly in the last period and to a lesser extent the number of employees. Although the change in capital expenditure was higher than the change in R&D investment, *R&D investments per company and R&D intensity registered a constant increase.*

Table 2. *Overall business performance of 1000 R&D Scoreboard companies based on 2012-2018 data*

Indicators	2011/2012	2013/2014	2015/2016	2017/2018
R&D investment (€ m)	152,920.9	165,759.8	193,220.7	206,288.5
R&D investment/company (€ m)	152.91	165.76	193.22	206.88
Change in R&D investment over previous year (%)	9.4	8.4	16.7	5.5
Net sales (€ m)	6,361,329.0	6,302,425.3	6,033,828.7	6,365,624.6
Change in net sales over previous year (%)	1.1	-1.8	-4.3	5.5
Capital expenditure (€ m)	278,570.7	370,850.4	335,119.6	373,680.4
Change in capital expenditure over previous year (%)	12.5	33.12	9.63	11.50
Employees (number of persons)	20,968,150	19,975,761	19,251,802	21,308,605
Change in number of employees over previous year (%)	-4.6	-0.1	3.6	10.7
R&D investment per employee (€)	7,293	8,298	10,037	9,681
Net sales/Employee (€)	30.3	31.6	31.3	29.9
R&D investment/Net sales (%)	2.4	2.6	3.2	3.2
Capital expenditure/Net sales (%)	4.4	5.9	5.6	5.9
Operating profit/Net sales (%)	9.8	6.8	6.7	10.0

Source: author's calculations based on the 2010-2018 EU 1000 Scoreboard.

However, as in the previous periods, the last Scoreboard data display the persistence of *industrial R&D concentration by company, country and sector*, as one of the major characteristics of R&D in the EU. That means that a small number of companies, countries and sectors perform a large share of R&D investment. Table 3 shows that there are 899 companies in the top 10 member states that accounted for 97% of the total R&D investment performed in the EU 1000 group in the period 2017/2018. Moreover, the general performance in terms of net sales one year growth appears to be positively correlated with R&D one year growth, but more influenced by the number companies operating in the same country. The German companies made the largest contribution to the performance of the 1000 EU companies, registering 6.3% R&D one year growth and 6.5% net sales one year growth.

Table 3. *R&D trends for companies placed in the top 10 EU member states*

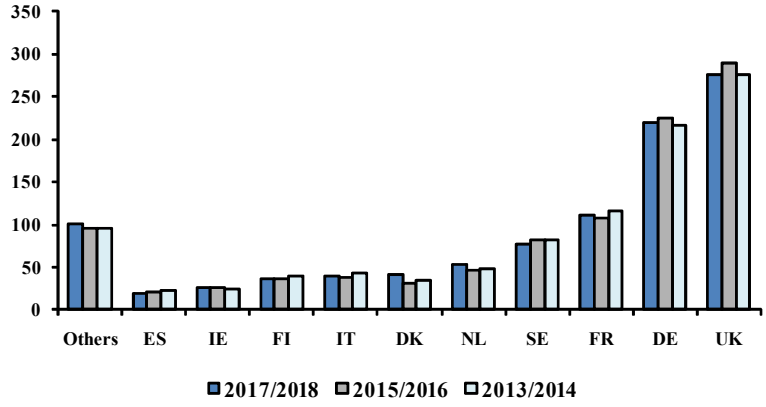
Country	Number of companies	R&D in 2017/2018 (€bn)	R&D share within EU (%)	R&D one year growth (%)	Net sales one year growth (%)
Germany	219	81.3	39.4	6.3	6.5
UK	275	30.5	14.8	6.9	16.2
France	111	29.0	14.0	8.2	9.1
Netherlands	53	18.5	8.9	0.6	5.3
Sweden	77	9.5	4.6	6.1	4.5
Ireland	27	8.5	4.1	-3.8	-1.1
Italy	39	6.5	3.2	9.5	6.3
Finland	36	6.4	3.1	1.1	5.2
Denmark	42	5.3	2.6	1.7	3.8
Spain	20	4.6	2.2	2.4	8.3

Country	Number of companies	R&D in 2017/2018 (€bn)	R&D share within EU (%)	R&D one year growth (%)	Net sales one year growth (%)
Top 10 EU countries	899	200.2	97.0	5.2	8.4
Other EU	101	6.1	3.0	13.0	11.2
Total EU	1000	206.3	100	5.4	8.5

Source: European Commission (2018b), p. 66.

The concentration of R&D by country is shown in Figure 3. 68% of the total R&D is the result of companies based in Germany, UK and France in 2017/2018 and this fact seems to persist. The aggregate indicator in each country is dependent on the figures of a small number of companies in the Scoreboard or the concentration of R&D at the level of a few firms. For example, five German automotive companies account for 45% of German R&D in 2017/2018.The data prove the importance of the investment behavior of a few large players for the country and sector R&D mix (Zaman and Goschin, 2012).

Figure 3. *R&D concentration by country within the 1000 EU companies, 2013-2018*



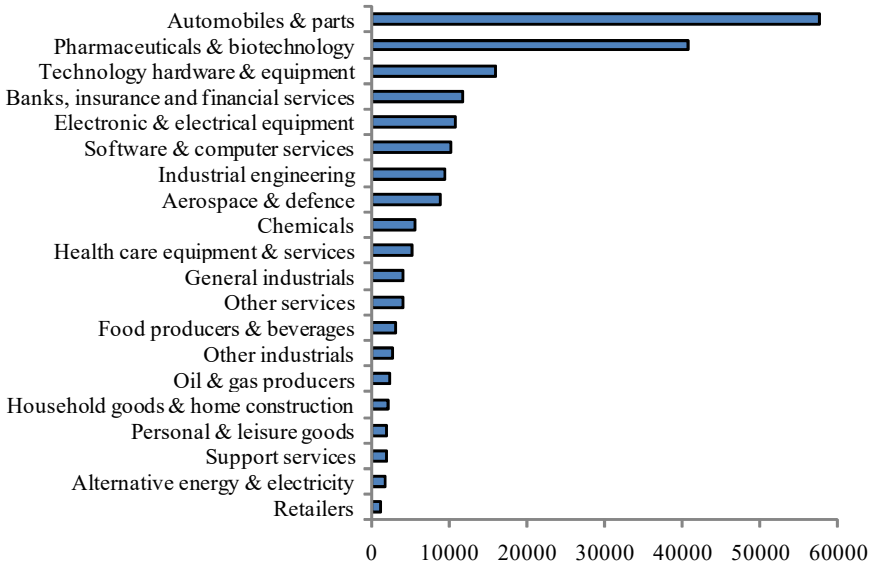
Source: European Commission 2016, 2017 and 2018b.

R&D investments are particularly *concentrated at the level of a few sectors* (Figure 4), such as automotive and aerospace, pharmaceuticals, technology hardware and equipment that account for more than 56% of the total R&D in the 1000 EU Scoreboard firms in 2017/2018. A similar concentration of R&D in a relatively small number of industrial sectors have been observed over the last 14 years (Ciupagea et al., 2003; Moncada-Paternò-Castello et al., 2006; Moncada-Paternò-Castello et al., 2010; Zaman and Goschin, 2012; Moncada-Paternò-Castello, 2016; European Commission, 2017, 2018b; EIB 2018).

According to the European Commission (2018a), there are three main technological areas where R&D is developing new and improved products for the future: biotechnology, software/AI (artificial intelligence) and new/improved materials. Examples of new developments in these three areas include cancer immunotherapies, gene and stem cell therapies, software robots to automate back office processes, graphene and solid state batteries. Autonomous electric vehicles provide an example involving two of these areas (software/AI and new materials. Biologically compatible structures that facilitate the sustained release of hormones or enzymes provide another example involving two areas.

A third example is digital health and the use of AI in drug discovery, in planning clinical trials and in diagnostics.

Figure 4. *R&D (€m) concentration by sector within the 1000 EU companies, 2017/2018*



Source: author's calculation based on the EU Industrial R&D Investment Scoreboard data.

However, in comparison with the USA, the EU is identified as having higher shares of R&D in medium-tech sectors that play a key role in shaping the EU R&D investments (see, for instance, Moncada-Castello, 2016, in which R&D intensity is examined and investigates its comparative distribution among firms, sectors and countries using the EU Industrial R&D Scoreboard data from 2005 to 2013 and the ICB sectoral classification). In this respect, the structural and intrinsic effects that impacted the EU's R&D intensity gap are analyzed. The structural composition of the economy is identified as the major factor impacting the EU's intensity gap, i.e. the prevalence of medium R&D intensity sectors in the EU's industrial structure. This is why, in the last decade, the EU was criticized for its slow dynamics toward high and medium high sectors of the economy. The intrinsic factor also play a major role in shaping the EU's R&D intensity gap in terms that the EU firms outperformed all their competing economies, but its importance in influencing the EU' R&D intensity gap is lower than the structural effect. That means that the most important share of the gap comes from the EU industrial mix, rather than from the individual RD intensity.

Coad (2017) observes that firms in the EU R&D Industrial Scoreboard for the years 2000-2015 display a large amount of heterogeneity in R&D intensities among firms in the same sector and the heterogeneity persists over time. That means that firms in the same sector cannot have always similar patterns of innovation activity. Some low tech firms have relatively high R&D intensities, while some high tech firms perform low R&D intensities. These findings have policy implications. In comparison with other studies that suggest that

national R&D intensity targets should be reached by adjusting the economic structure toward more R&D intensive sectors, it is recommended that the adjustment should be made by stimulating firm's entry in high tech sectors and encouraging incumbent firms their R&D within their sectors as well.

The EU Industrial R&D Investment Scoreboard data display *the highest share of very large firms* of the total sample (Table 4); the very large ones (71.5%) performed the 96.29% of the total R&D investments, 99.52% of total capital expenditures and obtained 99.12% of total net sales. They are the most capital intensive. In the 2017/2018 sample, large firms are the most R&D intensive and, to a lesser extent, capital intensive. SMEs invest less of their net sales in R&D than large firms. Also, SMEs and large firms are more R&D intensive than capital intensive. Large firms are the most R&D intensive in the sample.

Nonetheless, when we analyze the R&D and capital expenditure costs, as well as the R&D/Capital expenditures ratios, we can illustrate better the investments patterns of each group. We compute R&D and capital expenditure costs as R&D/(Operating profit + R&D + Capital expenditures) and also Capital expenditures/(Operating profit + R&D + Capital expenditures). These ratios indicate the investment average effort of the total available funds made by each group. From this perspective, SMEs appear more R&D oriented when compared to large and very large firms. The last ratios related to the two types of investments efforts lead to the same pattern. Also, the percentage of R&D investment of the total investments effort is the highest in SMEs and decreases as firm's size increases.

Table 4. *R&D and capital investments, net sales, R&D and capital intensities performed by companies in the EU Industrial R&D Investment Scoreboard 2017/2018, by size class*

Type of firm by size		Small and medium-sized firms	Large firms	Very large firms	Total
% of total companies		15.20%	13.30%	71.50%	100.00%
R&D investments	€m	4,218.2	3,432.9	198,637.4	206,288.5
	% of total	2.04%	1.66%	96.29%	100.00%
Capital expenditures	€m	858.9	935.2	371,886.3	373,680.4
	% of total	0.23%	0.25%	99.52%	100.00%
Net sales	€m	36,706.6	19,119.4	6309,798.6	6365,624.6
	% of total	0.57%	0.30%	99.12%	100.00%
R&D intensity		11.49%	17.95%	3.14%	3.20%
Capital expenditures intensity		2.34%	4.89%	5.89%	5.87%
R&D cost		148.59%	78.02%	16.44%	16.69%
Capital exp. cost		6.80%	21.25%	30.79%	30.72%
R&D / Capital expenditures		4.91	3.67	0.53	0.55
R&D × 100 / (R&D + capital expenditure)		83.08%	78.59%	34.82%	35.57%
Capital expenditure × 100 / (R&D + capital expenditure)		16.92%	21.41%	65.18%	67.43%

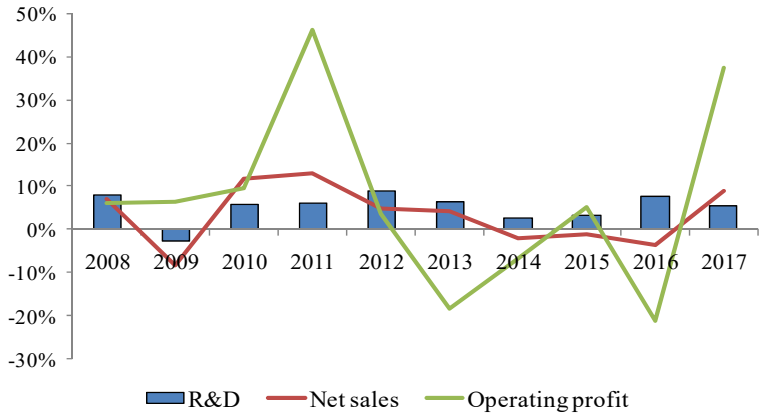
Source: author's calculations based on the 2017/2018 EU Industrial R&D Investment Scoreboard. We consider that small and medium-sized firms have 5-250 employees; large firms have 251-1000 employees and very large firms have more than 1000 employees.

The extent to which firm's investments impact their economic performance can vary across firms and economic sectors. There is an extensive literature associated with the impact of firm's size on its R&D behavior (see, for instance Ortega-Argilés and Brandsma, 2008 for a review of the literature). The same authors analyze the impact of firm's size on R&D intensity taking into account the firm's operating sectors. Using data from the top R&D

investors from the 2006 EU Industrial R&D Investment Scoreboard they conclude that smaller sized companies tend to spend a larger proportion of their income from sales on R&D and this result is independent of sectoral composition.

With respect to the trends in R&D, net sales and operating profit registered by the 1000 Scoreboard companies over a longer period of time, Figure 5 reveals several features. R&D shows positive trends for most of the 10 years period. Also, the growth rate of R&D investment has been significantly higher than the growth rate of net sales (except for the last year, when net sales have recovered strongly). Over the last year, companies' capital expenditures have improved, following several of negative performance or stagnation (European Commission, 2018b). Moreover, the growth rate of operating profit has improved as a response to the increase in net sales. Figure 5 reveals also two other important features: the major R&D players are continuous R&D investors and there seem to be a stronger positive correlation between R&D and net sales than between R&D and operating profit.

Figure 5. *One year R&D investments, net sales and operating profit change by the 1000 Scoreboard companies*



Source: the EU Industrial R&D Investment Scoreboard.

3.2. Economic effects of R&D investments in the 1000 EU companies

Statistics on R&D investments are often used to compare investment in innovation across countries and firms. R&D investment is viewed, in general, as an input in innovation activity, particularly in product innovation (Antonucci and Pianta, 2002), while capital expenditures are mainly involved in process innovation (Vaona and Pianta, 2008).

Firm productivity is associated with both R&D and capital investments, but the correlation can be affected by the performance of innovative firms. Factors such as product and market regulations, the development of capital markets to finance innovation, the protection of intellectual property rights, the nature of complementarities between investments in physical assets and intangible assets can also affect firm performance.

In order to investigate the relationship between firm's investments and the corresponding economic effects, we use data from the 2016-2018 EU Industrial R&D Investment

Scoreboard which centralizes micro-data on R&D investments, capital expenditures, net sales, operating profit, number of employees, market capitalization and profitability for each firm. Table 5 offers the description of each variable available in the data.

Table 5. *Variables included in the analysis to select the best regression models*

Variable	Description	Unit of measurement
RDexp	R&D expenditures funded by the company is the total R&D performed within a territorial unit that has been funded by the private or public companies.	€m
Capex	Capital expenditure is expenditure used by a company to acquire or upgrade physical assets such as equipment, property, industrial buildings.	€m
Opprofit	Operating profit is calculated as profit (or loss) before taxation, plus net interest cost (or minus net interest income) minus government grants, less gains (or plus losses) arising from the sale/disposal of businesses or fixed assets.	€m
Netsales	Net sales follow the usual accounting definition of sales, excluding sales taxes and shares of sales of joint ventures & associates.	€m
Profitability	Profitability is operating profit as percent of net sales.	%
Marketcap	Market capitalization is the share price multiplied by the number of shares issued at a given date.	€m
Emp	Number of employees is the total consolidated average employees or year-end employees if average not stated.	persons

Source: European Commission (2018b).

We present the results our econometric analysis in two parts.

First of all, we search for the best model that is able to explain the economic effects resulted from the investment efforts made by firms, using the entire sample of R&D investors. Second of all, we investigate whether the size matter for R&D. In this respect we engage two different sets of regression equations. We select net sales and operating profit as economic effects and dependent variables.

Between the independent variables used for the study, R&D expenditures and capital expenditures show the strongest impact on net sales and operating profit. That means that firms with higher R&D and capital expenditure will have increased net sales and operating profit. The research hypothesis investigated here is listed as follows: firms with high R&D and capital expenditures have improved net sales and/or operating income.

From this perspective, our approach is not new. Hsu et al. (2013) investigate the impact of R&D capability on firm's financial performance by using historical data of Taiwanese companies from 2000 to 2011, and find that firm's R&D investments rate impact net sales; firms with a high level of R&D rate have better stock returns and net sales, but such firms do not have an advantage in terms of operating income. These results can indicate that higher R&D investments increase operating costs which, in turn, decreases operating income despite increased net sales.

Using the EU Industrial R&D Investment Scoreboard data, Zaman and Goschin (2012) show that, although the economic crisis and slow recovery limited the firms' financing capacity to R&D, firms registered an increase in the R&D investments in 2008-2010, leading to an increase in their net sales. Also, the R&D growth rate positively impacted the net sales growth rate. These results reveal success cumulativeness in innovation activity, which capture the extent to which "success breeds success" (Dosi and Nelson, 2009)

demonstrated in the study to maintain itself, even in adverse market conditions with respect to financing and demand.

Parcharidis and Varsakelis (2007) find that the effect of R&D investments on profitability becomes positive after a period with decreasing returns. Using data from companies listed at Athens Stock Exchange for the period 1995-2000, the result obtained can be induced by production costs that tend to increase in the short-run, because new product development or new processes need time to show results.

We use the EU Industrial R&D Investment Scoreboard micro-data under the year of analysis draw from 2016-2018. Our analysis of R&D activity and its economic effects in the selected sample proceeds in the following equations:

$$Y_{it} = \alpha_0 + \sum_j \alpha_1 Z_{jit} + \varepsilon_{it} \quad (1)$$

where
Y_{ij} – the dependent variable, net sales or operating profits (in €m);
Z_{ij} – the independent (exogenous) variables;
α_j are the parameters that summarize the j factor contribution to the dependent variable;
t stands to the year and i for the company;
ε_{it} is an independently and identically distributed error term for i and t with zero mean and variance σ^2.

Because the purpose of our analysis is to select the best regression model that is able to explain the relationships established between the variables analyzed, we tried building several models. We started the analysis with all variables considered and removed the weakest predictor at every step, respectively the independent variable that determines the smallest reduction of Fisher statistics. The parameters of the models were estimated using Ordinary Least Squares and the estimated regression coefficients, alongside their corresponding standard errors and the values of standard econometric tests, are shown in Table 6. Only the statistically significant variables were preserved in the final specification of each econometric model.

Table 6. *Regression analysis results for the years 2017/2018 and 2016/2017 – whole sample*

Models: t =2017/2018 t-1 = 2015/2016	Independent variables					Tests				
Model 1 *Y = Net sales* (t)	RDexp (t)	Capex (t)	Emp (t)	Marketcap (t)	Intercept	Obs.	Adj. R^2	F	Prob	Durbin-Watson
Coefficient	4.140 (0.000*)	9.049 (0.000*)	0.083 (0.000*)	0.039 (0.000*)	191.273 (0.582*)	940	0.868	1,098	0.000	1.793
Std. error	0.438	0.252	0.007	0.022	346.954					
Model 2 *Y=Opprofit* (t)	RDexp (t)	Capex (t)	Emp (t)	Marketcap (t)	Intercept	Obs.	Adj. R^2	F	Prob	Durbin-Watson
Coefficient	0.345 (0.000*)	0.681 (0.000*)	0.009 (0.000*)		154.173 (0.001*)	940	0.546	363.900	0.000	1.914
Std. error	0.070	0.039	0.001		48.369					

Model 3 *Y=Net sales* (t-1)	RDexp (t-1)	Capex (t-1)	Emp (t-1)		Intercept	Obs.	Adj. R^2	F	Prob	Durbin-Watson
Coefficient	4.827 (0.001*)	7.470 (0.001*)	405.290 (0.001*)		-136.68 (0.474*)	898	0.999	3,665	0.001	2.194
Std. error	0.299	0.144	3.527		90.603					
Model 4 *Y=Opprofit* (t-1)	RDexp (t-1)	Capex (t-1)	Emp (t-1)		Intercept	Obs.	Adj. R^2	F	Prob	Durbin-Watson
Coefficient	0.437 (0.001*)	0.344 (0.001*)	11.221 (0.001*)		12.260 (0.001*)	898	0.994	52,782	0,001	1.826
Std. error	0.059	0.029	0.701		37.723					

Source: author's calculations. *Significant at 5%.

The results from the first model referring to the year 2017/2018 indicate that the net sales are positively influenced by increases in the R&D investments, in capital investments and in the number of employees as well as in the market capitalization. The operating profit is positively influenced by investing in R&D activities, as well as in fixed assets and by increasing the number of employees. The influences of R&D and capital expenditures on the net sales and operating profit is positive in the year 2017/2016 as well, meaning that firm's performance can be explained by the increase in R&D and capital expenditures and number of employees. Only the variation in exogenous variables under the year of analysis is found to be statistically important ($p < 0.05$). R&D and capital expenditures from t-1, t-2 and t-3 do not influence net sales and operating profit in year t. The models 1-4 are statistically significant and explain in a very large proportion the variability in net sales and operating profit ($R^2 = 0.868$; 0.546; 0.999; 0.994).

Looking within the whole group of top R&D investors, the role of company size in R&D can be analyzed. We investigate whether size has an effect on the R&D investments of the companies. The group consists of companies with established records of sales, R&D and capital expenditure. We carry out regressions of the net sales in firms on the size of firms, separately for each size class, considering the total number of employees a measure of firm′s size. The results are shown in Table 7:

Table 7. *Regression analysis results for the years 2018/2017-2016/2015 by firm's size class Dependent variable – Net sales; Independent variable – Rdexp; Capex.*

Dependent variables and tests	Small and medium-sized firms *Y = Net sales*	Large firms *Y = Net sales*	Very large firms *Y = Net sales*
RDexp	5.460 (0.000)*	1.925 (0.000)*	7.593 (0.000)*
Capex	15.859 (0.000)*	1.117 (0.085)*	8.867 (0.000)*
Intercept	-83.828 (0.000)*	107.703 (0.000)*	2,313.432 (0.000)*
F	95.76	8.177	2,831
Prob.	0.000*	0.000	0.000
Adjusted R^2	0.520	0.058	0.815
Durbin Watson	2.138	1.864	1.713
Obs.	176	234	1,038

Source: author's calculations. *Significant at 5%.

The R&D and capital expenditures show positive and significant coefficients in all groups of firms. However, firms belonging to the very large group seem to be in a better position to innovation through R&D than SMEs and large firms. The impact of R&D investments on the net sales is greatest at the level of very large firms. This fact confirms the market power that very large firms have, including ensuring them legal protection which can provide short-run market power to create an incentive to invest in R&D.

4. Conclusions ad policy implications

Given the large differences in R&D investment across EU countries, there is scope for public policy to intervene on several fronts to incentivize R&D investment. In addition, public intervention can be justified not only because firm performance is positively related with net sales or operating profit in firms, but due to the positive externalities that are typically associated with R&D spending and innovation outputs.

The EU's strength in science is an important asset, but it will not be enough if the EU does not put in place the right enabling conditions and business climate for stronger and more impactful, breakthrough and deep-tech innovation activity. Overcoming the EU's limitations to reap the full benefits of the new wave of innovation needs a concerted effort across stakeholders, including research institutions, regulators, businesses and governments at regional, national and EU level. Addressing the EU's innovation challenges requires a coordinated effort from all stakeholders in all member states at different levels that need to upgrade their efforts to boost investment in innovation and other intangible assets, such as education and skills development and ICT, and build a backdrop that incentivizes the development and uptake of innovation (European Commission, 2018b).

In recent years, the EU has adopted many measures to strengthen its innovation capacity. However, the EU needs to reinforce its policy efforts in order to establish a framework for stronger and more impactful innovation creation and diffusion, against the backdrop of today's rapidly changing innovation dynamics and enhanced uncertainty.

The EU needs investments to cover the whole science-innovation spectrum, from basic research to breakthrough innovation, as well as education and skills. While member states benefit from different fiscal spaces for public investment, those able to do so should invest more in intangible assets. The EU is strong in incremental innovation and medium-tech (e.g. transport, health or energy sectors) innovation and needs to boost R&D investments particularly business R&D investments, an area which EU notably lags behind. In addition, public R&D investment will benefit from moving away from supporting specific fields towards more comprehensive mission-oriented policy approaches that maximize the impacts of public R&D and galvanize private investment.

The average size of the top R& investors among EU-based companies is rather very large than large. Although they invest less form their net sales in R&D and have a lower R&D cost (Table 4), they can better exploit the results from their investments than SMEs (Table 7). In order to become a competitive global player, EU needs particularly to incentivize the innovation in SMEs by boosting sufficient access to risk capital. Public efforts to invest

and leverage private risk capital are crucial. Initiatives like the Capital Markets Union or the creation of a pan-European Venture Capital "Fund of Funds" aiming at making European capital markets deeper, broader, better integrated and with greater capacity to leverage business resources will help bridge this gap.

Continuing structural reforms that allow markets to react better and faster to the changes that innovations bring to the markets and which facilitate the entry, as well as the orderly exit of firms, will help reallocate resources towards the most innovative and productive companies, avoiding the negative lock-in of resources in unproductive and zombie companies (European Commission, 2018b).

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Volatility experience of major world stock markets

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Abstract. *The stock markets are characterized with relatively higher returns and higher risk & uncertainty, which reflect in the volatility that has been increasing day by day, especially, after the globalization and integration of capital markets. Volatility is an important input to many investment decisions and portfolio selection. A reliable technique for modelling stock market volatility is crucial for effective hedging of stock market risk. There are several studies about the volatility in individual stock markets. However, there are very few studies about the volatility in a group of stock markets as developed, emerging and frontier markets. This paper aims at examining the volatility experiences, informational asymmetries and leverage effects in the major developed, emerging and frontier markets. The daily returns of stock indices of twenty-four markets have been considered from 2000 to 2018. This study observes that all the markets confirm the stylized facts of the financial time series. The volatility is highly persistent in all the markets, informational asymmetries and leverage effects exist in the developed and emerging markets, whereas the frontier markets do not exhibit any tendencies of informational asymmetries and leverage effects except the stock market of Argentina.*

Keywords: stock market, risk, volatility, asymmetries, leverage effect, impact curves.

JEL Classification: C22, C58, G11, G15.

1. Introduction

The Stock market yields relatively higher returns for our investments, however, they are ever dynamic with rapid dissemination of information into the markets leading to fluctuations in stock prices that cause volatility. The volatility of the stock market is closely related to the risk of assets. Higher volatility leads to higher risk with large variations in the prices. In finance, volatility is a crucial input to many investment decisions such as portfolio selection as well as risk management. As volatility is not directly observable in financial markets, it has to be estimated from directly observable quantities such as asset prices or returns. The common properties observed in most financial time series are classified as stylized facts. Employing quantitative models that capture these properties of asset returns would be helpful to estimate volatility (Cont, 2010). Rising levels of volatility across different asset classes, markets, and industries have increased the importance of volatility models. Proper modelling of asset price volatility is of paramount importance in assessing investment risk because the investors, portfolio managers and other stakeholders of the market make decisions based on the level of volatility and their risk appetite. Volatility has received substantial attention from investors, academicians, and regulators because of its role in the asset allocation, hedging, risk management and policy-making (Moreira and Muir, 2017).

The investors are more concerned about this stock market volatility because it affects the returns on their investments, whereas the policy makers attempt to curb excessive volatility to ensure financial and macroeconomic stability posed by the stock market phenomenon. It is observed that this volatility has been increasing ever since integration and globalization of capital markets. Due to this integration, price variations in one market affect the asset prices in other interlinked markets. These co-movements of stock market prices have major implications on investors' diversification strategies and decision-making (Li, 2009). It is necessary in the global financial markets to be informed about the volatility patterns of various assets and the relative volatility of the stock market. In this regard, there has been a lot of research to find the best volatility model that can capture various stylized facts associated with market volatilities. Stock market volatility, as witnessed during the recent "Global Financial Crisis of 2008", as well as earlier, can have wide repercussions on the economy as a whole. Hence, reliable models for stock market volatility is crucial for effective hedging of stock market risk.

Various methods have been developed to model the stock market volatility. There are two major approaches to estimate volatility. The first approach is implied volatility, which indicates the future volatility of an asset is determined by today's price of the asset. The second approach is the historical volatility, which is categorised into two methods, range based volatility and conditional heteroscedasticity. First, the range-based volatility can be estimated from the historical prices and uses a variety of information about stock prices during the trading day, such as the open, close, low, and high (Yang and Zhang, 2000). Second, conditional heteroscedasticity approaches, i.e., Autoregressive Conditional Heteroscedasticity (ARCH) proposed by Engle (1982) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) by Bollerslev (1986). The GARCH classes of models are now the standard tools for volatility modelling. Two of the widely used

extensions are the EGARCH developed by Nelson (1991), and GJR GARCH developed by Glosten et al. (1993).

There are several studies about volatility modelling in stock markets. Siourounis (2002) used GARCH models to estimate the volatility in Athens stock exchange, and discovered that negative shocks affect asymmetrically on the daily return series. Najand (2003) estimated the volatility for S&P 500 returns and found that EGARCH and TGARCH models are more fit compared to symmetric GARCH. When the market is stable, the GARCH model performs better and during the times of wide fluctuations, and under the circumstances of asymmetric information, EGARCH and TGARCH can describe the volatility more accurately compared to GARCH model (Awartani and Corradi, 2005).

Banerjee and Sarkar (2006) observed that the asymmetric GARCH models are more suitable than the symmetric GARCH models in the Indian stock market. Girard and Biswas (2007) and Hung (2009) found that asymmetric GARCH models perform better in the estimation of stock market volatility. Whereas, Magnus and Fosu (2006) were in favour of the view that GARCH (1, 1) with an assumption of normal error distribution is superior to other conditional volatility models in modelling the daily data in the stock exchange of Ghana. A study conducted by Pagan and Schwert (2007) revealed that the predictive abilities of both GARCH and EGARCH models are preferable. Guidi (2009) applied some of the GARCH type models to the German, UK, and Swiss stock market indices and found that the EGARCH model is considered to be optimal in conditional variance modelling and forecasting. Sabiruzzaman et al. (2010) compared the accuracy of volatility estimation of GARCH and TGARCH models on the Hong Kong stock market and showed that between these two models, the TGARCH model could estimate the leverage effect in the stock better than the GARCH model. Liu and Huang (2010) verified that in case of asymmetric information and different distributions, the asymmetric GARCH models are of greater accuracy in modelling and predicting volatility in stock market returns, in their study on S&P 100 Index.

A plethora of studies on volatility in stock markets seem to have focused majorly on individual stock markets, small group of markets and African markets (see for ex. Gabriel, 2012; Lim and Sek, 2013; Guptha and Rao, 2014; King and Botha, 2015; Ismail et al., 2016; Herwarth, 2017). However, there are hardly any studies on different groups of markets, such as developed, emerging and frontier markets. The objective of this study is to see the volatility experiences, asymmetries and leverage effects in the world stock markets.

Hence, this study contributes to the existing literature through the expansion of the research concerning the estimation of volatility in major stock markets of the world consists of developed, emerging and frontier stock markets.

The rest of the paper is organized as: Section 2 describes the data and methodology. Section 3 presents the empirical results, and finally, the conclusions are given in Section 4.

2. Data and methodology

This section describes the data and methodology of various models. Here we considered representative markets of three groups viz. developed, emerging and frontier markets as classified by Morgan Stanley Capital International classification (MSCI, 2018). Based on the availability of data in open sources and for uniformity, we considered the following markets for the study. The markets in the developed category are Australia (ASX 200), Canada (TSX), France (CAC 40), Germany (DAX), Japan (NIKKEI 225) South Korea (KOSPI), Switzerland (SMI), United Kingdom (FTSE 100), and the United States of America (S&P 500). The markets in the emerging group are Brazil (BOVESPA), China (SSEC), Egypt (EGX 30), India (SENSEX), Indonesia (IDX), Mexico (BMV IPC), Russia (MOEX), South Africa (JSE 40), Thailand (SET), and Turkey (BIST 100). The markets in the frontier category are Argentina (S&P MERVAL), Estonia (TSEG), Kenya (NSE 20), Sri Lanka (CSE AS), and Tunisia (TUNINDEX). The daily closing prices of the selected indices data ranging from 1st January 2000 to 31st December 2018 have been obtained from the website www.investing.com.

The asset returns (R_t) are calculated as:

$$R_t = \frac{(P_t - P_{t-1})}{P_{t-1}} * 100 \quad (1)$$

Where, P_t is the price of the asset in the current time period and P_{t-1} is the price of an asset in the previous time period.

2.1. GARCH models

Autoregressive Conditional Heteroscedasticity (ARCH) model proposed by Engel (1982) is the basis for GARCH model. This model was introduced to overcome one of the major limitations of the traditional volatility modelling techniques, i.e., the assumption of homoscedasticity in the returns series as these models were not able to capture the varying variance, i.e. heteroscedasticity observed in the series. Therefore, in order to model the varying variance, more sophisticated models needed to be developed to accommodate the heteroscedasticity. Thus, models under GARCH framework were developed to model volatility in the financial time series.

2.1.2. GARCH Model

The GARCH model has its root in the ARCH model. Under the Autoregressive Conditional Heteroskedasticity (ARCH) model, proposed by Engel (1982) the autocorrelation in volatility is modelled by allowing the conditional variance of the error term to be related to the immediately preceding value of the squared error term. Therefore, variance of the error term ε_t, which signifies the amount of volatility, and ARCH (P) model represented as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \cdots + \alpha_p \varepsilon_{t-p}^2 \quad (2)$$

Later on, Tim Bollerslev (1986) introduced the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. Although the ARCH model has the basic form, one of its characteristics is that it requires many parameters to describe appropriately the volatility process of an asset return. Thus the GARCH model has been introduced. GARCH

model is more parsimonious than the ARCH model. The GARCH (p, q) model can be written as:

$$\sigma_t^2 = a + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (3)$$

A GARCH (1, 1) model incorporates the assumption that today's volatility depends upon three factors such as a constant, yesterday's "news" about volatility, and yesterday's variance.

The sum of the ARCH and GARCH $(\alpha + \beta)$ terms gives an idea of the level of persistence of volatility in the series measured. If the sum is close to one (unity), then volatility is said to be persistent. Furthermore, the GARCH specification incorporates and handles well the frequently observed financial time series behaviour called "volatility clustering" as well as the other stylized facts associated with the stock market.

2.1.3. EGARCH Model

The asymmetric effects of a shock upon volatility i.e. the impact of good news and the bad news will not have the same magnitude and are different. In order to model such asymmetric effects. Nelson (1991) proposed Exponential GARCH model. EGARCH model with a specification for the conditional variance:

$$\mathrm{Log}(\sigma_t^2) = \omega + \beta.\log(\sigma_{t-1}^2) + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma(\varepsilon_{t-1}/\sigma_{t-1}) \quad (4)$$

Where γ will indicate whether there are asymmetries in the financial data. The model has several advantages over the pure GARCH model: Since log σ_t^2 is modeled, then conditional variance will be positive even if the parameters are negative. Hence, it is not necessary to enforce non-negative constraints. Asymmetries are taken care of under this specification if γ is negative it implies that the relationship between volatility and returns is negative.

2.1.4. TGARCH Model

This is an extension of the GARCH model given by Zakoian (1990) and Glosten, Jagannathan and Runkle (1993) independently and it was proposed with an additional term added to the conditional variance equation (3) to account for the asymmetric property of the stock returns. In TGARCH or GJR- GARCH, the conditional variance is thus given by:

$$\sigma_t^2 = a + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma\varepsilon_{t-1}^2 I_{t-1} \quad (5)$$

Where, $I_{t-1} = 1$ if $\varepsilon_{t-1} < 1$

$= 0$ otherwise

In the case of leverage effect, we would expect $\gamma > 0$, i.e., the sign of γ should be positive. It should be noted that if the effect is positive, then the volatility measure would equal that of GARCH. But, if the effect is negative, then the volatility measure would rise by $\gamma\varepsilon_{t-1}^2$ Thus, good news and bad news have differential effects on the volatility. While the good news has the impact of α, bad news have an impact of $\alpha + \gamma$. Thus, the leverage effect is taken care off.

3. Empirical results

In this section, we present the empirical results including descriptive statistics, and the estimates of GARCH, EGARCH and TGARCH models for the stock returns of developed, emerging and frontier markets.

3.1. Descriptive statistics of the stock returns

The summary statistics such as mean, standard deviation, skewness, kurtosis and JB test statistic of developed, emerging and frontier stock markets returns are presented in Table 1. We can see that the mean returns in all the markets are positive, indicating overall positive returns on investments during the period of this study. The kurtosis values of the returns series of all the markets are observed to be greater than three indicating that all the series are leptokurtic, i.e. thick tails, which is a common phenomenon of stock returns. The Jarque-Bera test shows that the series are non-normally distributed. All these statistics confirm the stylized facts of financial time series observed in globally (Cont, 2010; Humala, 2013; Mallikarjuna et al., 2017).

Table 1. *Descriptive Statistics of Developed, Emerging and Frontier Markets*

	Stock Market	Mean	Standard Deviation	Skew-ness	Kurtosis	Jarque Bera Test	ARCH - LM Test
Developed Markets	**Australia**	0.0169	0.9813	-0.3661	8.457	5732.6 (0.000)	1064.3 (0.000)
	Canada	0.0167	1.0431	-0.4667	13.589	21277.9 (0.000)	1419.3 (0.000)
	France	0.0057	1.4296	0.1414	8.712	6275.9 (0.000)	828.34 (0.000)
	Germany	0.0217	1.4753	0.0970	8.111	4987.2 (0.000)	873.68 (0.000)
	Japan	0.0195	1.5011	-0.2113	9.413	7642.1 (0.000)	1081.2 (0.000)
	South Korea	0.0403	1.3845	-0.3503	9.724	8473.8 (0.000)	720.95 (0.000)
	Switzer-land	0.0077	1.1747	-0.0122	10.188	9766.6 (0.000)	1034.6 (0.000)
	UK	0.0092	1.1718	-0.0043	9.918	9061.4 (0.000)	1081.7 (0.000)
	US	0.0206	1.1479	-0.0890	12.102	15630.0 (0.000)	1309.3 (0.000)
Emerging Markets	**Brazil**	0.0555	1.7690	0.0750	7.347	3439.1 (0.000)	1064.8 (0.000)
	China	0.0164	1.5850	-0.2187	7.684	4025.9 (0.000)	422.28 (0.000)
	Egypt	0.0796	1.6588	-0.1214	13.150	18891.5 (0.000)	506.16 (0.000)
	India	0.0597	1.4143	0.1206	12.839	17795.2 (0.000)	515.88 (0.000)
	Indonesia	0.0706	1.3261	-0.5015	9.570	8083.9 (0.000)	597.36 (0.000)
	Mexico	0.0518	1.2132	0.1537	9.3565	7644.2 (0.000)	785.27 (0.000)
	Russia	0.0827	1.9653	0.3700	24.338	85492.6 (0.000)	738.93 (0.000)
	South Africa	0.0476	1.2987	0.0368	6.299	2044.6 (0.000)	901.03 (0.000)
	Thailand	0.0477	1.2639	-0.5200	13.237	19417.1 (0.000)	633.39 (0.000)

	Stock Market	Mean	Standard Deviation	Skew-ness	Kurtosis	Jarque Bera Test	ARCH - LM Test
	Turkey	0.0696	1.9733	-0.0374	9.689	8426.7 (0.000)	761.13 (0.000)
Frontier Markets	**Argentina**	0.1209	2.1628	0.0184	7.2029	3230.9 (0.000)	716.33 (0.000)
	Estonia	0.0526	1.0368	0.3168	14.296	24406.2 (0.000)	413.54 (0.000)
	Kenya	0.0127	0.8313	0.5557	15.160	28057.5 (0.000)	1115.2 (0.000)
	Tunisia	0.0351	1.2924	0.6036	20.461	59408.8 (0.000)	223.91 (0.000)
	Sri Lanka	0.0664	1.1288	0.9933	43.750	30019.2 (0.000)	1151.6 (0.000)

Figure 1. *Returns of developed markets*

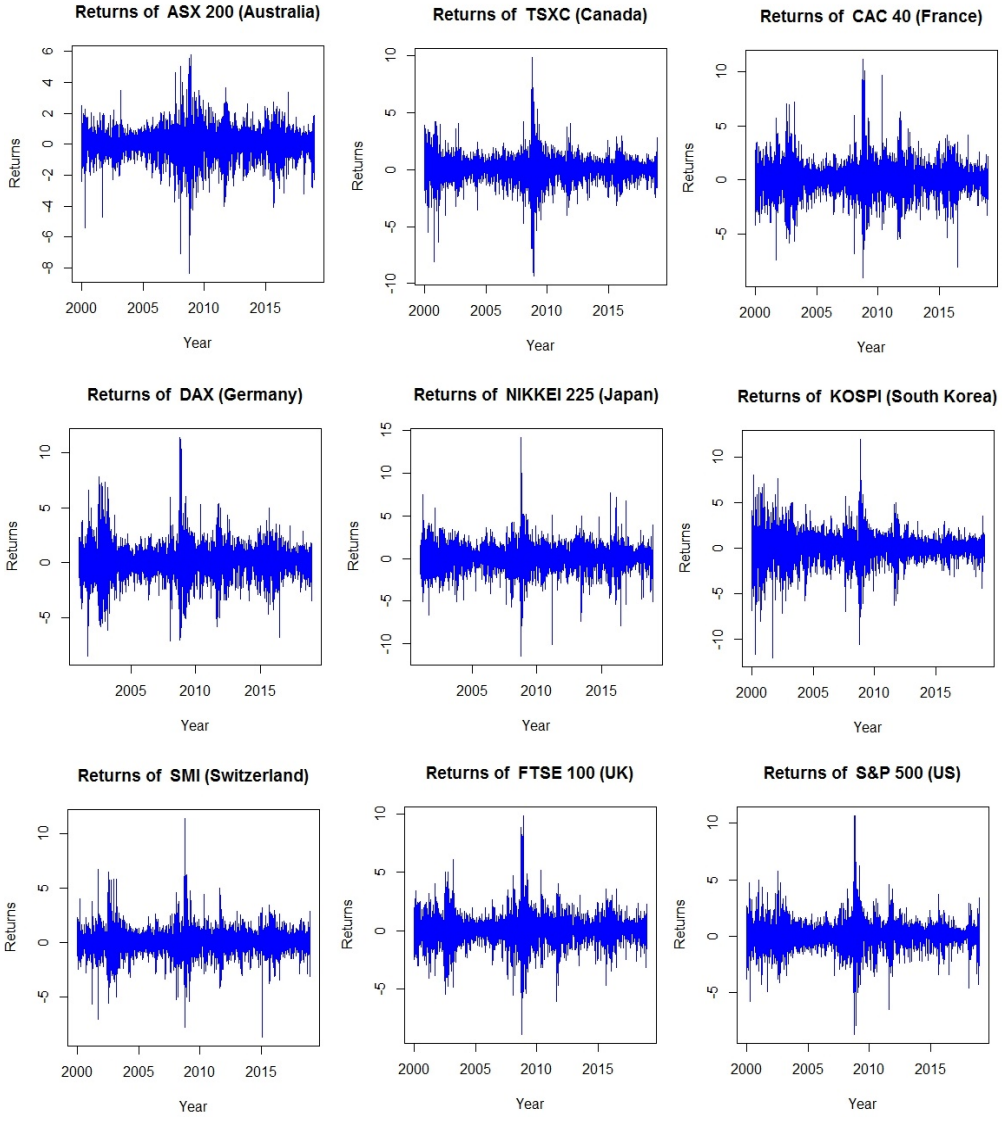


Figure 2. *Returns of emerging markets*

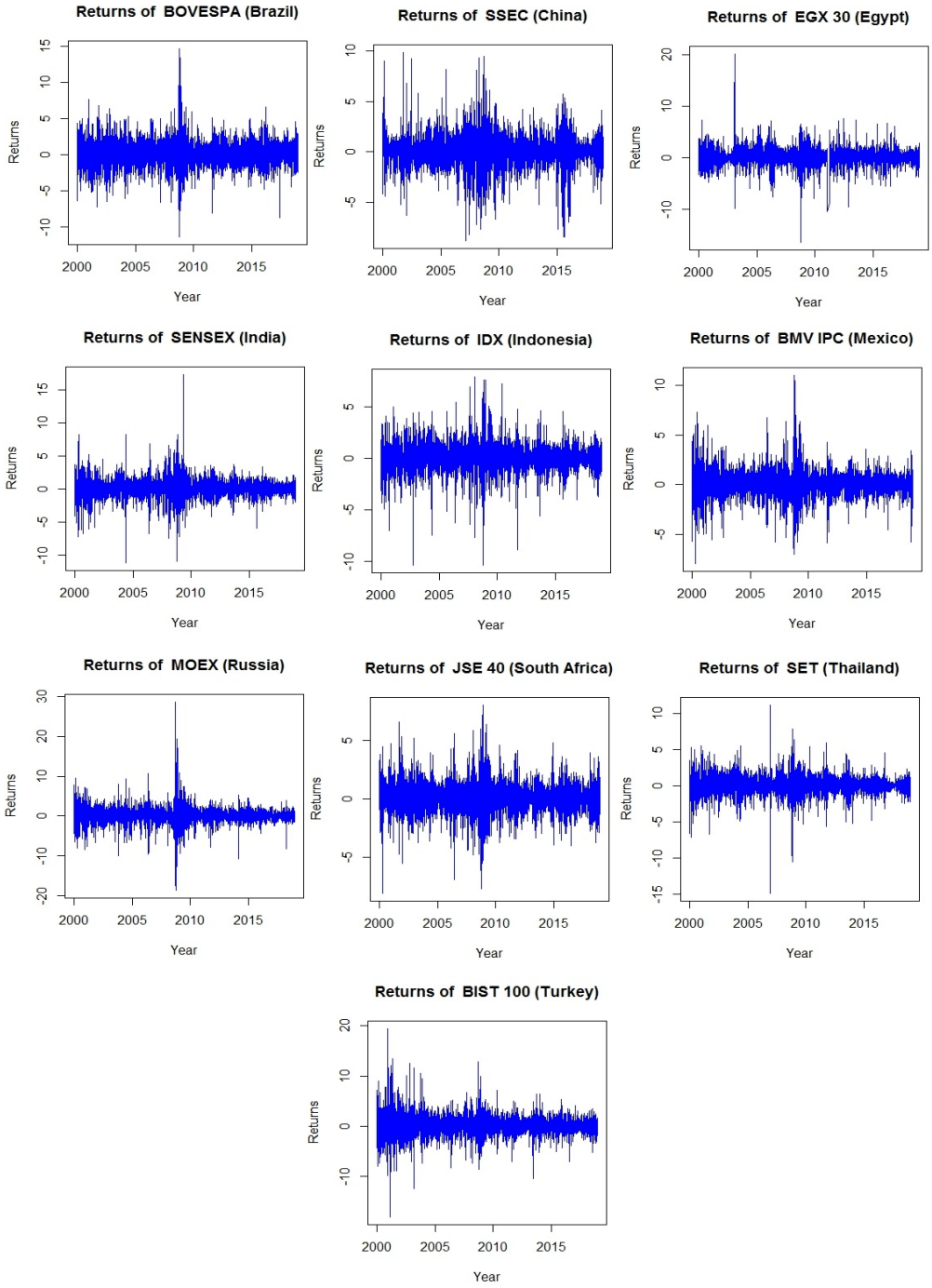
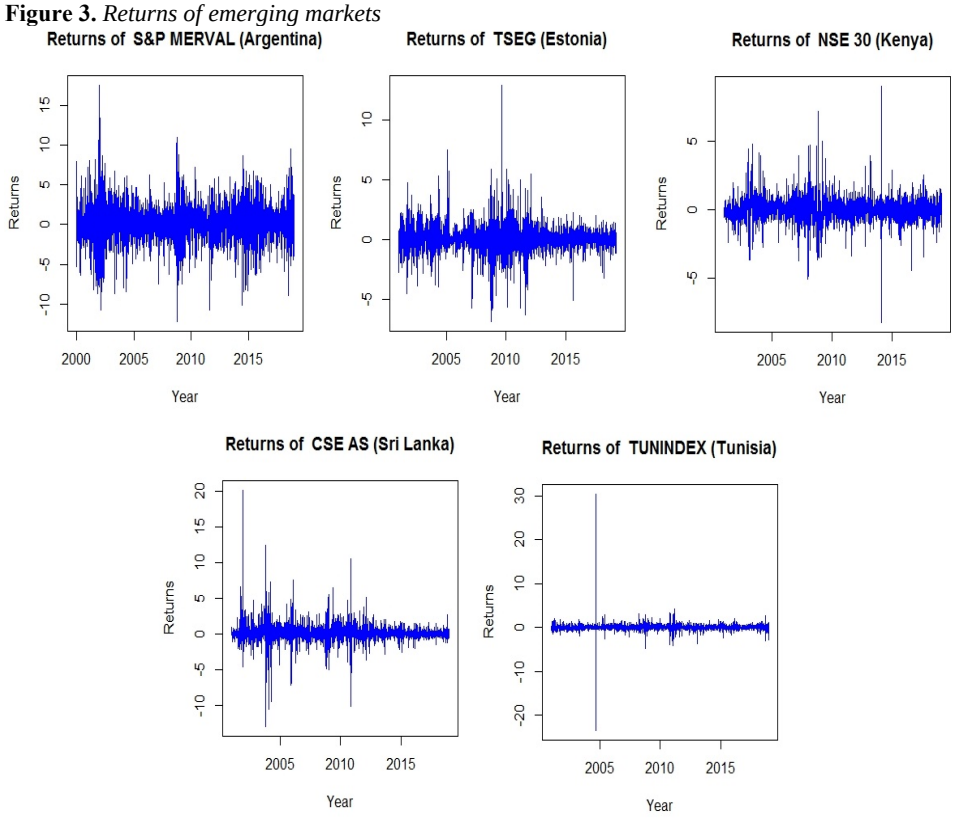


Figure 3. *Returns of emerging markets*



3.2. Results of GARCH Models

The returns of all the markets have been tested for Autoregressive Conditional heteroscedasticity (ARCH) effect in the data by employing Engle's ARCH test and found that all the market returns exhibit the ARCH effect. We employed the GARCH (1, 1) model the volatility persistence, EGARCH (1, 1) model to check the informational asymmetries, and to know the leverage effect we used TGARCH (1, 1) model. The estimates of GARCH (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models for all the markets are given in Tables 2, 3 and 4 respectively.

3.2.1. Estimation of GARCH (1, 1)

It is evident from the Table 2 that the sum of ARCH (α) and GARCH (β) terms in all the indices is very high and close to one, which indicates the volatility persistence is very high in all the selected markets. Also, we can see that in developed markets, South Korea is relatively high volatile and Switzerland is relatively less volatile. In emerging markets, Indian stock market is relatively high and Egypt is relatively less volatile. Among frontier markets, Estonia and Sri Lanka are highly volatile and Tunisia is relatively low among all the twenty-four markets considered for this study. High volatility persistence is observed in all the markets. This phenomenon can be observed from the Figures 1, 2 and 3.

Table 2. *Estimates of GARCH (1, 1) model for developed, emerging and frontier markets*

	Stock Market	ARCH Term(α)	GARCH Term(β)	(α+ β)
Developed Markets	Australia	0.087448 (10.3352)	0.903005 (97.9755)	0.990453
	Canada	0.081584 (10.1410)	0.912677 (109.5037)	0.994261
	France	0.095482 (10.7096)	0.896320 (96.9243)	0.991802
	Germany	0.090369 (10.8664)	0.898893 (101.3136)	0.989262
	Japan	0.113641 (11.4915)	0.876162 (84.4562)	0.989803
	South Korea	0.073957 (8.8871)	0.922764 (110.6626)	0.996721
	Switzerland	0.126558 (11.8869)	0.853876 (73.6445)	0.980434
	UK	0.110249 (10.4685)	0.877237 (77.0517)	0.987486
	US	0.106848 (7.0175)	0.883275 (58.5636)	0.990123
Emerging Markets	Brazil	0.064213 (8.4084)	0.917087 (8.4084)	0.981300
	China	0.073446 (9.8876)	0.923887 (68.6512)	0.973330
	Egypt	0.16579 (11.9619)	0.80520 (21.4074)	0.970990
	India	0.099491 (7.1814)	0.893863 (61.9600)	0.993354
	Indonesia	0.115532 (10.0344)	0.869836 (67.0351)	0.985368
	Mexico	0.082577 (10.1843)	0.909424 (105.9648)	0.992001
	Russia	0.093930 (10.4857)	0.893251 (93.2743)	0.987181
	South Africa	0.09242 (10.8217)	0.894103 (94.3941)	0.986524
	Thailand	0.123447 (6.6988)	0.860446 (25.7845)	0.983893
	Turkey	0.088759 (4.2327)	0.901247 (38.1484)	0.990006
Frontier Markets	Argentina	0.10529 (7.2471)	0.86627 (46.2711)	0.971560
	Estonia	0.129805 (11.5247)	0.869195 (84.4573)	0.999000
	Kenya	0.246703 (12.9633)	0.708852 (35.4662)	0.955550
	Sri Lanka	0.31539 (15.7176)	0.68361 (30.6311)	0.999000
	Tunisia	0.342619 (12.3678)	0.440387 (10.3040)	0.783006

3.2.2. Estimation of EGARCH (1, 1)

From the Table 3, we can observe that the signs of asymmetry term in all the indices are negative, which indicates that there exists an inverse relationship between returns and volatility and it is in consistent with theoretical considerations. Among the developed markets, the US has relatively higher informational asymmetry, and Canada has relatively

lower asymmetry. In case of emerging markets, South Africa has relatively higher informational asymmetry, and China has relatively lower asymmetry. In the frontier markets, the asymmetry term of Argentina is significant, the rest of the markets are observed to be statistically insignificant, which means that there are no asymmetric effects on the volatility of these markets. Overall, all the markets in developed and emerging groups have informational asymmetries. However, there is no informational asymmetry in frontier markets group, except Argentina.

Table 3. *Estimates of EGARCH (1, 1) model for developed, emerging and frontier markets*

	Country	EARCH Term	Asymmetry Term
Developed Markets	Australia	0.979363 (909.0633)	-0.105923 (-14.5342)
	Canada	0.987478 (1135.3223)	-0.082517 (-12.1054)
	France	0.981131 (1139.08438)	-0.142102 (-17.65517)
	Germany	0.979707 (1121.4799)	-0.116034 (-15.4356)
	Japan	0.966730 (213.6108)	-0.096694 (-9.9270)
	South Korea	0.988378 (1078.1696)	-0.067469 (-9.5875)
	Switzerland	0.971914 (262.83202)	-0.143354 (-11.64258)
	UK	0.981834 (1041.561502)	-0.125133 (-17.541989)
	US	0.974597 (904.5760)	-0.148677 (-18.4064)
Emerging Markets	Brazil	0.978998 (1016.0517)	-0.066900 (-9.2837)
	China	0.989359 (1075.5473)	-0.023933 (-3.9457)
	Egypt	0.943380 (36.2628)	-0.038982 (-4.0771)
	India	0.979667 (1119.9390)	-0.074531 (-9.4856)
	Indonesia	0.969499 (184.3736)	-0.060089 (-6.8800)
	Mexico	0.985194 (1159.5506)	-0.082389 (-11.4020)
	Russia	0.980620 (1135.5401)	-0.041319 (-5.8110)
	South Africa	0.982389 (1145.9315)	-0.092504 (-13.1189)
	Thailand	0.961514 (49.7916)	-0.078864 (-2.6438)
	Turkey	0.982841 (1694.6875)	-0.047544 (-4.0164)
Frontier Markets	Argentina	0.960604 (48.741)	-0.049973 (-5.8395)
	Estonia	0.981625 (173.7795)	-0.000105 (-0.016459)
	Kenya	0.921242 (37.85145)	-0.002684 (-0.27559)
	Sri Lanka	0.947095 (66.7727)	-0.016937 (-1.3924)
	Tunisia	0.772143 (33.70463)	0.003298 (0.24201)

3.2.3. Estimation of TGARCH (1, 1)

The leverage effect term in Table 4, reveals the presence of leverage effect in all the markets in developed markets, the US has a relatively higher leverage effect and South Korea being the relatively lower. Thailand has relatively higher leverage effect, and China has relatively lower in emerging markets. Among the frontier markets, there exists leverage effect in Argentina, but the rest of the markets are observed to be statistically insignificant, which means that there are no leverage effects on the volatility of these markets. Overall, the all the markets in developed and emerging group are have informational asymmetries and leverage effects.

Table 4. *Estimates of TGARCH (1, 1) model for developed, emerging and frontier markets*

	Stock Market	ARCH Term(α)	GARCH Term(β)	Leverage Effect(γ)
Developed Markets	**Australia**	0.006557 (1.0272)	0.909456 (107.9523)	0.133830 (9.8585)
	Canada	0.015504 (2.1820)	0.921839 (109.7080)	0.100044 (8.0599)
	France	0.004000 (0.000003)	0.905384 (102.294699)	0.168479 (11.006784)
	Germany	0.006030 (0.000007)	0.910565 (101.100687)	0.150442 (10.396660)
	Japan	0.045512 (5.6155)	0.874473 (85.7492)	0.123949 (8.1058)
	South Korea	0.029405 (4.2799)	0.919794 (100.1141)	0.086918 (6.9904)
	Switzerland	0.010054 (1.3876)	0.873521 (87.8389)	0.189487 (11.3118)
	UK	0.004512 (0.08745)	0.896009 (86.434830)	0.174758 (11.070792)
	US	0.000670 (0.000004)	0.889269 (90.902010)	0.189973 (11.482873)
Emerging Markets	**Brazil**	0.016757 (2.5704)	0.916838 (82.5600)	0.089274 (6.6702)
	China	0.059477 (8.1496)	0.923303 (69.55386)	0.027909 (3.2791)
	Egypt	0.132176 (10.1165)	0.796885 (20.5615)	0.073326 (4.2605)
	India	0.048024 (6.2358)	0.890208 (63.4005)	0.101698 (7.2559)
	Indonesia	0.073292 (6.8492)	0.865653 (60.8294)	0.076653 (5.2264)
	Mexico	0.018488 (2.9291)	0.918639 (99.2788)	0.106243 (8.5341)
	Russia	0.065986 (7.5800)	0.892412 (89.6307)	0.054222 (4.7325)
	South Africa	0.019974 (3.3316)	0.904279 (101.4396)	0.124233 (9.4904)
	Thailand	0.073900 (5.3482)	0.844869 (18.4998)	0.124757 (7.0532)
	Turkey	0.057254 (3.6798)	0.897725 (39.2394)	0.066849 (3.1310)

	Stock Market	ARCH Term(α)	GARCH Term(β)	Leverage Effect(γ)
Frontier Markets	Argentina	0.069520 (5.2301)	0.859759 (43.3162)	0.074825 (5.2769)
	Estonia	0.134295 (10.32631)	0.868914 (32.71373)	-0.008428 (-0.40467)
	Kenya	0.241861 (11.77118)	0.707655 (13.16432)	0.011788 (0.54881)
	Sri Lanka	0.312783 (13.74514)	0.683200 (30.52333)	0.006033 (0.23434)
	Tunisia	0.304917 (9.8682)	0.438640 (10.2324)	0.071390 (1.9748)

The informational asymmetry and the leverage effects can by observed from the news impact curves as well, which are given in Figures 4, 5 and 6. The news impact curves for developed markets are more or less L- Shaped, which indicate, the effect of bad news is more compared to same amount of good news on volatility. The news impact curves for frontier markets are U-shaped, indicating stock prices show symmetric effects to both good news as well as bad news. In case of emerging markets, the impact curves are neither L-shaped, nor U-Shaped, indicating that the stock prices in these markets are relatively more sensitive to information compared to frontier markets and are less sensitive compared to developed markets.

The findings of this study are consistent with the studies of Christensen et al. (2015), who confirmed the presence of the asymmetric volatility effect across fifteen stock markets. Guptha and Rao (2017) on BRICS markets, Baur and Dimpfl, (2017) and Herwarth (2017) with respect to asymmetries and leverage effects in stock returns. However, these results are in contrast with the results of Baig et al. (2015), where the authors found less volatility persistence in Sri Lankan Stock Market, this might be due to different time period (2005 – 2015) considered for the study.

Figure 4. *News impact curves for developed markets*

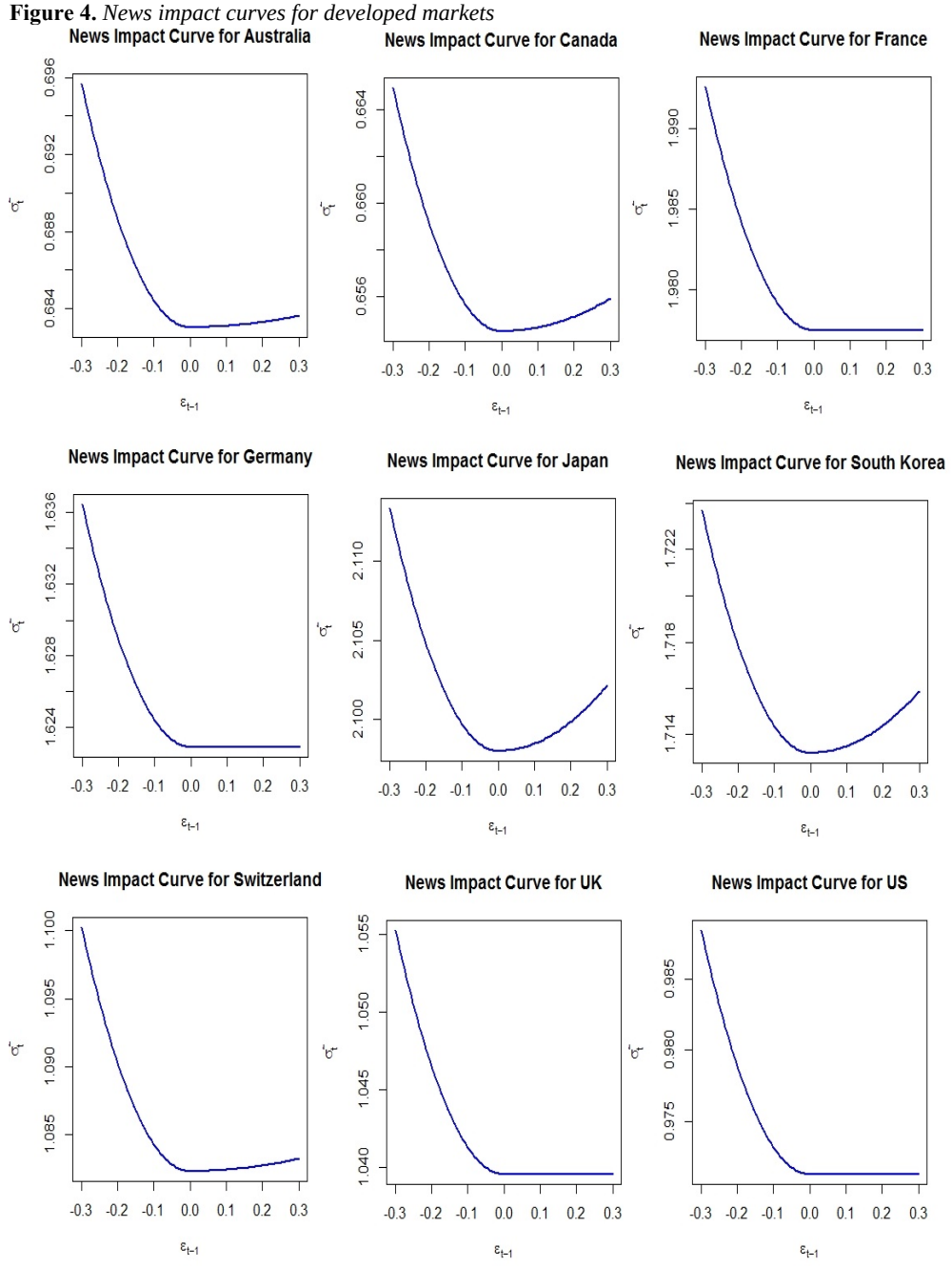


Figure 5. *News impact curves for emerging markets*

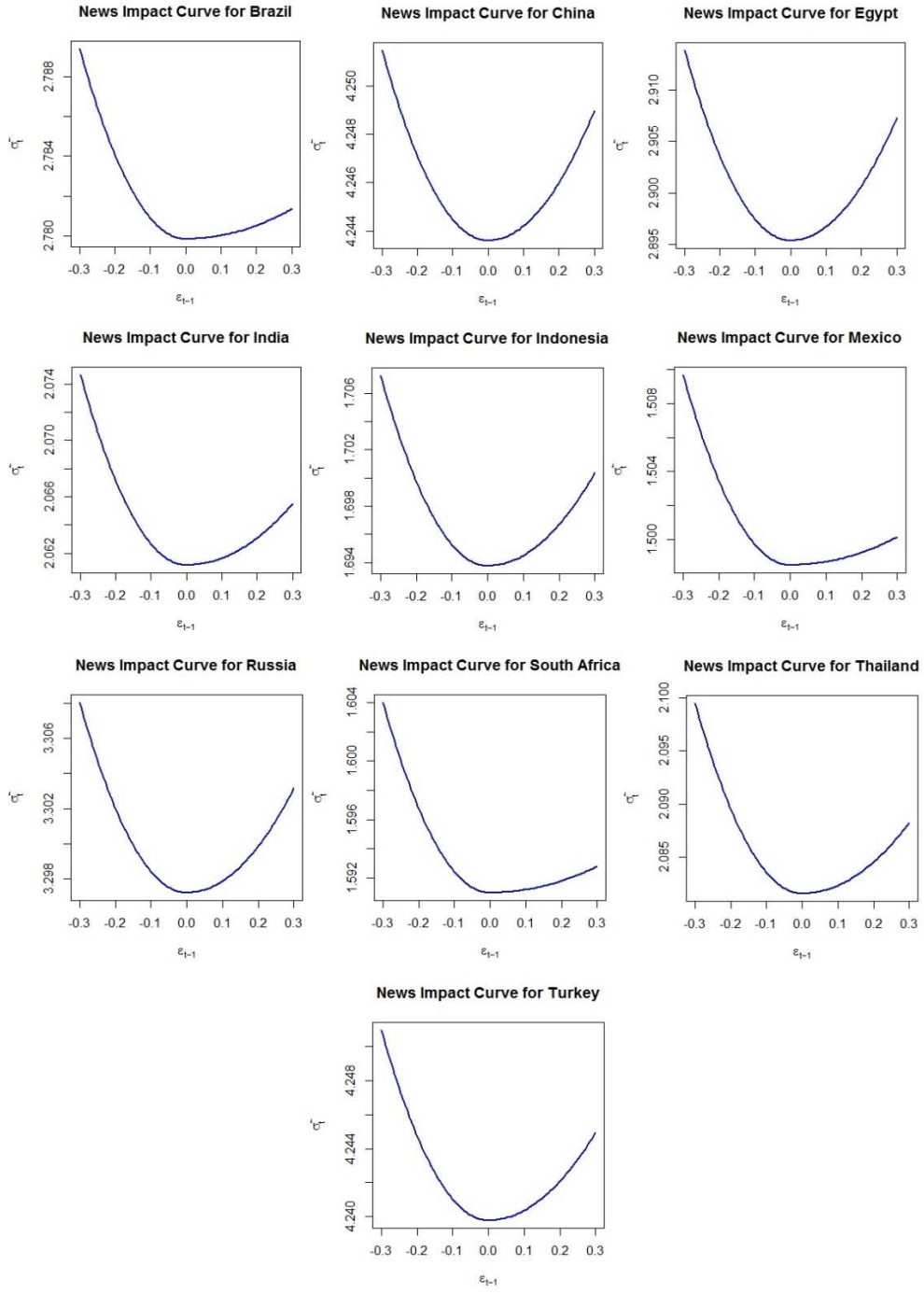
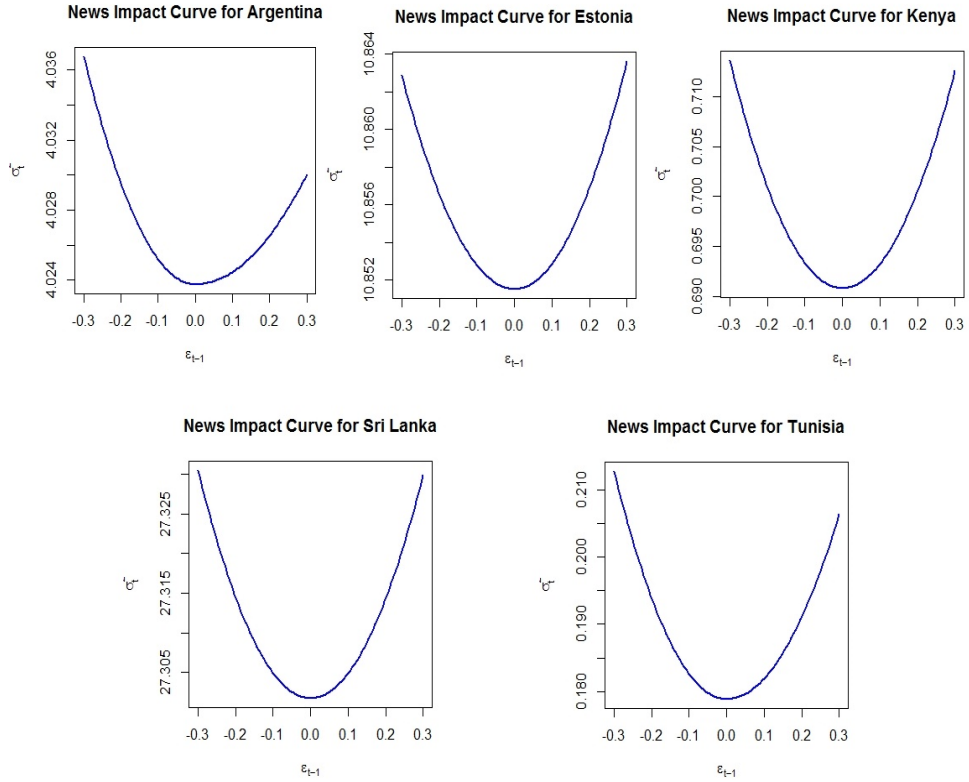


Figure 6. *News impact curves for frontier markets*



4. Summary and conclusions

Volatility in the stock markets has numerous implications on the real economy. Volatility affects investors' investment decisions and confidence to hold risky assets. Modelling volatility in the stock market is therefore crucial in order to hedge against risk, select portfolio and investment decision making. This paper examines the volatility in major global stock markets under three groups, i.e., developed, emerging and frontier markets according to MSCI classification of markets. The daily returns of selected stock indices were taken from 01st January 2000 to 31st December 2018. This study observes that the average returns of all the indices are positive, implying that these indices have appreciated during the period of the study and all the markets exhibit the stylized facts of financial time series. Further, the inferences from the estimated results of the GARCH, EGARCH and TGARCH models revealed that the volatility is found to be highly persistent in all the markets. Also, this study found that the developed markets exhibit relatively higher leverage effect and informational asymmetries compared to emerging and frontier markets. There exist leverage effect and information asymmetries in emerging markets as well. However, these tendencies are relatively lower compared to developed markets. Whereas the frontier markets do not exhibit any asymmetries and leverage effects at all, except the stock market of Argentina.

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Unemployment hysteresis analysis for OECD countries

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Abstract. *Unemployment is one of the main problems of many developed and developing countries. The two concepts used to examine the structure of unemployment are unemployment hysteresis and natural unemployment rate. The aim of this study is to investigate the validity of the unemployment hysteresis in 32 OECD countries for the period January 2005 - July 2017. The nonlinear unit root test by Kruse (2011) and the test by Güriş (2018) that take into consideration structural breaks and nonlinearity were used in the analyses. The findings indicate that the unemployment hysteresis in the OECD countries is generally valid according to both test results.*

Keywords: unemployment, unemployment hysteresis, nonlinear unit root test, OECD countries.

JEL Classification: C22, E24, J64.

1. Introduction

Unemployment, which is one of the major problems of today's economies, causes various problems including economic and sociological problems. Policy makers and researchers are developing different approaches and suggestions about the structure of unemployment. Two of the most remarkable of these approaches are the natural unemployment rate and the unemployment hysteresis.

As a concept, unemployment is the presence of labor force that wants to work and can physically work but cannot find jobs. At this point, one of the key concepts is the unemployment rate, which is the percentage of the population that cannot find work in comparison to the total population. Given the natural flow of labor markets, it is not possible to eliminate unemployment altogether. The unemployment rate accepted as normal in each country is called the natural unemployment rate (Güriş et al., 2017, p. 36). The natural unemployment rate was introduced to the literature by Friedman (1968) and Phelps (1968). The natural rate hypothesis is one of the important issues of the market equilibrium theory and distinguishes between long cyclical fluctuations and short cyclical fluctuations in economy. Although the distinction between the natural rate hypothesis and the hysteresis hypothesis is clear in theory, the distinction is somewhat blurred in practice. At this point, the concept of persistence of unemployment is important. Persistence in analytic terms is a special case of the natural rate hypothesis. It takes some time for a strong and continuous economy to adjust to return to the balance after a shock. Hence, even if the natural rate hypothesis is a real model of the economy, continuity implies that the effects of shocks are long and that short-term macroeconomic policy may be effective (Mitchell, 1993, pp. 1489-1490). In the case of natural unemployment rate, it can be said that the unemployment rate is stationary.

The notion of unemployment hysteresis was introduced to the literature by Blanchard and Summers (1986). Unemployment hysteresis indicates that cyclical changes will cause structural changes on unemployment, which, in the long run, will have lasting effects and will thus increase the natural unemployment rate. Highly persistent unemployment rates, which characterize many countries and regions in Europe, are generally perceived as evidence for the hysteresis hypothesis. The traditional view defines unemployment fluctuations as natural cyclical deviations or unemployment rate that does not accelerate inflation, while theories that define unemployment rate as a hysterical process indicate that transient shocks will have lasting effects (Lanzafame, 2012, p. 415). In the case of unemployment hysteresis, it can be said that the unemployment rate is not stationary, that is, it has a unit root.

This study investigating the validity of unemployment hysteresis in OECD countries consists of four parts. In the second part of the study, the studies in the literature on the countries that make up the OECD countries are examined. In the third part, the Kruse (2011) test and the newly proposed Güriş test (2018) from among the non-linear unit root tests will be explained. In the last part, the dataset to be used in the empirical study will be

introduced, the results of the unemployment hysteresis implementation in OECD countries will be given and the results obtained will be evaluated.

2. Literature review

There is not much comprehensive literature on the validity of unemployment hysteresis for country or country groups. When the current literature is examined, it appears that there is no common law for the validity of unemployment hysteresis. The main reasons for this could be the difference between the group of country (or) countries studied, the examination periods and the econometric method used in empirical practice.

Blanchard and Summers (1986) studied the validity of unemployment hysteresis in France, Germany, the UK and the USA using the data from 1953-1984. As a result of the analysis using Dickey-Fuller and Augmented Dickey-Fuller tests, it was concluded that the unemployment hysteresis is valid for France, Germany and the UK. Papell, Murray and Ghiblawi (2000) studied the validity of the unemployment hysteresis for 16 OECD countries for the period 1955-1997. As a result of the analysis carried out using the unit root tests with structural breaks of Zivot and Andrews (1992), it was concluded that the unemployment hysteresis for Belgium, Canada, Denmark, Finland, Ireland, Norway, Sweden, Spain and the USA is not valid. Røed (2002) studied the validity of unemployment hysteresis for 10 OECD countries using the data for the period 1960-1995. The analyses were carried out using the ADF and KPSS unit root tests and it was concluded that the natural unemployment rate applied for the United States and that the unemployment hysteresis applied for the nine other countries. In the study by León-Ledesma (2002), it was investigated whether the unemployment hysteresis was valid for 51 US states and 12 European countries for the period 1985-1999. According to the results of the ADF unit root test and the analyses made using the Im, Pesaran and Shin (1997) test, the unemployment hysteresis was valid for European countries and the natural unemployment rate was valid for the USA. Camarero and Tamarit (2004) examined the validity of unemployment hysteresis for 19 OECD countries. The ADF, MADF and SURADF unit root tests were used in the analyses for the period 1956-2001. According to the findings, the unemployment hysteresis was valid in Germany, Austria, Sweden, Italy, Japan, Norway and New Zealand. Another study was carried out by Chang et al. (2005) on 10 European countries. Analyzes were made for the period 1961-1999, and classical and panel unit root tests were used. The result was that the unemployment hysteresis was valid in countries other than Belgium and the Netherlands. The validity of the unemployment hysteresis by Gustavsson and Österholm (2006) was investigated for Australia, Canada, Finland, Sweden and the USA. Linear and nonlinear unit root tests were used in the examinations of different periods for the relevant countries. Gustavsson and Österholm (2006) found the hysteresis impact in Australia, Canada and Sweden based on linear unit root tests, and based on nonlinear unit root test, only Australia displayed the hysteresis impact. In the study by Yılancı (2008), the validity of the unemployment hysteresis in 17 OECD countries was examined using the ADF unit root test and the nonlinear unit root tests by Kapetanious,

Shin and Snell (2003). The data ranges of 17 OECD countries differ in the analyses made. According to the results of the analysis, the unemployment hysteresis applied for Germany, Australia, Finland, Japan, Canada, Luxembourg, Norway, Slovakia and Turkey. Khraief et al. (2015) investigated the validity of the unemployment hysteresis in 29 OECD countries for the period 1980-2013. According to analyses using univariate and panel unit root tests, the unemployment hysteresis in OECD countries was strongly rejected. The empirical studies made clearly demonstrate that there is no common result about the acceptance or disapproval of the unemployment hysteresis.

3. Econometric method

Investigating the stationarity of the variables studied in the analysis of economic issues is one of the important issues in terms of reliability of the work done. In empirical studies, linear unit root tests appear to be more commonly used than nonlinear unit root tests. Two important reasons for this are the use and the interpretation of linear unit root tests being easier than nonlinear tests. However, in the literature, the studies by Terasvirta, Van Dijk and Mederios (2005), Baillie and Kapetanios (2007), Yoon (2009), Yoon (2010), Chen and Lin (2014), Yılancı and Tıraşoğlu (2016) have come to the conclusion that many economic variables exhibit nonlinear properties. Nonlinear unit root tests that do not have a very long history appear to be in rapid development. Nonlinear unit root tests with different properties continue to be introduced to the literature during this process. Some of these are the Kapetanios, Shin and Snell (2003) test (hereafter referred to as KSS) and the Kruse test (2011) which is an improved version of this test. However, Güriş (2018) is another nonlinear Fourier unit root test introduced in the literature recently.

The KSS (2003) unit root test is an improved version of the linear ADF unit root test for nonlinear structure. This unit root test is based on the smooth transition autoregressive (STAR) model structure. The KSS (2003) test assumes that the position parameter c is zero. Kruse (2011) suggested that the probability of nonzero position parameters in real world examples is more probable and modified the KSS (2003) test. The nonlinear time series model to allow a non-zero position parameter (c) in the exponential transition following the operation of the KSS (2003) can be shown as follows.

$$\Delta y_t = \phi y_{t-1}(1-\exp\left\{-\gamma(y_{t-1}-c)^2\right\}) + \varepsilon_t$$

By applying the first degree Taylor approach, $G(y_{t-1};\gamma,c) = (1-\exp\left\{-\gamma(y_{t-1}-c)^2\right\})$ around $\gamma = 0$. The test regression continues as follows:

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + \beta_3 y_{t-1} + u_t$$

Following the KSS (2003) study, the power of the test could be further developed by applying $\beta_3 = 0$.

$$\Delta y_t = \beta_1 y_{t-1}^3 + \beta_2 y_{t-1}^2 + u_t$$

Here, $\beta_1 = \gamma\phi$ and $\beta_2 = -2c\gamma\phi$. The Wald test statistics modified by Kruse (2011) is based on the Hessian matrix. The τ test statistics that belong to the test could be expressed as follows:

$$\tau = t_{\beta_2^{\perp}=0}^2 + 1(\hat{\beta}_1 < 0) t_{\beta_1=0}^2$$

Kruse (2011) showed that Monte Carlo simulation is superior to the KSS (2003) test in most cases.

The concept of structural break has become important in unit root literature with the Perron (1989) study. The tests that take structural breaks into account for different structures have become available. The test introduced in the literature by the Güriş (2018) the nonlinear unit root test was developed using the Fourier functions. The most important advantage of this improved test is that it takes into consideration both structural breaks and nonlinearities in the test procedure.

In the Güriş (2018) test, the Fourier function considered besides the ESTAR nonlinearity is based on the Becker, Enders and Lee (2006) study. Becker, Enders and Lee (2006) propose to use a Fourier series expansion to approximate the unknown number of breaks. Güriş (2018) proposed a test procedure similar to that of Christopoulos and Leon-Ledesma (2010). In the first step, a nonlinear deterministic component is specified.

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi k^* t}{T}\right) + \alpha_2 \cos\left(\frac{2\pi k^* t}{T}\right) + v_t$$

k^* indicates the suitable frequency and the k ranging between 1 to 5 is obtained by minimizing the total of the squares of error terms by using OLS. The error terms of the estimated equation can be obtained as follows.

$$v_t = y_t - \alpha_0 - \alpha_1 \sin\left(\frac{2\pi k^* t}{T}\right) - \alpha_2 \cos\left(\frac{2\pi k^* t}{T}\right)$$

The test statistics are calculated in the second phase. These statistics are calculated by using the (v_t) equation based on the error terms obtained in the first phase.

$$\Delta v_t = \delta_1 v_{t-1}^3 + \delta_2 v_{t-1}^2 + \sum_{j=1}^{p} \varphi_j \Delta v_{t-j} + \varepsilon_t$$

In the third stage, the hypothesis tests are carried out. If the unit root hypothesis is rejected, the $H_1 : \alpha_1 \neq \alpha_2 \neq 0$ alternative hypothesis is tested against the $H_0 : \alpha_1 = \alpha_2 = 0$ null hypothesis using the F test. If the null hypothesis is rejected here, the result is that the variable is stationary around a deterministic function that is broken.

Güriş (2018) calculated the critical values for the Fourier Kruse test. The critical values were obtained using T = 50, 100, 250, 500 and 50,000 repetitions for k = 1, 2, 3, 4 and 5. In addition, Güriş (2018) used the Monte Carlo simulations for the size and power analyses. It has been found that this test has got higher power than the KSS (2003) and Kruse (2011) tests. Especially in the case of small sampling, the recommended size and power performance of the test is very good.

4. Empirical analysis

The validity of the unemployment hysteresis in OECD countries has been investigated using current nonlinear time series methods. Data from 32 OECD countries were used in the empirical study. Monthly data for the January 2005 - July 2017 period were used in the analysis. The data used in the study were obtained from the OECD database. Kruse (2011) and Güriş (2018) nonlinear unit root tests were used to examine whether the unemployment hysteresis is valid in OECD countries and the results are tabulated in Table 1 and Table 2.

Table 1. *Unit Root Test Results with Demeaned*

Country	**Kruse (2011)**		**Güriş (2018)**			
	Lag	*Test Sta.*	*Lag*	*k*	*F Sta.*	*Test Sta.*
Australia	0	1.8999	0	1	126.760	2.2818
Austria	12	1.3881	12	1	99.7043	1.3967
Belgium	5	5.4012	5	3	57.4151	2.2956
Canada	11	5.7288	12	1	51.0902	3.5734
Chile	6	2.0458	6	1	67.4303	2.7492
Czech Rep.	5	2.2980	2	3	43.3472	2.2608
Denmark	7	2.1069	7	1	243.189	5.0677
Estonia	8	7.4488	8	1	79.7013	9.3712
Finland	5	2.6923	2	1	93.5337	1.9642
France	5	2.3251	1	1	328.543	1.2901
Germany	3	8.0170	3	1	91.2854	10.103
Greece	5	2.0779	5	1	128.243	3.6853
Hungary	1	0.6495	3	1	47.3478	1.9930
Iceland	3	0.5463	2	1	337.651	2.8584
Ireland	6	1.4201	4	1	124.381	6.966
Italy	12	1.5180	4	1	67.9214	1.2261
Japan	0	0.5092	0	1	124.661	1.4153
Korea	4	4.2679	8	2	55.4946	7.0102
Latvia	4	2.8448	4	1	109.265	6.0698
Luxembourg	12	2.2429	12	1	145.860	0.7110
Mexico	3	1.2992	3	1	301.432	1.9549
Netherlands	6	3.5357	3	1	44.5424	1.5007
Norway	7	2.4776	7	1	95.2560	2.9707
Poland	9	5.6158	2	2	55.7380	5.1051
Portugal	2	1.4432	2	1	74.9542	0.7878
Slovak Rep.	8	6.2390	1	3	35.2611	1.8314
Slovenia	8	2.2391	6	1	96.0951	0.9967
Spain	4	1.2256	4	1	100.720	0.8852

Country	Kruse (2011)		Güriş (2018)			
	Lag	*Test Sta.*	*Lag*	*k*	*F Sta.*	*Test Sta.*
Sweden	11	6.7774	11	1	47.7004	12.042
Turkey	5	7.4203	6	2	168.887	2.3850
UK	10	1.4319	12	1	83.2994	0.1958
USA	6	4.0978	5	1	389.876	4.0586

Note: *k* represents the frequency selected for the approximation. The * indicate rejection of the null hypothesis of unit root at the 10% level. The critical values were obtained from the studies by Kruse (2011), Becker, Enders and Lee (2006) and Güriş (2018).

Table 1 shows the results of the analysis for the demeaned structure. According to the results obtained, the unit root null hypothesis for the 32 OECD countries was not rejected in the Kruse (2011) test. Similarly, the Güriş (2018) test results support this. According to the Güriş test (2018), the unit root null hypothesis cannot be rejected in all countries. According to the test results, the unemployment rate series in OECD countries is not stationary. These results show that the unemployment hysteresis is valid in the OECD countries for the demeaned structure.

Table 2. *Unit Root Test Results with Detrended*

Country	Kruse (2011)		Güriş (2018)			
	Lag	*Test Sta.*	*Lag*	*k*	*F Sta.*	*Test Sta.*
Australia	4	6.1258	1	3	89.5397	2.3738
Austria	12	3.0822	12	1	70.0303	1.4871
Belgium	5	5.8419	5	3	72.1049	2.5655
Canada	11	6.1929	12	1	48.5467	3.2579
Chile	5	4.6926	6	2	115.597	1.8323
Czech Rep.	5	4.5375	5	1	179.265	5.9063
Denmark	7	2.5500	7	1	145.726	3.7439
Estonia	8	7.3133	8	1	78.9481	9.3474
Finland	6	4.7805	2	3	58.5575	1.3999
France	5	4.0892	1	1	106.3771	1.1846
Germany	3	7.5736	3	1	142.913	4.4407
Greece	10	5.9279	3	1	70.8960	5.7089
Hungary	1	0.4391	3	1	160.717	0.8748
Iceland	3	0.3447	2	1	331.731	2.3240
Ireland	6	1.6095	4	1	118.833	3.6402
Italy	8	4.0527	1	1	287.89	0.4109
Japan	0	2.0885	0	1	150.869	1.7006
Korea	4	4.0119	8	1	54.6866	6.6779
Latvia	4	2.8408	4	1	107.127	5.7268
Luxembourg	12	5.7065	12	1	39.643	0.7768
Mexico	3	1.0008	3	1	285.664	1.8071
Netherlands	6	3.7328	3	1	53.3562	0.4536
Norway	9	7.3068	7	1	63.7103	3.3567
Poland	10	11.254*	3	1	303.242	2.2681
Portugal	2	1.5332	2	1	53.1996	1.1201
Slovak Republic	8	6.2390	8	1	232.384	10.478
Slovenia	8	2.5591	6	1	55.4954	1.2026
Spain	4	0.5442	4	1	117.408	0.0588
Sweden	11	7.2356	11	1	58.3250	12.062

Country	Kruse (2011)		Güriş (2018)			
	Lag	*Test Sta.*	*Lag*	*k*	*F Sta.*	*Test Sta.*
Turkey	6	4.4920	6	2	150.668	2.3889
UK	10	1.4295	12	1	95.5572	0.3118
USA	6	4.0732	5	1	387.152	4.0433

Note: *k* represents the frequency selected for the approximation. The * indicate rejection of the null hypothesis of unit root at the 10% level. The critical values were obtained from the studies by Kruse (2011), Becker, Enders and Lee (2006) and Güriş (2018).

Table 2 shows the results of the analysis for the detrended structure. According to the results obtained, the unit root null hypothesis for 32 OECD countries was rejected only for Poland in the Kruse (2011) test. The natural unemployment rate applies in Poland. The unemployment hysteresis applies in the other 31 OECD countries. According to the Güriş (2018) test result, the unit root null hypothesis cannot be rejected in all countries. These results demonstrate the validity of the unemployment hysteresis in the OECD countries (except for one test for Poland) for the detrended structure.

5. Conclusion

Unemployment is one of the major problems of many developed and developing countries' economies. Two of the concepts on unemployment that draw attention are the unemployment hysteresis and the natural unemployment rate. The natural unemployment rate was introduced to the literature by Friedman 1968 and Phelps (1968), and the concept of unemployment hysteresis was introduced by Blanchard and Summers (1986).

The purpose of this study is to analyze whether the unemployment hysteresis is valid in OECD countries using up-to-date non-linear time series methods. For this reason, the Kruse (2011) test, which is an improved version of the KSS (2003) test, and the test developed by Güriş (2018) were used in this analysis. The most important advantages of the Güriş test (2018) are that it takes into consideration structural breaks and nonlinearity together in the test procedure.

In the analysis carried out for the OECD countries for the period January 2005-July 2017, it was found that the unemployment hysteresis was valid when the non-linearity of the OECD countries was taken into consideration, according to the results of both tests. The findings show that the shocks experienced in the economies of the OECD countries and the stabilization policies applied cause permanent changes in the natural unemployment rate. Findings also indicate that unemployment is moving in a non-stationary manner around the changing mean over time. The validity of the unemployment hysteresis can be detrimental to the economic structure by affecting unemployment related macroeconomic variables. For this reason, it is necessary for countries to take necessary measures in combating unemployment taking into account their own economic structures.

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Culture as a driving factor for foreign direct investments in the Western Development Region of Romania

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Abstract. *The author of the article performs a brief analysis of the mentality and cultural differences of the Western Development Region of Romania compared to the other seven development regions of Romania.*
In this framework, the cultural factors characterizing the Western Development Region are highlighted, culture being approached as a factor favoring foreign direct investments and considered are also the attitude and mentality of the population from the Western Development Region compared to those of the population residing in the other development regions in Romania.

Keywords: attitude, Banat, cultural differences, power distance, equality, German ethnics, uncertainty avoidance, cultural factors, individualism versus collectivism, foreign investors, masculinity versus femininity, mentality, multicultural character, Western Region of Development, Romania.

JEL Classification: O52, R11, Z10.

Introduction

Our research analyzes the mentality and cultural differences present in the Western Development Region (WDR) in Romania. The present research begins with a brief presentation of the historical evolution of the cultural space of the Banat, respectively of the WDR, and investigates the ethnic structure of the business environment in Romania and the special cultural rooting of the German population, which have been living to date in the territory of the WDR.

1. Cultural factors in the Western Region of Development in Romania

1.1. Cultural development in the current territory of the Western Region of Development in Romania

"By its marginal position in the south-east corner of the Danube-Carpathian space, the Banat region is located at the crossroads of interests between East and West, between East and West, wide open towards the West and defended by a hilly and mountainous barrier to the East, wherefrom it is accessible only through mountain paths or on the waves of the rivers" (Schneider, 86, p. 5).

The Banat region, respectively the WDR, is a region that is not only geographically but also culturally determined. From a political point of view, the WDR is an integral part of Romania, but the inhabitants developed a different mental pattern compared to the eastern and southern regions of the country, on the basis of centuries-old belonging to the Austrian-Hungarian Empire, as well as based on the different ethnic belongings. To date, the ethnic groups of Romanians, Hungarians, Roma, Germans (Banat Swabians), Serbs, Czechs, Slovaks, Banat Bulgarians, Jews, even minorities of Italians and Spaniards live in the territory of the WDR (Wolf, 2008, p. 911).

Especially in the past, minorities were present in greater numbers. Starting with the last century and until the second half of the 1990s, the Banat Swabians and Jews almost disappeared due to their emigration from the WDR region. This development can be proven on the basis of different censuses of the population. The demographic structure of the city of Arad, for example, was in 1930 as can be seen below (consider data from NIS).

Table 1. *The ethnic structure of Arad in the year 1930*

Arad 1930	**Population: 77.181**	
Ethnicity	**Absolute**	**%**
Romanians	30.795	39,9
Hungarians	20.277	26,3
Jews	7.016	9,1
Germans (Banat Swabians)	6.090	7,9
Serbs	1.310	1,7
Slovaks	1.079	1,4
Rroma	463	0,6
Other ethnic belongings	10.100	13,1

The current district of Aradul Nou was not taken into consideration. It had at that time a share of 84.3% German population out of a total population of 6,065 inhabitants. At that time, the share of the Romanian population in the WRD was for Timiș County of 42%, for Arad County of 62%, for Caraș-Severin County of 74% and for Hunedoara County of 82%.

In 1930, the Romanian population represented of 77% of the total population in Romania. The WRD comprised a share of 17% German population. And these values were especially diverse at inter-county level. Of the 281,000 Germans in the territory of the WRD, 8,000 lived in the Hunedoara County, thus representing 2.5% of the total number of inhabitants. 36,000 Germans lived in the Caraș-Severin County, which results into 11% of the total population. 59,000 German people lived in the Arad County, representing 12% of the population of the county, and 178,000 German inhabitants lived in the Timiș County, that is 32% of the total. The three constituent counties of the historical region of Banat comprised 633,000 inhabitants of German ethnicity, thus representing 43% of the total population of German ethnicity in Romania.

Currently it should be noted that the Romanian population in Romania has increased to 84%. In some counties, such as Gorj County located in the south of the country, the share of Romanians in the total population is 94%.

In the WRD the share of ethnic Romanians is still below the average of 84% (Arad: 77%, Timiș: 80%, Caraș-Severin: 82% and Hunedoara 85%).

In the counties located in the center of the country, namely Covasna and Harghita, the Hungarian ethnicity represents the absolute majority with a percentage of 70-80% of the total population. In other counties, especially in the eastern part of the country, there are high rates of Rroma inhabitants. WRD still comprises 42% of the entire population of German origin in Romania. Currently, of the 15,500 Germans in the WRD, about 8,500 reside in the Timis County, 3,000 in the Arad County, 3,000 in the Caraș-Severin County and 1,000 in the Hunedoara County.

Of the total population of Romania 81% are of Orthodox religion. In the WRD the Orthodox population reflects a share of only 75%. For the integrative counties of the WRD the percentages are as follows: 69% in Arad, 75% in Timis, 76% in Caras-Severin and 80% in Hunedoara. Some counties in eastern and southern Romania exceed 90%. On the other hand, the counties in the center of the country, i.e. Covasna and Harghita, are considered an exception, comprising only 10% -20% of Orthodox population due to the population of Hungarian ethnicity, which is Catholic (see data of NIS).

The multicultural character of the WRD is also observed in the names of the towns. For example, the towns are often named in two, three or even four languages. The signs at the entrance to towns there are often other names accompanying the Romanian name of the town. Thus, the city of Timisoara bears the German name Temeschburg, the Hungarian name Temesvár and the Serbian name Temisvar. Examples of German towns are: Jimbolia (Germ. Hatzfeld), Sântana (Germ. Sanktanna), Becicherecu Mic (Germ. Kleinbetschkerek), Masloc (Germ. Blumental), Sânnicolau Mare (Germ. Großsanktnikolaus), Aradul Nou (Germ. Neuarad) etc.

In addition, there are also settlements established by the Bulgarians in Banat, such as Vinga (BUHGA/Slavonic alphabet) or the Czechs, such as Ravenska village (Czech Rovensko) (see Kunz, 1974, pp. 39, 96). The city of Lipova (Germ. Lippa) is located in the Arad County, 30 km east of the city of Arad, the county's main city- capital, and on the southern shore of the Mures River. In Radna, actually a district in Lipova, is the only place of pilgrimage in the WRD, namely the monastery of Maria Radna, where religious services are celebrated in Romanian, Hungarian and German (see Hoffstadt and Zippel, 1996, p. 92).

The German traditions rooted in the Romanian West region of development are another proof for the German culture that is to be found up to this day:

- In many Swabian villages throughout the territory of the West region for development typical holidays such as the quail (Germ. Kirchweih) are still celebrated today.
- The German newspaper "Neue Banater Zeitung" founded in 1957 appears in Timișoara five times a week.
- "Radio Timișoara" has been in existence since 1958 and broadcasts daily for two hours in German. The German National Theater in Timisoara.
- The German Consulate in Timisoara.
- The Democratic Forum of Germans in Romania: Banat Regional Forum.
- Religious services are held partly in German, for example in Radna.
- Since 2001, the German Cultural Center exists in Timisoara. It aims to promote the German language and the Romanian-German cultural relations through exhibitions, public readings, concerts, as well as a wide range of literary offerings (see Kuropka, 2010, p. 187).
- Schools with teaching in German: "Adam-Müller-Guttenbrunn" High School in Arad and "Nikolaus Lenau" High School in Timișoara are two high schools with teaching in the German language, well- known as well outside the region. With the diploma of graduating from these high schools, the graduates also obtained the Romanian baccalaureate, the second degree diploma for languages and the diploma of graduation of the German gymnasium (Abitur), which guarantees access to higher education in Germany, Austria and Switzerland. (see Bundesverwaltungsamt-Zentralstelle Für Auslandsschulwesen).

Another indicator of the special status of the WRD in Romania, besides its cultural features, would be the architecture, which is very different from the one in the Former Kingdom. In the region of Banat, the architecture took after that in Vienna or Budapest until 1918, while in other parts of the country it was influenced by the Ottoman culture (see Hoffstadt and Zippel, 1996, p. 89).

In 2021 Romania will have, besides Serbia and Greece, a European capital of culture. In this regard, several Romanian cities including Timisoara, Arad and the Transylvanian city of Cluj-Napoca (Germ. Klausenburg) have applied. Timisoara has supported in its candidacy the argument of multiculturalism, by which it could reflect Europe at micro-level with its entire ethnic and cultural spectrum, being able to show how a larger number of ethnic groups can live together without generating problems in this urban conglomerate.

Finally, the city of Timisoara reached the status of being granted the title of cultural capital of Europe due to the arguments that the city was founded on the principles of historical enlightenment, tolerance, and multiculturalism. Timisoara is the only city in Europe that houses three national state theaters: Romanian, German and Hungarian.

1.2. Economic unions and associations using the German language in the West Region for Development in Romania

Economic associations represent local voluntary associations of various industrial and craft economic enterprises. Their goal is to pursue their common interests. In this process synergetic effects can be reached, as they can become a forum for exchanging experience and interest for investors who want to set up an enterprise on the spot (Lepping, 2004, p. 24).

WRD in Romania has two of the seven German economic associations, respectively communicating in the German language in Romania. Firstly, it is the Romanian-German Economic Association of Arad (RGEA Arad), and secondly, the German Economic Union (GEU Banat) in Timisoara.

GEU Arad was established on May 1, 1997 and is chronologically the second German-Romanian economic association in the country. This association has a total of 43 member companies from all over the county. GEU Arad has the following principles:

- promotes open and free exchange of members' experience and opinion; acts constructively in the pursuit of success and recognition of its members in the economic and personal field;
- aims at holding the status of a mediator between East and West in reducing prejudices and the envy in competition, as well as promoting fair and honest competition;
- wants to become a forum for future-oriented entrepreneurs who want to establish a liberal social community.

The aims of the *RGEA Arad* are as follows:

- organizes a “Round Table” discussion for interested members on a monthly basis for an open exchange of opinion and experience;
- promotes and supports through instructions the advice of future entrepreneurs;
- it is oriented according to the needs of its members and brings up a current theme four times a year;
- promotes the exchange of experience between the official institutions, chambers of commerce and other institutions, as well as the media, in the form of partners and sponsorship;
- organizes a celebration twice a year under the motto “German-Romanian Association” with the desire to create for Germany a positive image about Romania;
- displays an information network between Romania and Germany by setting up other associations in the other regions of Romania;
- seeks cooperation with the other existing German-Romanian economic associations in other regions of Romania.

GEU Banat was established in Timisoara in June 2002 as a Public Association for promoting economic relations between the Germanic countries and Romania and has 165 members, who come from all the surrounding area.

GEU Banat in Timisoara has the following goals:
- perception of economic interests at German and Romanian officials, public law corporations and authorities;
- support in communicating with the Romanian authorities, as well as assistance granted to its members for obtaining approvals regarding the right for residence and work;
- collecting and communicating information on the economic situation in the German-speaking territory and in Romania, in particular on the status and evolution of the economic and commercial-political problems through publications, memos, information sheets and other publications;
- Recycling programs and seminars for improving the professional knowledge of the Romanian employees in the member companies of the association;
- promoting cultural celebrations in German, as well as supporting schools with teaching programs in German, of German as a foreign language in schools and study courses at the West University of Timisoara and at the Polytechnic University of Timisoara;
- establishing employment associations with the following topics (among others) and as needed: trade, customs, transport, investments and privatization, law, taxes and finances, culture.

GEU Banat in Timisoara enjoys, in cooperation with the Chambers of Commerce of Germany, Austria and Switzerland, the following achievements:
- advisers of any kind (labor law, commercial law, tax law, construction law, traffic law, customs law, the convention to avoid double taxation, advisers on technical issues, advisers on the conclusion of contracts of different kinds);
- the establishment of companies can be organized without the associate partner from Germany being present in Romania;
- legal support in exceptional or conflict cases;
- mediation of labor, buildings, production and storage spaces, sales and office space, construction and agricultural land, means of transport, protection and safety of all kinds, insurance, housing of all categories, etc.;
- information of any kind from the economic and social field throughout the country, including statistical data;
- accounting and human resources service;
- organizational support as well as in the field of logistics;
- setting up bank accounts, support for obtaining a bank loan, etc.

Also, GEU Banat in Timișoara has set an official aim, that of introducing twofold professional training according to the German model.

Both associations function as reference points in various issues for German investors and aim at removing various barriers. In addition, the WRD has established in Timisoara the German Consulate, which has the mission to promote the economic and cultural relations between the WRD and Germany, through close cooperation with the aforementioned economic associations. Further, the German-Romanian institutions, such as the German

Cultural Center in Timisoara, as well as the specializations/faculties for German language studies of the two important universities in Timisoara (the West University and the Polytechnic University) and German-language media institutions will be supported.

The German Consulate in Timisoara cooperates with members of the German ethnic group in the WRD. The reference partner in this case is its political body which is represented by the German Democratic Forum of Romania (FGDFR).

1.3. The West Regional Development Agency (RDA West) in Timișoara

In 1999, the West Regional Development Agency (RDA West) was established in Timisoara as a public and non-governmental public organization.

This is an integrative part of financial organizations and tools as well as of regional and national decision-making institutions. RDA West contributes to the sustainable development and to the prosperity of the WRD by promoting and encouraging investments and promoting long-term employment, by engaging in industrial restructuring and creating new jobs. RDA West has an active department (Regional Policy and Internationalization Department) that acts directly in the political process of internationalization and of attracting direct international investments. In addition, RDA West also coordinates and manages the technical and financial associations "Tehimpuls", "Automotivest", as well as the regional Cluster "ICT Cluster".

2. Culture as factor for foreign direct investment in the West region for development in Romania

As the West Region of Development in Romania has a specific population structure and history compared to the other 7 development regions in Romania, we will investigate in what follows the influence of culture on the economic activity. "In the context of the activity of some international enterprises, culture is regarded as an integral part of the infrastructure of economic enterprises, which influences the action of individuals as well as economic structures" (Strunz and Dorsch, 2001, p. 253).

An important contribution to this subject is made by Geert Hofstede through his work, "The Consequences of Culture" (1980), in which he describes the results of a study begun in the 1960s the last century, containing data collected from 88,000 people in 53 countries, study culminating in the definition and foundation of four intercultural dimensions, namely: power distance, uncertainty avoidance, individualism versus collectivism and masculinity versus femininity.

"The dimensions were prepared with the help of questions related to job satisfaction, prejudices, aspirations and beliefs. These dimensions explain 50% of the differences between the values of the observed countries. The remaining differences are specific to every country and cannot be explained by cultural dimensions." (Hofstede, 1982, p. 39).

The first cultural dimension, the power distance, is defined as the extent to which the less powerful members of institutions and organizations in a country expect and accept that power is unevenly distributed (Hofstede et al., 2010). Specifically, the scores recorded for

this dimension provide us with information on the dependency relationships within a country. Thus, according to the authors, in countries with a low power distance (a low score), the dependence of the subordinates on the ones in power is limited and there is a preference for consultation, that is, an inter-dependence between the chief and the subordinate. Conversely, a high score shows us that there is a high dependency of subordinates on bosses. For evaluating this dimension, questions related to the relationship between managers and subordinates were used, as well as questions that reflect the expectations that the subordinates have in the relationship with the manager, namely: From your experience, how often the following situation occurs: the employees are afraid to express disagreement with superiors?; The way in which the subordinates perceive the real style in which the superior makes the decisions; "The preference of subordinates for their bosses' style of making decisions".

The second dimension, *individualism versus collectivism*, divides the countries into two categories: individualistic and collectivist. According to the authors, individualism is characteristic for societies where the relationships between individuals are weak: everyone is expected to take care of themselves and their immediate family. Contrary to this, collectivism characterizes the societies in which from birth onwards people are integrated into strong, cohesive in- groups that throughout their lives continue to protect them, in exchange for unconditional loyalty (Hofstede et al., 2010). In order to assess this dimension, the authors included in the questionnaires questions that reveal the expectations of the employees in the workplace. Thus, an individualistic society is made up of individuals who prefer the following: a job that offers enough free time for personal or family life, freedom about how to approach work and the existence of challenges that give the feeling of personal fulfillment. With regard to collectivist societies, their members allot greater importance to the following criteria: the opportunity to improve the skills at work, the favorable working conditions and the opportunity to make the most of the skills and abilities in the workplace.

The third dimension, *masculinity versus femininity*, was also established with the help of questions regarding the expectations of the employees in the workplace. Following the data processing, the authors define the societies according to this dimension as follows: a society is called masculine if the emotional roles of the gender differ clearly: men must be authoritarian, tough and focused on material success, while women must be modest, gentle and concerned about the quality of life. A society is called feminine if the emotional roles of the genders overlap: both men and women must demonstrate modesty, gentleness and concern for the quality of life (Hofstede et al., 2010). According to the authors, the individuals belonging to the masculine societies express preferences for the following aspirations: the chance of substantial gains, obtaining the recognition for certain merits in the workplace, the opportunity to become promoted to higher positions, to get an exciting job that gives the feeling of personal fulfillment. At the opposite pole are the feminine societies, whose individuals prefer the following: a good working relationship with the manager, a good collaboration with work colleagues and job security.

The fourth dimension, *uncertainty avoidance*, is defined by the authors as follows: "the extents to which members of a culture feel threatened by ambiguous or unknown

situations" (Hofstede et al., 2010). This is determined with the help of questions regarding compliance with rules, job stability and stress. Based on the answers, the author observes that those individuals who seek safety offer answers that suggest respecting the rules and/ or maintaining the same job for a long period.

It must be borne in mind that national and ethnic peculiarities hold in many countries a higher importance than in Germany. As an example we can recall the rivalry that exists between northern Italy and southern Italy or between the Wallonia and Flemish regions in Belgium. Another example would be Scotland and England, which cannot hold the same position (see Strunz and Dorsch, 2001, p. 327).

Table 2. *Cultural dimensions in various countries considered*

	Individualism	Power distance	Uncertainty avoidance	Masculinity
Romania	**30**	**90**	**90**	**42**
Germany	**67**	**35**	**65**	**66**
Austria	55	11	70	79
France	71	68	86	43
Italy	76	50	75	70
Greece	35	60	112	57

Source: own analysis based on Hofstede, 2001.

Romanians can be strongly identified, despite their geographical distance, with the French and Italians. Here the common Roman heritage must be taken into account, among others, mostly due to the Latin language (see Strunz and Dorsch, 2001, p. 356). This can be seen from the data presented in Table 2. Except for individualism, the other cultural dimensions for the case of Romania really resemble most of those of France, although Austria is geographically closer. It should not be forgotten here that in a state there can be major differences regarding state unity, and such differences have not been taken into account in statistical processing.

"Although in Romania egalitarianism is favored, certain prejudices towards the social and ethnic minorities are still cultivated. The Hungarian and the German minority are first and foremost to be indicated as examples" (Strunz and Dorsch, 2001, p. 356). These ethnic minorities are particularly represented in the West development region. Religion has never had a role in business relations with foreign economic partners because it has always been regarded as a private problem. The vast majority of the population in the region is of Orthodox faith, but there is also a large Catholic minority (especially Hungarians in the West development region), as well as a reformed minority (especially in Transylvania). In business it takes a lot of patience in establishing business contacts, but once a stable relation has been made, economic partners can rely on sustainable business cooperation. The official correspondence is recommended to be carried out in English or French, and in the meantime it can also be performed in German.

Hierarchical awareness is obviously relevant especially in larger enterprises. In Romania punctuality is generally very important. "A handshake is in Romania customary for occasions such as greeting, presentation or farewell. The verbal address must take place by indicating the person's title." (Strunz and Dorsch, 2001, p. 357).

For foreign investors there are certain topics of taboo discussions, namely the political situation and also the state policy on national minorities. It is not indicated that the Roma

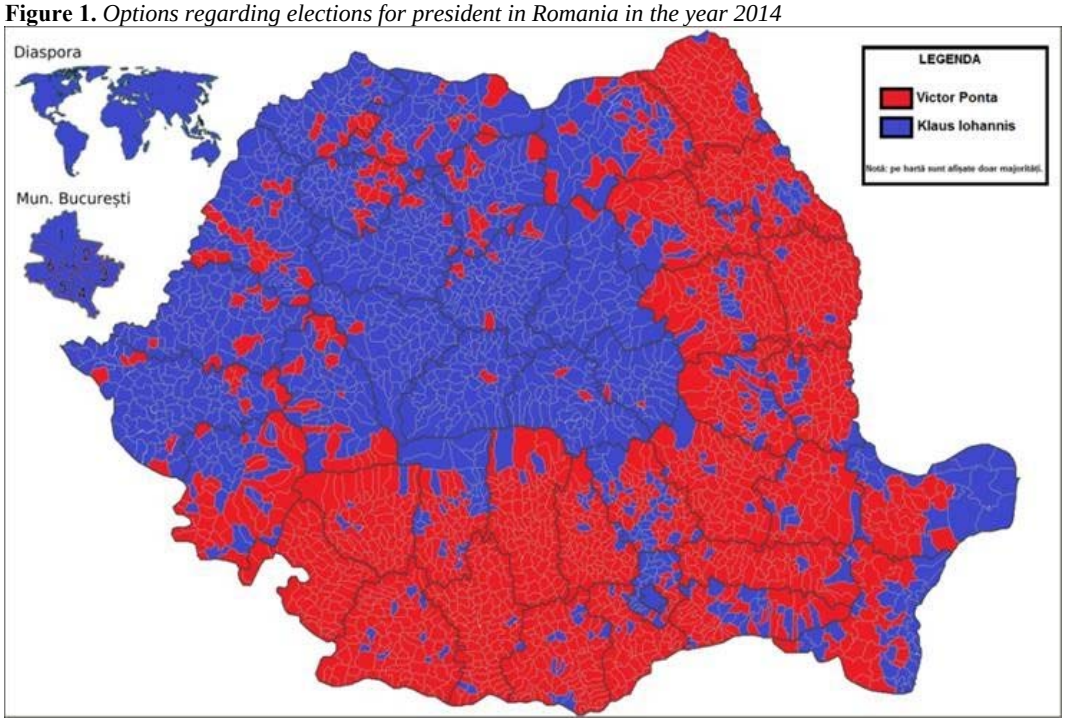
minority in the country be confused with the Romanians (see Strunz and Dorsch, 2001, p. 356).

3. The attitude and mentality of the population in the West development region in Romania

Next we will investigate the attitude and mentality of the population in the West development region, starting from the realization that they are very different in comparison with the other 7 regions for development in Romania.

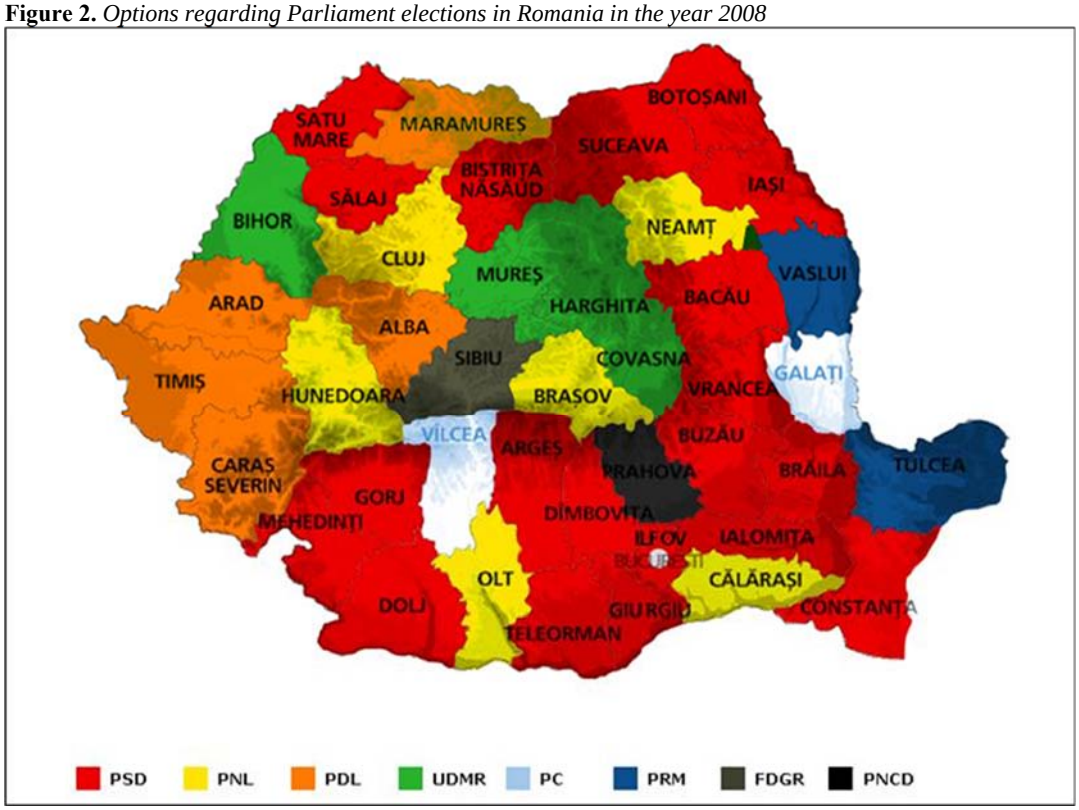
There are several reasons supporting this reality. On the one hand, it can be explained by the geographical position of the West region of development as the most western region in Romania, and on the other hand, by the ethnic structure of the population. For the mentality of the population of this region, the leading economic position of the region has always played a special role (Scharr, 2008, p. 168). The difference in the mentality also comes from observing the results of the 2014 presidential elections. Thus, both the West development region and the multiethnic Transylvanian population chose the Liberal candidate - as well as the Romanians overseas - while the citizens from the other historical regions in Romania, Muntenia in the south of the country and Moldova in the east of the country, chose showing preference towards the candidate of the social-democratic (conservative) party. The same was true in the 2008 parliamentary elections. Clear examples can be seen in the following two figures. Figure 1 refers to the 2014 presidential elections, and Figure 2 refers to the 2008 parliamentary elections.

Figure 1. *Options regarding elections for president in Romania in the year 2014*



Source: https://ro.wikipedia.org/wiki/Fi%C8%99ier:Alegeri_Prezidențiale_în_România_2014,_turul_2.png

Figure 2. *Options regarding Parliament elections in Romania in the year 2008*



Source: http://media.hotnews.ro/media_server1/image-2008-06-1-3141348-0-apartenența-politică-actualilor-președinți-consilii-județene.jpg

Another indication for the more liberal and pro-Western mentality of the population in the West region of development is found in the Revolution of December 1989. In Romania, the phrase "Timișoara - from here freedom spread throughout the country" became well-known everywhere. The Romanian revolution of December 1989 started with the resistance actions of the Hungarian Reformed minister Laszlo Tökes from Timisoara. Starting from Timisoara, the revolution spread quickly throughout the country, having as background the wish of the majority of the population to remove from power the couple Nicolae and Elena Ceausescu.

Hungarian and Yugoslav TV programs, as well as the broadcast of the "Free Europe" radio station, enjoyed good reception in the West region of development, so the population here, especially the ethnic minorities, was better informed among others about the fall of regimes in the other countries in Eastern Europe (see Hoffstadt and Zippel, 1996, p. 96).

The mentality and international thinking pattern of the population are also promoted due to their belonging to the Euro-Danube-Criș-Mureș-Tisa region. Thus, every year there are joint projects in economy, culture and sport, which aim at encouraging the populations' mutual tolerance (see Rieser, 2005, p. 16).

Conclusions

In conclusion, it can be seen that in the economic activity of the foreign investors in the West development region in Romania the culture has never played a negative role or a drawback, but on the contrary, the native culture may offer several advantages/gains.

The West development region – in terms of mentality and culture – is not homogeneous with the other regions of Romania, the reasons being the ethnic structure of the region. This arises as a result of its history and based on its geographical location.

The West development region in Romania has a completely different historical and political development compared to the southern and eastern regions of the country, which received their distinctive attributes due to the Ottoman occupation which lasted for centuries thus not comprising national minorities.

Abbreviations

ADR Vest – West Regional Agency for Development
DWC Banat – German Economic Union Banat
DWR Arad – the Romanian-German Economic Association in Arad
INS – National Institute for Statistics
WDR – West Development Region

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A Deep Neural Network (DNN) based classification model in application to loan default prediction

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Abstract. *In this study, we applied a Deep Neural Networks (DNN) based classification model along with the conventional classification methods (Logistic Regression, Decision Tree, Naïve Bayes and Support Vector Machines) on a two distinct datasets containing characteristics of the loan clients in a medium-sized Turkish commercial bank. Python programming language and libraries (Sklearn, Tensorflow and Keras) have been used in data cleaning, data preparation, feature engineering and model implementation processes. Our empirical findings document that the accuracy of the deep learning classification model increases with the size of the dataset, implying that the deep learning models might yield better results than regression-based models in more complex datasets.*

Keywords: data analytics; credit scoring; deep learning; risk management.

JEL Classification: C01, C40, C87.

1. Introduction

Following the 2008 US subprime mortgage crisis which had devastating effects on many financial institutions across the globe, the need for building reliable and solid credit scoring systems has been intensified, thus, for the banks and lending institutions, discriminating bad customers from the good ones became pivotal. Since the pioneering study of Altman (1968), many statistical and machine learning techniques have been employed for credit risk measurement. There is a plethora of research in the literature devoted to prediction of defaults in the consumer loan market. The regression and classification based models have been the status quo in both the industry and the academic literature for a long time. Discriminant analysis, Logistic Regression, Support Vector Machines (SVMs), classification and regression trees and Naïve Bayes classifiers have been frequently used for classifying loans into bad and good categories.

Previous studies in the field (Hand and Henley, 1997; Abdou and Pointon, 2011; Lessman et al., 2015; Louzada et al., 2017) suggest that, machine learning methods yield better predictive accuracy compared to statistical models. On the other hand, as suggested by Hinton and Salakhutdinov (2006), these methods mainly focus on the outputs of classifiers at the shallow level, while ignoring the rich information hidden in the confidence degree thus their limited modelling and representational power can cause difficulties when dealing with more complicated datasets.

Due to recent developments in computer technology, it is possible to construct training algorithms for deep architectures. The deep belief networks (DBN) and ANNs with sufficient hidden layers are developed as powerful ensemble techniques to capture the rich information hidden in the datasets. Deep learning methods have been applied for classification tasks in various fields from computer vision to speech and language processing. Recently, the deep learning methods have also been used in financial applications (Ribeiro and Lopes, 2011; Tomczak and Zieba, 2015; Giesecke et al., 2016; Luo et al., 2017; Kvamme et al., 2018; Hamori et al., 2018).

In this study, we applied a Deep Neural Networks (DNN) with multiple hidden layers to assess the risk profiles of loan clients on datasets taken from a Turkish commercial bank. We compared the predictive ability of deep learning method vis-à-vis Logistic Regression (LR), J48 Decision Tree, Naïve Bayes and Support Vector Machines (SVM).

The rest of this paper is laid out as following. Classification methods are described in section 2. Section 3 gives a brief overview of the datasets used in the experiments. Model implementation processes and results are presented in section 4, and section 5 concludes.

2. Methods

The quantitative techniques that adopted in this paper are these four aforementioned methods of constructing the default characteristic predicting model: DNN, Logistic Regression, J48, Naïve Bayes and SVM. The brief description of each model that used in this study is as follows.

2.1. Deep Neural Networks

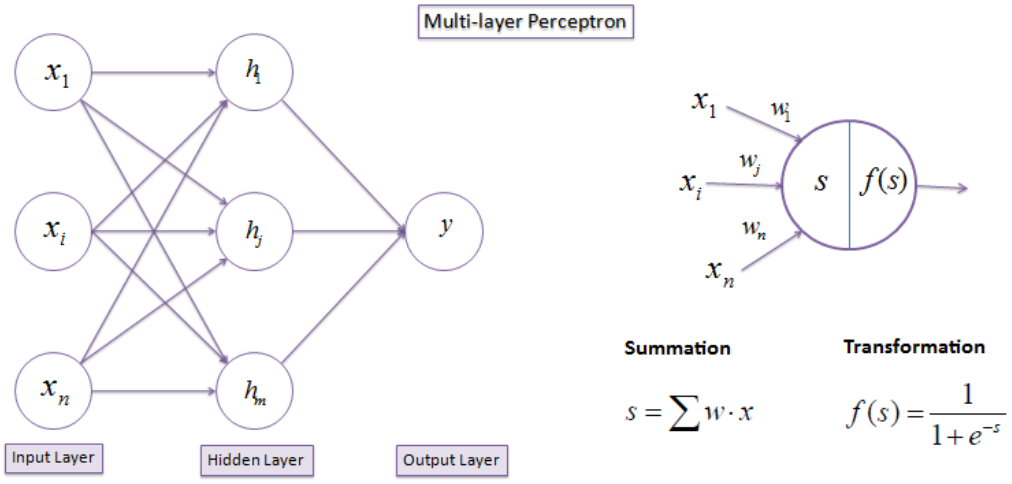
A neural network (NN) is a network structure comprising multiple connected units. It has three layers of units: input layers, hidden layers, and output layers (Figure 1). The neural network configuration is determined by the manner in which the units are connected. When the number of hidden layers is more than or equal to two, the network is called a deep neural network (DNN). The feed-forward neural network is the most widely used neural-network model and is configured by the connection of multiple units, with reference to West (2000), the propagation of the network in each layer is accomplished in following steps.

Step 1: A weighted sum is calculated at each neuron, that is the output value of each neuron in the proceeding network layer times the respective weight of the connection with that neuron.

Step 2: A transfer function $f(s)$ is then applied to this weighted sum to determine the neurons output value.

Step 3: The output value y, can be expressed as a function of the input values and network weights

Figure 1. *The architecture for a three-layer artificial neural network*



2.2. Logistic regression

Logistic Regression is part of a widely used general family of models, introduced by McCullagh and Nelder (1989), known as generalized linear models (GLM). GLMs provide a unified framework to model response from any member of the exponential family distributions, such as Gaussian, Binomial, or Poisson. In GLM framework, the model is quantified from a binary target variable, Y which represents the status of a loan over the outcome window where bad (defaulted) loan is labelled as 0 and good loan is labelled as 1 and related to the linear combination of predictor $\beta_1 * X1 + \ldots + \beta_m * X_m$ in the form of

$$\boldsymbol{G(E(Y|X)) = G(u) = \beta_0 + \sum_{i=1}^{m} \beta_i X_i,} \quad (1)$$

where $\boldsymbol{u}$ is the mean of dependent variable $\boldsymbol{Y}$ and $\boldsymbol{G(.)}$ is a monotonic differentiable function known as Link Function. For Logistic Regression, the functional form can be expressed as

$$\boldsymbol{Logit(p) = \log\left(\frac{p}{1-p}\right) = \beta_0 + \sum_{i=1}^{m} \beta_i X_i,} \quad (2)$$

where $(\boldsymbol{u})$ is $\boldsymbol{p = Prob(Y = 1|X)}$ and $\boldsymbol{G(.)}$ is $\boldsymbol{Logit(.)}$ function in this case.

2.3. J48 Decision Tree

Decision tree learning algorithms use a decision tree as a predictive model which maps observations about an item (represented in the branches) to conclusions about the item's target value (represented in the leaves). Tree models where the target variable can take a finite set of values are called classification trees; in these tree structures, leaves represent class labels and branches represent conjunctions of features that lead to those class labels. In this study, J48 which is an open-source Java implementation of C4.5 (Quinlan, 1986) algorithm has been used to construct the decision tree.

2.4. Support Vector Machines

The main aim of the SVM algorithm is to separate good credits ($y = 1$) from bad credits ($y = 0$) described with a d dimensional vector of characteristics x. We use $y = \{-1,1\}$ instead of the common $y = \{0,1\}$ notation since it is more convenient in the following formal expressions. The SVM separates the two groups with the maximum distance (margin) between them. The score for x is computed as

$$\boldsymbol{f(x) = \sum_{i=1}^{n} \alpha_i y_i K(x, x_i) + b} \quad (3)$$

In our classification problem, we use radial basis function or Gaussian kernel due to unknown relationships between the input variables. The Gaussian kernel on two samples $\boldsymbol{x}$ and $\boldsymbol{x_i}$ is defined to be:

$$\boldsymbol{K(x, x_i) = \exp\left(-\frac{||x - x_i||^2}{2\sigma^2}\right)} \quad (4)$$

When the distance between $\boldsymbol{x}$ and $\boldsymbol{x_i}$ gets narrower, $\boldsymbol{K(x, x_i)}$ becomes wider; therefore, the score $\boldsymbol{f(x)}$ is mainly defined by the observations that are close to $\boldsymbol{x}$. The $\boldsymbol{n}$ factors $\boldsymbol{\alpha_i}$ (Lagrange multipliers) are the free coefficients which are the solution of an SVM optimization problem and have higher magnitudes for the observations at the boundary between the classes which are most relevant for classification (Moro, 2006).

2.5. Naïve Bayes

The Naïve Bayes classification method is based on the Bayesian theorem which postulated independence amongst the predictors. A Bayesian network represents a joint probability distribution over a set of discrete input variables $\boldsymbol{X_i}$. The following equation designs a Naïve Bayes classifier as;

$$\boldsymbol{P(Y = y_j | X_1, \dots, X_n) = \prod_i P(X_i | Y = y_j)} \quad (5)$$

Assume a new occurrence that $\tilde{X} = (X_{1,\dots,}X_n)$, Eq.(5) shows the estimation of the probability that Y will take on any given value, given the observed input values of $\tilde{X}$ and the distributions of $P(Y)$ and $P(X_i|Y)$ estimated from the training set. Incorporating the above assumption, the Naïve Bayes classifier is given by,

$$Y_{NB} \leftarrow \underset{y_j}{\operatorname{argmax}} P(Y = y_j) \prod_i P(X_i | Y = y_j) \quad (6)$$

3. Data

The methods were applied on two distinct real-world credit datasets (loan performance data and loan application data). The first dataset is the loan performance dataset that composed of the default characteristics of 79254 granted loans in a Turkish financial institution(1) for the period between August, 2015 and September, 2017, of whom 71513 were good credits and 7741 were bad credits implying that the default rate is around 10%.

Due to the low proportions of defaulted observations, the accuracy rate expectedly remains high at almost 90% when all observations are used for model implementation, thus making it difficult to understand the importance of using deep learning algorithms. In order to keep a more balanced sample, we randomly selected 14303 observations from all non-defaulted credits, by this means preventing misrepresentation. The sample dataset in this case consists of 22044 observations and the ratio of bad credits is about 35%. The dataset includes one target variable (Default = 0, and Non-Default = 1) and 64 explanatory attributes (31 numeric and 33 categorical).

The second dataset is the application dataset that lists the characteristics of the 496196 loan applicants from the abovementioned institution between the period of January, 2014 and December, 2017. The dataset includes one target variable (Rejected = 0, and Approved = 1) and 60 explanatory attributes (22 numeric and 38 categorical). The number of approved loans was 257524 (52%) and 238972 (48%) of them were rejected applications. Thus, it is a more balanced sample.

The explanatory attributes in both datasets can be summarized into several groups such as:

- *demographical characteristics* (age, gender, education, disposable income, marital status, number of dependents, housing status, length of current residency etc.);
- *employment characteristics* (occupation, length of present employment, total employment etc.);

- *credit characteristics (*type, amount, maturity, frequency, collaterals, instalment rate, purpose etc.);
- *credit history* (number/amount of previous credits, number of previous defaults/late payments/prepayments, credit score etc.).

4. Model implementation and results

In model implementation process, we use 80% of the both dataset, randomly selected from the whole sample and referred to as the training set. The outstanding 20% is used for model evaluation purposes and is referred to as the out-of-sample test set. Extreme observations and missing data points were handled by using Elliptic Envelope (Rousseeuw and Driessen, 1999) and Soft Impute (Mazumder et al., 2010) methods, respectively.

Before the implementation of LR, J48, Naïve Bayes and SVM algorithms, a prior feature engineering process was carried out. For this purpose; redundant attributes were eliminated with the use of Information Value and Kolmogorov-Smirnov algorithms. The Principal Component Analysis (PCA) was employed to eliminate collinearity and extract the statistical factors that were used as final input variables in model estimation. In contrast, instead of using handcrafted input variables, we use raw features in the construction of the DNN model in order to allow the algorithm to extract all the information hidden in the deep levels of the datasets.

We implement the models, using Python programming language- specifically, the "scikit-learn" (Pedregosa et al., 2011) library for LR, J48, Naïve Bayes and SVM; "Tensorflow" (Abadi et al., 2015) and "Keras" (Cholet et al., 2015) libraries for the DNN. We evaluate the classification performance of each model through "weighted accuracy", "Type I Error" (misclassification of good loans) and "Type II Error" (misclassification of bad loans) rates obtained from confusion matrix which gives us a summary of prediction results on a classification problem (Table 1).

Table 1. *Confusion matrix*

			Actual Class	
			Good Loan	Bad Loan
Predicted Class		Good Loan	TP (True Positive)	FP (False Positive)
		Bad Loan	FN (False Negative)	TN (True Negative)

The "accuracy" is a common measure for evaluating a classification model's ability to discriminate between two classes. The "accuracy" is calculated by dividing all correctly classified instances (TP+TN) by all observations. However, due to imbalanced nature of the response variable and asymmetric misclassification cost (Type II Error yields more financial losses than Type I Error); we used an asymmetric accuracy rate that weights specificity rate three times higher than sensitivity rate. The weighted accuracy rate (WACC), in our case, is calculated as;

$$\text{WACC} = 0.25 * \left(\frac{\text{TP}}{\text{TP+FN}}\right) + 0.75 * \left(\frac{\text{TN}}{\text{TN+FP}}\right) \quad (7)$$

4.1. Results for the loan performance data

In this part, DNN is compared with other models to predict the default characteristics of the loan borrowers in a loan performance dataset. As illustrated in Table 2, the proposed DNN model acquires a testing accuracy (WACC) of 77.98%, which is higher than the accuracy rates obtained by LR, J48 and Naive Bayes methods. However, SVM model performs slightly better than the DNN model due to its relatively lower Type II error.

When we look at the Type I and Type II error values, we can notice that J48 and Naive Bayes models are not suitable for the classification tasks. Since, J48 model yields highest Type I and Type II errors, while Naive Bayes predictions are heavily biased towards positive class as shown with imbalanced Type I (very low) and Type II (very high) errors.

Based on the Type I and Type II errors of the competing models, we can say that a lower Type I error indicates that DNN model has a smaller probability to misclassify a good borrower when predicting the loan defaults. And lower Type II error value represents that SVM is more powerful to identify the default behaviour.

Table 2. *The comparison between predicting models for the loan performance data*

	WACC	Type I Error	Type II Error
LR	77.31%	12.31%	26.15%
J48	70.05%	17.99%	33.94%
SVM	78.14%	11.51%	25.31%
Naive Bayes	57.04%	8.19%	54.55%
DNN	77.98%	10.20%	25.95%

4.2. Results for the loan application data

When dealing with the loan application data, we test the usefulness of our model to discriminate between the creditworthy and non-creditworthy applicants to decide whether approve or reject the loan application. The validation results are displayed in Table 3 below. At this model validation stage, the predictive ability of the DNN model is found to be 85.69%, which is significantly higher than the other models.

Moreover, the DNN also performs better than LR and SVM models in the aspects of sensitivity and specificity. The Type I error rate of 15.45% suggest that, there is a 15.45% chance that a creditworthy application will be misjudged and rejected. On the other hand, the Type II error rate of 13.92% implies that, there is a 13.92% probability that a highly risky and unworthy borrower will be accepted for credit.

Table 3. *The comparison between predicting models for the loan application data*

	WACC	Type I Error	Type II Error
LR	78.01%	16.67%	23.76%
J48	82.34%	17.91%	17.58%
SVM	77.93%	14.27%	24.67%
Naive Bayes	75.25%	90.00%	3.00%
DNN	85.69%	15.45%	13.92%

Looking at the results obtained from both datasets, one might conclude that deep learning models perform better than conventional models in bigger datasets. As the bigger sample size of the loan application dataset significantly improves the DNN model's performance over the other models in terms of accuracy, Type I and Type II error values.

5. Conclusion

In this paper, we have presented an application of Deep Neural Network (DNN) based classification model to credit risk assessment. The model has been trained and tested on two different data sets related to the characteristics of loan borrowers/applicants of a Turkish commercial bank. The performance of the DNN model was compared with four different predicting methods, namely LR, J48, Naïve Bayes and SVM.

Our experimental results indicated that, the DNN model significantly improves the performance of a credit scoring system relative to LR and SVM models in terms of balanced accuracy, Type I error and Type II error metrics in loan application dataset which has a larger sample. On the other hand, the DNN model does not significantly outperforms LR and SVM models in the loan performance dataset. Thus, linear classification models might be preferred in small sample datasets due to simplicity of their implementation. Furthermore, it is also known that deep learning algorithms are hard to implement and require a rigorous process of hyper-parameter tuning. Thus, deep learning based classification models are not always panacea, especially for datasets which have relatively small dimensions.

Future work is focused on both methodological and application issues. As to applications, we plan to assess the predicting abilities of the deep learning models by testing them on more complex data sets and to explore on the applicability. On the side of methodology, we are currently working on the design of other deep learning methods, such as classification Restricted Boltzmann Machine (classRBM) and Deep Belief Networks (DBN).

Note

(1) For confidentiality reasons, we are obliged to keep the name of the financial institution unpublished.

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The new Keynesian Phillips Curve. Implications. Strengths and weaknesses

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Abstract. *The present paper explores the first Dynamic Stochastic General Equilibrium New Keynesian Model and it seeks to emphasize the main advantages and disadvantages involved by the NKPC. Firstly, we start the analysis by discussing briefly about the history of the Phillips Curve and then we try to stress the most important aspects regarding the standard and the hybrid New Keynesian Phillips Curves. Secondly, our goal is to provide an insight about this topic which can represent the starting point for further analysis. Moreover, a special section is included which emphasizes the evidence referred to the NKPC and the hybrid NKPC.*

Keywords: the new Keynesian Phillips curve, the hybrid new Keynesian Phillips curve, dynamic stochastic general equilibrium models, forward-looking inflation, backward-looking inflation.

JEL Classification: H10, O23.

1. The traditional Phillips Curve and the transition to the NKPC

In most industrialized countries, inflation seems to be pro-cyclical. Therefore, inflation rate is high when economic activity is high. Moreover, when economic activity is quantified through the rate of unemployment, this yields to the statistical relationship called "the Phillips curve". This can also be considered as a menu for policymakers, as they can choose either low inflation-high unemployment or high inflation-low unemployment. Hence, there exists a trade-off.

Also, the interpretation of the Phillips curve underlines that the relationship unemployment-inflation is structural and it cannot break down if a monetary decision-maker seeks to exploit the trade-off. But after the high inflation periods that many economies faced during the 1970s, the Phillips curve's structural interpretation was not accepted anymore. Nevertheless, after periods with low inflation rates during the 1980s and early 1990s, more economists have started their work in finding a new structural interpretation of the naive Phillips curve and that was the time when the NKPC appeared.

2. DSGE new Keynesian Model

2.1. The new Keynesian Phillips Curve

In this section, we present the main elements of the standard model. That is, the NKPC assumes the existence of nominal price rigidities. Imperfect competition in the market of goods is included by supposing that each firm can produce differentiated goods for which it has the power to set the price (an important assumption is that firms are price setters and not price takers). Furthermore, there are some constraints imposed on the mechanism of price adjustment, by supposing that there are firms that decide to change their prices every period, while there are other firms that keep the prices fixed. At every point in time a fraction θ of firms keep prices fixed and the rest, $(1-\theta)$ adjust prices optimally. Therefore, the following analysis is based on the model proposed by Calvo (1983, pp. 383-398). In this model, every firm can keep fixed prices until it observes a random signal which stresses that the price can be changed. Hence, these changes of the price are considered as "staggered" and when fixing prices, firms take into consideration the prices the other firms will ask for until they can set prices again.

Following Gali (2005, pp. 1-10) notation, we obtain the following formulas for the basic NKPC:

a. in terms of the marginal cost:

$$\Pi_t = \beta E_t\{\Pi_t + 1\} + \lambda m\hat{c}_t \quad (1)$$

where $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}\Theta$

b. in terms of the output gap:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + k\widetilde{y_t} \quad (2)$$

where $k = \lambda\left(\sigma + \frac{\varphi+\alpha}{\varphi-\alpha}\right)$

Next, we are going to underline the first set of weaknesses and strengths based on what the assumptions of the model implied and what the evidence showed. We consider as strengths the characteristics that match both the assumptions in the model and in practice and weaknesses the ones that are not true after being tested.

Table 1. *Strengths and weaknesses of the standard NKPC*

In the model….	vs. the evidence:	Strengths	Weaknesses
Inflation conducts measures of $\tilde{y}_t$(output gap)	The output gap seems to lead measures of inflation (for instance, Fuhrer and Moore in 1995)	✓	
There is no trade-off between the output gap and inflation	Inflation stabilization requires large output fluctuations (for supply shocks)		✓
Disinflation can be obtained in a costless way	Periods of disinflation involved over time massive output losses		✓
Inflation is mainly forward-looking and lagged inflation is not relevant	Inflation seems to exhibit a lot of inertia (for example, Ball in 1994)		✓
NKPC is able to reproduce inflation persistence	Hump-shaped response of π_t to shocks		✓

Source: Table made by the author based on the analysis of Gali, Jordi (2002) on the 15th of March 2019.

Another important strength to mention is that the NKPC is micro-founded. Sandeep Mazumder affirmed that: "Fischer (1977), Taylor (1980) or Calvo (1983) are the pioneers of analyzing the inflation in a modern econometric way by observing the nominal wage and the process of price-setting by firms and individuals that look forward. If we aggregate such individual behavior, this yields to the relation between real marginal cost and short-term inflation. So, this is the NKPC, which stands out because it represents a macroeconomic relation that was borne out of explicit micro-foundations" (Mazumder, 2008, pp. 1-25).

Additionally, Walsh (2003, pp. 195-225) believes that the NKPC is different from traditional Phillips curves, as the former was derived from the model of optimizing the behavior on the side of price setters, conditioned by the supposed economic environment (that is, monopolistic competition, constant elasticity in terms of demand curves, randomly arriving chances to set prices). He underlines one advantage of expressing the basic NKPC

depending on real marginal cost. Through λ (see equation 1) it can be seen what is the impact that real marginal cost exhibits on inflation (depending on β and θ, which are structural parameters). On the first hand, if beta increases this implies that for the firm is more important the expected profits from future and as a result λ goes down, while on the other hand, if theta goes up, λ is being reduced (under the circumstances that firms can adjust prices less frequently this implies that firms focus less on present marginal cost -but more on marginal costs expected in the future- when it is possible to fix the prices).

Also, as it can be observed from the above formulas, that the NKPC can be measured either by overall detrended GDP or in terms of the marginal cost. However, the coefficients on the output gap seems to be negative and insignificant from the statistic point of view. Gali and Gertler (1999, pp. 195-222) stressed that the output gap resulted from the detrended real GDP is not a suitable proxy and the level of output includes important fluctuations.

Nonetheless, even though Gali, Gertler and Salido proved in some papers (via GMM estimation) that for both the USA and Euro-area, the labor income share's coefficient is statistically significant, considering labor income share the proxy for marginal cost cast a lot of controversy. The first reason is that labor income share is countercyclical, in contrast with the theory which suggests that marginal cost has to be procyclical.

We can conclude that the real marginal cost has a countercyclical proxy, as it violates what theory predicts, that is, marginal cost is procyclical. Secondly, labor share proxy of marginal cost is based on a very restrictive assumption, in other words, Gali and Gertler consider that the input (labor) is adjusted automatically at a fixed rate of the real wage and it is considered to be too simplistic. Mazumder (2010, pp. 747-765) tries to find a solution to this problem by constructing a 'disaggregated NKPC' (for the manufacturing sector) and seeks to improve the measurement of the marginal cost, but the test of this 'disaggregated NKPC' stresses an insignificant (negative) coefficient on marginal cost.

However, Bratsiotis and Robinson (2016, pp. 1826-1849) offer an alternative to the previous studies and construct unit total costs as a real marginal cost proxy by adding something new in the literature in two dimensions:

- transition from non-farm Gross Domestic Product, to all-sectors GDP;
- consider labor and non-labor costs proxy to marginal cost.

The results of using the Unit total costs emphasized:

- a more important role of forward-looking behavior than the one implied by the unit labor costs;
- the better fit of noticed inflation, that is, the current evidence for real marginal costs seen as the main variable in the NKPC;
- the duration of fixed nominal contracts which is closer to those proposed by firm-level surveys or than that involved by unit labor costs.

Nevertheless, Nason and Smith (2008, pp. 361-395) also debates the problem of finding a small and less significant coefficient on real marginal cost, result that is very bad for the NKPC as being a model of inflation and for monetary policy as well. Another weakness of the standard NKPC that is useful to point out is that there is a massive difference between the baseline NKPC and what individuals use to measure the inflation with real data.

2.2. The hybrid new Keynesian Phillips curve

However, the standard NKPC was attacked by the Keynesians as well who believed that it is too forward - looking and this does not capture reality at all. Moreover, for almost all measures of inflation and those considered optimal for marginal cost, inflation appears to be more persistent in comparison with the marginal cost. Furthermore, because marginal cost leads to inflation in the basic NKPC, this makes very difficult for the model and the data to match each other. Therefore, economists used the 'rule of thumb' (backward looking) in order to derive the Hybrid New Keynesian Phillips Curve (HNKPC).

$$\pi_t = \gamma_b \Pi_{t-1} + \gamma_f E_t\{\pi_{t+1}\} + \lambda m\hat{c}_t \quad (3)$$

where $\lambda = \frac{(1-\omega)(1-\theta)(1-\beta\theta)}{\theta+w[1-\theta(1-\beta)]}$

Fuhrer (1997, pp. 214-234) explains that the HNKPC is driven by inflation inertia. It is better than the standard NKPC, but if one looks at the coefficient obtained from the estimates, it is lagged inflation which drives the equation and not the forward-looking.

Jeffrey Fuhrer (1995, pp. 1-17) observes that for policy simulations or any other longer-run simulations, a mixture of forward-looking/backward-looking price specification can provide a better behavior without accepting a trade-off on empirical performance (strength).

Furthermore, most of the economists agree that the HNKPC performs better than the standard NKPC (strength), but it continues to fail to match the dynamics of inflation and also to explain the length of price contracts (weakness).

3. Empirical evidence

Abbas, Bhattacharya and Sgro (2016, pp. 378-403) together with supplementary studies such as Gali and Gertler (1999, pp. 195-222) and Gali et al. (2001, pp. 1237-1270) etc. have been tested mainly the standard NKPC and the HNKPC for the United States and for the countries from the Euro-area.

The practical performance of the baseline NKPC essentially relies on the proxy for the real economic activity. The output gap is generally used for estimation of the standard NKPC. But, the predicted coefficient on output gap seems to be negative and that is, statistically insignificant.

Gali and Gertler (1999, pp. 195-222) underline that the output gap resulted from the de-trended Gross Domestic Product (GDP) does not represent a good proxy and the potential output level might contain substantial variations. For this reason, marginal cost was proposed to be a better proxy of $\widetilde{y_t}$ (the output gap). They tested the baseline NKPC and the hybrid NKPC (HNKPC) for the US and they employed the GMM estimation method. Additionally, the authors used the share of labor income as a proxy for the $m\hat{c}_t$ (marginal cost). Their finding is that for the baseline NKPC the coefficient on share of labor income is positive and significant from the statistical point of view. In contrast, if the output gap is

utilized as a proxy for the real economic activity, the coefficient seems to be negative and statistically insignificant. In terms of the HNKPC with the labor income share identical findings are reported. Specifically, the coefficient on predicted inflation which ranges from 0.59 to 0.87 is significant and dominates the parameter on lagged inflation that varies from 0.085 to 0.383. This implies that dynamics of inflation are forward looking in the US.

Gali, Gertler and Lopez-Salido (2001, pp. 1237-1270) showed that analogous to the results for the United States, the New Keynesian Phillips Curve (NKPC) with the labor income share explained dynamics of inflation for the Euro-area data. The parameter on labor income share stayed positive and statistically significant in the standard NKPC and HNKPC. The parameter on expected rate of inflation was again quantitatively bigger than the parameter on lagged inflation. This means that dynamics of inflation are forward looking as well, a finding compatible with the theoretical expectations of the NKPC.

However, employing the GMM estimation in Gali and Gertler (1999, pp. 195-222), Gali et al. (2001, pp. 1237-1270), together with the use of labor income share as a proxy for marginal cost have been examined and criticized. Particularly, Rudd and Whelan (2006, pp. 303-320) stressed that the parameter on lagged (forward) rate of inflation is biased downwards (upwards) as the domination of the lagged inflation has already been represented by the predicted inflation in the first-step of the regression. Rudd and Whelan (2006, pp. 303-320) also discovered that the NKPC exhibited a deficient empirical fit for the US data. The share of the labor income was not the right proxy for the economic activity whereas the data also did not tolerate the dominant role of future rate of inflation against lagged rate of inflation. These discoveries are in contradiction with those of Gali and Gertler (1999, pp. 195-222) and Gali et al. (2001, pp. 1237-1270).

In addition, Rudd and Whelan presented empirical evidence to demonstrate that the share of labor income displays counter-cyclical movements in periods of recessions whereas the output gap is pro-cyclical in economic recessions. Thus, the output gap appears to decline with recessions and this implies that it is a better proxy than the share of labor income for real economic activity.

As a response to the critics, Gali, Gertler and Lopez-Salido (2005, pp. 1107-1118) explained that the previous empirical discoveries of Gali and Gertler (1999, pp. 195-222) and Gali, Gertler and Lopez-Salido (2001, pp. 1237-1270) stayed valid under distinctive empirical specifications, methods of estimation as well as distinctive sets of instruments.

4. Conclusion

However, this literature developed by the New Keynesian School has been criticized a lot from the neoclassical because they not only used some elements from their theory, but also from Keynesian School (as they used imperfections from Keynesian models in order to match reality). Being so forward looking can also imply trouble (if one can run any regression of any variable, there will be observed a lot of correlation in terms of inflation; even if the variable is stationary, there can still be observed high correlation; this is where exactly the standard NKPC was “hit”). Nevertheless, Central Banks across the world use

Dynamic Stochastic General Equilibrium models, because they include imperfections observed in the real world.

There are lots of economists who criticized this model, but unfortunately nobody suggested a model that can fit better for the Central Banks to use. Last but not least New Keynesian School intended to capture the fact that it does not really matter what happens in the present or in the past in terms of surprises (in contradiction with the Keynesian School's way of thinking), but what matters the most are the expectations regarding leading inflation.

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Corporate ownership structure and performance: An enquiry into India

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Abstract. *Influence of corporate ownership structure on corporate performance and governance has been a matter of debate and investigation in the literature of financial performance, and financial economics. This study explores the nature and extent of the relationship between ownership category and financial performance of the firm in limited manner. It investigates as to how heterogeneity of owners as well as the ownership category of the firm, per se, impacts the corporate performance. Employing panel regression model, the results show ownership structure impacts financial performance but only selectively, and the strength of the impact appears weak. This creates a basis for further analysis to understand the incentives and examine the impact of ownership structure on corporate financial performance across the sectors and the markets.*

Keywords: ownership structure, financial performance, panel data analysis.

JEL Classification: G30, G31.

Introduction

The impact of ownership structure and financial performance has been studied extensively in the theoretical as well as empirical research. Investigations have been carried out to analyse the impact of alignment and entrenchment effects of the owners and the management. Alignment of interest happens when the interests of the owners and the management converge. Often this situation arises when ownership of the owner-cum-manager is dominant. The entrenchment of the management, arising out of typical ownership structure that increases the chances of higher agency cost, risk of funds appropriated unreasonably and made replacement of the management difficult. In such a situation, the management tends to pursue suboptimum value enhancing strategy and focus on short term investment decisions. This leads to sub-optimum performance.

Empirical studies investigating the alignment of interest of the owners and the management and the entrenchment of the management, in the backdrop of the corporate form of organisation, have remained inconclusive. Theory suggests that alignment of interest is likely reduce agency costs and improve corporate performance; while the ability of the management to entrench in the company is likely to increase agency cost and other leakages and hence poses a challenge to monitor them effectively leading to relatively low performance.

Globally, the result of an investigation of the relationship between ownership category and performance has been mixed. Demzets and Lehn (1985) and Morck et al. (1988) tested the thesis of Berle and Means (1932) of the relationship between ownership and performance. La Porta et al. (1999) and Shleiferand Vishny (1997) have given a new perspective to this thesis where a group of owners holding substantial ownership in the firm also manages the firm.

In Indian markets, there has been an only limited and preliminary investigation in this area. Panchali (2000), Mohanty (2003) and Sarkar and Sarkar (2000) have made inquiries in the domain of institutional investors activism and performance, while Balasubramanian and Ramaswamy (2014) has investigated changing the pattern of ownership in India.

This study combines these two aspects and enquires into the concentration of promoters' (owners-cum-management) ownership, dispersal of retail investors' ownership, collective ownership of institutional investors, and their interaction *inter se,* and their impact on performance in Indian stock markets.

This paper explores the nature and extent of the relationship between the ownership category and financial performance of the firm in a limited manner. It further investigates as to how heterogeneity of owners as well as the ownership structure of the firm, *per se*, impacts the corporate performance. This assessment and investigation can be extended across the sectors. Performance variables are selected to represent profitability, operational efficiency, and financial strength. Ownership variables are broadly classified into three categories viz. promoters, institutional investors, public or residual ownership (not covered in the previous two categories).

The rest of the sections of the paper has been organised in the following manner. Section 2 presents review of existing literature on the relationship between ownership structure and financial performance, Section 3 presents data sources and model, Section 4 presents analysis of the result and Section 5 concludes the study with broad policy implications and area of further research.

Section 2. Review of literature

Berle and Means (1932) in their book have first initiated the theory and empirical research on the impact of ownership structure on firm performance. However, the origin of this debate has happened from Adam Smith. The literature on the impact of ownership structure on financial performance focused on how owners and managers are responsible for lower rate of return.

The issue is on what process ownership impacts the performance of a company. The classical theory of managerial firm (like-Galbraith 1967; Williamson, 1964; Marris, 1964; Baumol, 1959) concludes that the performance of the management controlled firm and the owners controlled firm differs each other due to dispersed ownership allows the former to pursue goals different from those of the shareholders (see Leech and Leahy, 1991; McConnell and Servaes, 1990; Morck et al., 1988l; Demsetz and Lehn, 1985).

Most of the existing theoretical and empirical literature on the impact of ownership structure on financial performance is dominated by the model of the Anglo-American firm with dispersed share ownership and wide managerial discretion (see Holl, 1951; Kamerschen, 1968 and Monsen et al., 1968). However, the management controlled firm is not the dominant form of enterprise in India. Ownership is highly concentrated in India relative to some of the developed markets. In the Indian market, the issue is family own substantial ownership and also manages the company. The issue, in Indian corporate sector, is not whether the dispersed ownership structure allows managers to pursue goals different from those of the shareholders but how the owner-cum-manager group (often holding less than majority ownership) along with non-owner-manager group impact the performance of the firm.

In Indian corporate sector, the companies are owned and controlled by shareholders holding higher levels of ownership, which helps to reduce the agency problem between managers and shareholders. On the other hand, this causes the emergence of several conflictual cases between majority and minority shareholders. The high level of ownership shareholders is getting more power and incentives to hold off the expropriation for the benefit of the minority shareholders (La Porta et al., 2002).

There have been several studies investigating the impact of ownership – concentrated or dispersed or insiders against outsiders – on firm performance. Broadly, they offer mixed results. Studies have documented positive, negative, and no relationship between ownership structure and financial performance. They offer various rationale(s) for such a relationship by looking from different perspectives. The positive relationship offers the

following reasons. First, concentrated ownership leads to closer alignment of interest leading to a reduction of agency cost and enhancement of efficiency gains. Second, even in the case of companies managed by professional management, the concentration of ownership makes it easier to monitor them effectively even when owners are not involved in management. Third, the concentration of ownership due to family managed business gives the management higher sector and firm-specific skill and longer investment horizon and low level of agency cost.

Studies are revealing negative relationship offer the following reasons. First, an intermediate level of concentration of ownership reduces the probability of takeover and increases entrenchment possibility and hence adversely affects efficiency and performance. Second, the companies are owned and managed by section of family increase the chances of appropriation of corporate funds for the family. Third, the concentration of the family ownership brings culture and legacy of family which may or may not always good for the company, and also often leads to either risk aversion or assuming high risk in investment decision leading to adversely impacting the performance.

There is also evidence that shows no relationship between ownership structure and financial performance. They found endogeneity between ownership structure and firm performance and hence argues for no significant impact. Secondly, an efficient market will lead to an optimal ownership structure, given the company and industry-specific characteristics.

Thus, the rationale for and outcome of the impact of ownership structure and financial performance has been summarised in Table 1.

Table 1. *Reasons for impact of corporate ownership structure on performance*

	Positive	Negative	No significant impact
1	Concentrated ownership by insiders improves corporate performance due to the alignment of interests reducing agency cost (Jensen and Meckling, 1976)	Intermediate level of concentration reduces the probability of takeover and entrench less efficient management (Stulz 1988; Barclay and Holderness (1989)	Because of endogeneity between ownership structure and financial performance. (Demsetz and Villalonga, 2001; Demsetz and Lehn, 1985).
2	Block shareholders are efficient to monitor the professional management, although they are not connected in management (Shleifer and Vishny, 1986)	Family cum Managers ownership may lead to high risk of appropriation (Morck et al., 1988)	In a given firm as well as industry specific characteristics, an efficient markets will lead to an optimal ownership structure.
3	Family owned firms, perhaps, make more efficient investment decisions than their counter parts due to more firm-specific knowledge, less agency cost, and longer horizons of investment (Stein, 1998)	The high concentration of family ownership may lead to concern for family legacy, risk aversion, forgoing profitable merger opportunities and hence adversely impact performance (Morck et al., 2000)	

Performance variables in most of these studies are investigated through four types of variables. They are:

a. Financial leverage or capital structure choices represented by either debt to equity or debt to total assets.
b. Market-based valuation represented by Tobin q or excess market returns.
c. Profitability measures, like, Return on capital employed or Return on equity.
d. Operational efficiency measures related to turnover.

Variables of ownership structure are, one, promoters, non-promoters, institutional investors, and non-promoter - institutional investors.

A snapshot of empirical evidence related to ownership and a variety of performance variables is summarized in Table 2.

Table 2. *Evidence from impact of ownership structure on performance*

	Financial leverage	Market performance	Accounting measures of performance
1	Globally, the results are mixed.	The ownership structure is endogenous, and hence there is no relationship with market-based performance (Demsetz and Lehn, 1985)	Studies do not find a significant relationship between ownership and accounting-based measures of performances such as ROA, RONW, etc.
2	Negative relationship exists between financial leverage and ownership structure (Holderness and Sheehan, 1988).	Low and high levels of ownership increase alignment and hence are associated with higher levels of valuation ratios or market performance	The above inconsistency may arise out of the inability of researchers to employ econometric methods appropriately (Coles et al., 2007)
3	Kim and Sorensen (1986) find a level of financial leverage increases with insider ownership.	Intermediate level of ownership increases entrenchment and hence is associated with lower levels of market performance.	
4	Andersen and Reeb (2003) and King and Santor (2008) find insider ownership whether by managers or families, does not affect capital structure choices.		

The review of literature also suggests different methodological issues. The classical proposition of inverse relationship between ownership structure and financial performance has been objected by Demsetz (1983), and supports the endogeneity of ownership structure. McConnell and Servaes (1990) find an *inverted* U shaped association between performance and insider ownership. Hermalin and Weisbach (1991) find a non-monotonic relation between ownership structure and financial performance. Short and Keasey (1999) observe, in their sample of UK firms, a similar cubic association (Morck et al., 1988) between profitability and managerial ownership. Chung and Pruitt (1996) used a simultaneous equation model to study this relationship. Palia and Lichtenberg (1999) observe a positive relationship between managerial ownership and total factor productivity. Loderer and Martin (1997) employ a simultaneous equations model to find endogeneity of ownership structure and negative relationship between ownership and performance. Cho (1996) however, in a simultaneous regression model with cross-section data in 1991, reveals that performance is a positive predictor of insider ownership and not vice versa. In the context of a panel data model, Himmelberg et al. (1999) find that managerial ownership has a positive relationship with firm size and a negative relationship with the firm's idiosyncratic risk. Hermalin and Weisbach (1987) and Morck, Shleifer, and Vishny (1988) both used a piece-wise linear regression to investigate this impact. Applying Demsetz and Villalonga (2001) model to Australian listed firms, Welch (2003) finds limited evidence of a non-linear relationship between managerial share ownership and firm performance. More recently, Villalonga and Amit (2004) conclude that family ownership creates value only when it is combined with certain forms of control and management. Finally, Sheu and Yang (2005) in the Taiwan market, find that insider ownership has no influence on total factor

productivity. Besides, studying ownership and performance linkages, these studies have experimented with different methodological issues that guide further research in this area. This study experiments and employs cross-section data and panel regression model to analyse this linkage.

Given inconclusive evidence globally, and the dearth of empirical study in the Indian context, this study attempts to investigate into linkages between ownership and performance in a limited manner. It develops on cross-section data and employs panel regression to observe the significance or otherwise.

Section 3. Data panel models

Data

We source all annual data from the Centre for Monitoring Indian Economy (CMIE) – Prowess. This is company data base of Indian companies. The study considers ownership data of promoter, non-promoter institution and non-promoter non-institution to represent ownership structure and financial variables such as sales/net fixed assets, sales/net working capital, sales/total assets, investment/total assets, total liability / total net worth, net cash flows from operating activities/average capital employed, profit before depreciation interest and tax/average capital employed, profit after tax/ average net worth, net cash flows from operating activities/average net worth and debt-equity ratios (times) to represent financial performance of companies. The variables and their codes have been presented in Table 3. The study period covers from 2000 to 2015 of 11 years. We consider companies under various Bombay Stock Exchange (BSE) sectors. Finally two BSE Sectorial Indices are considered, one BSE IT sector and other BSE Oil & Gas sector. After data alignment, 49 companies are analysed for which data on ownership and performance for 11 years were available.

Table 3. *Variables and codes*

	Variables	Codes
Performance Variables	Sales/Net Fixed Assets	Snf
	Sales/Net Working Capital	Snw
	Sales/Total Assets	Sta
	Total Outsiders Liability(TOL)/Total Net Worth(TNW)	Totn
	Investment/Total Assets	Int
	Net Cash Flow from Operation/Average Capital Employed	ncac
	PBDIT-Depreciation/average capital employed	pbac
	PAT/Average Net Worth	paan
	Net Cash Flow from operation/Average Net Worth	ncan
	Debt to equity ratio (times)	De
Ownership Variables	Promoter	P
	Non-Promoter Institution	Npi
	Non-Promoter non-institution	npni

Panel Models: For analysis through panel models, the initial check of the panel unit root test has been applied. Subsequently**,** we proceed for analysis of data through panel regression including choice of application of fixed effect and random effect model. The brief of this model is given below.

Panel Unit Root Test: Assessment of stationarity of data series is required to be carried out before proceeding for econometric analysis. For this purpose, Panel stationarity tests are applied to measure unit root in the data under consideration. A test of Levin et al. (2002) assumes a homogeneous autoregressive unit root under the alternative hypothesis. Hadri (2000) develop a technique which is a reverse procedure of testing the unit root. The Lagrange Multiplier (LM) test of Hadri (2000) is made to confirm and strengthen the above two procedures.

Panel Regression

Fixed Effect Model

We use a fixed effect model to analyse the impact of variables that vary over time. It explores the relationship between predictor and outcome variables within an entity. When we use this model, we assume that something within the individual may impact or bias the predictor or outcome variables, and we need to control for this. This is the rationale behind the assumption of the correlation between the entity's error term and predictor variables. Fixed effect removes those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variables. An important assumption of the fixed effect model is that those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. Each entity is different; therefore, the entities error term and the constant should not be correlated with others. If the error terms are correlated, then fixed effect model will not be suitable. This is the main rationale for the Hausman test (Reyna, 2007). The fixed effect equation

$$Y_{it} = \beta_1 X_{it} + \alpha_i + U_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots (i)$$

Where:
α_i(i =1, …, n) is the unknown intercept for each entity (n entity-specific intercepts);
Y_{it} – dependent variable where i – entity and t – time;
X_{it} – independent variable;
β_1 – coefficient for the independent variable;
U_{it} – error term.

Random Effect Model

The rationale behind the random effect model is that, unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model. If we assume the differences across entities have some influence on your dependent variable, then you should use random effects. We can use time-invariant variables in this model. In the fixed effect model, these variables are absorbed by the intercept (Reyna, 2007).

"The crucial distinction between fixed and random effect is whether the unobserved individual effect embodies elements that are correlated with the repressor's in the model or not; whether these effects are stochastic or not" (Greene, 2008, p. 183)

The random effect model is-

$$Y_{it} = \beta_1 X_{it} + \alpha + U_{it} + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots (i)$$

Where:
U_{it} – between entity error;
ε_{it} – within entity error.

Random effect assumes that the entity's error term is not correlated with the predictors, which allow for time-invariant variables to play a role as explanatory variables. This model allows generalising the inferences beyond the sample used in the model. (Reyna, 2007).

To decide between the fixed effect model and random effect model, we need to perform the Hausman test. The null hypothesis for this test is that the preferred model is random effects vs. the alternative hypothesis is fixed effects (Greene, 2008, Chapter 9)

Hausman test: Fixed Effect (FE) or Random Effect(RE)

The choice between fixed effects and random effects specification is generally based on Hausman (1978) test, which is designed to detect the violation of random effect modelling assumption that explanatory variables are orthogonal to unit effects. The test chooses the appropriate model between FE and RE. The null hypothesis is that no correlation exists means no difference between the estimators since both of them are consistent. While the alternative suggests that both are dissimilar if the null hypothesis is rejected, then the FE is the appropriate model.

$$H = (\beta_{RE} \acute{-} \beta_{FE})[Var(\beta_{FE}) - Var\beta_{RE}]^{-1}(\beta_{RE} \acute{-} \beta_{FE})$$

Where:
$\beta_{RE} and\ \beta_{FE}$ is the vector of random effects and fixed effects estimates.

Under the null hypothesis of orthogonality, H-statistics follows chi-square distribution with degrees of freedom equal to the number of regressors in the model. A finding that $p< 0.05$ is taken as evidence that at conventional levels of significance, the two models are different enough to reject the null hypothesis and hence to reject the random effects model in favour of the fixed effect model.

Section 4. Results

Descriptive statistics of the results are presented in Table 4 to appreciate the statistical properties of the sample. The variability of a series has been measured by mean, median, maximum, minimum, and standard deviation. We observe the mean of all variables is positive. The standard deviation of sales/net working capital is higher, and non-promoter institutions' is lower than the average observed in respective categories. Most of the variables are positively skewed except promoters' ownership. The values of Kurtosis of all variables are positive, implying leptokurtic and high peaked distribution of data series than a normal distribution. The Jarque-Bera test for normality is significant in case of all

variables indicates that the series over the periods are non-normal. This initial exercise provides early and preliminary insights into the data sets and variables. This helped us a further investigation.

Table 4. *Descriptive statistics*

	DE	INT	NCAC	NCAN	NP	NPI	NPNI
Mean	0.479	0.241	0.153	0.194	0.506	0.174	0.331
Median	0.090	0.208	0.125	0.163	0.500	0.140	0.316
Max	8.700	0.834	1.177	2.516	1.000	0.595	0.990
Min	0.000	0.000	-0.609	-1.223	0.000	0.000	0.000
Std.Dev	1.020	0.185	0.188	0.326	0.193	0.149	0.193
Skewness	4.480	0.855	1.068	1.612	-0.208	0.568	0.459
Kurtosis	28.392	3.247	8.204	17.616	2.758	2.266	2.847
Jarque-Bera	16283*	67.035*	710.705*	5031.519*	5.202	41.094*	19.425*
Observations	539	539	539	539	539	539	539

	P	PAAN	PBAC	SNF	SNW	STA	TOTN
Mean	0.466	0.164	0.243	7.117	4.542	0.935	0.677
Median	0.480	0.162	0.200	4.782	3.584	0.762	0.330
Max	0.925	1.250	1.668	62.453	90.816	4.156	10.000
Min	0.000	-1.830	-0.279	0.000	-76.214	0.000	-5.800
Std.Dev	0.198	0.237	0.226	8.651	17.189	0.745	1.231
Skewness	-0.209	-0.936	2.424	3.401	0.047	1.757	1.116
Kurtosis	2.481	16.546	12.614	16.727	9.747	5.945	16.763
Jarque-Bera	9.986***	4199.786*	2603.823*	5270.531*	1022.585*	472.063*	4365.84*
Observations	539	539	539	539	539	539	539

***** indicates significant at the level of 1%.

Table 5. *Co-relation matrix among variables*

	Snf	Snw	Sta	totn	Int	ncac	Pbac	paan	Ncan	De	P	Np	npi	npni
snf	1.00													
snw	0.08	1.00												
Sta	0.42	0.23	1.00											
totn	0.19	0.00	0.20	1.00										
Int	0.02	-0.09	-0.38	0.03	1.00									
ncac	0.09	0.08	0.29	-0.11	-0.21	1.00								
pbac	0.24	0.07	0.30	-0.14	-0.25	0.61	1.00							
paan	0.17	0.09	0.24	-0.07	-0.17	0.46	0.77	1.00						
ncan	0.03	-0.01	0.15	0.05	-0.15	0.65	0.28	0.19	1.00					
De	0.02	-0.09	0.04	0.25	-0.07	-0.13	-0.23	-0.26	0.23	1.00				
P	0.04	0.06	0.18	0.04	-0.06	0.15	0.24	0.22	0.10	-0.03	1.00			
np	0.00	-0.09	-0.13	-0.02	0.08	-0.14	-0.23	-0.23	-0.09	0.06	-0.73	1.00		
npi	0.04	-0.07	0.11	0.04	0.01	0.04	0.00	0.02	0.07	-0.02	-0.31	0.39	1.00	
npni	-0.03	-0.03	-0.22	-0.05	0.08	-0.18	-0.23	-0.25	-0.14	0.07	-0.49	0.70	-0.38	1.00

We observe the existence of linkages between financial performance and ownership variables. We find PBDIT-Depreciation/average capital employed (pbac) and Net Cash Flow from Operation/Average Capital Employed (ncac), Net Cash Flow from operation/Average Net Worth (ncan) and ncac, PAT/Average Networth (paan) and

PBIT/Average capital employed (pbac) have a high positive correlation. Promoter and non-promoter non-institution have high negative correlations. Within financial performance variables, in some cases, correlation is high, and within ownership variables, it is weak except in two cases. This requires further investigation to uncover extent, quality, and consistency in these linkages.

To check the stationarity of variables, we employ panel unit root tests, those are: Levin et al. (2002) known as LLC, IM et al. (2003) known as IPS, ADF Fisher, PP Fisher and Hadri (2000) test. The null hypothesis of all tests except Hadri (2000) is that panel data have unit root means non-stationary. If the probability of the coefficient is significant than we reject null and accept alternative hypothesis which indicates data are stationary. The null hypothesis for Hadri (2000) is just the opposite of all other methods. From all the tests (as presented in Table 6), we find all variables are stationary at the level both in intercept & trend and intercept.

Table 6. *Panel stationarity test result*

Variables	Type	intercept	Trend and intercept	Variables	Type	intercept	Trend and intercept
Promoter (p)	LLC	-696.274*	-586.770*		LLC	-23.891*	-26.738*
	IPS	-93.896*	-40.926*	Investment/total assets(int)	IPS	-2.630*	-1.989*
	ADF Fisher Chi-Square	170.749*	179.705*		ADF Fisher Chi-Square	125.395**	147.601*
	PP Fisher Chi-Square	177.415*	137.456*		PP Fisher Chi-Square	159.411*	157.924*
	Hadri	11.512*	15.008*		Hadri	7.501*	13.331*
Non Promoter (np)	LLC	-693.968*	-520.059*		LLC	-8.440*	-13.519*
	IPS	-93.759*	-44.291*		IPS	-3.508*	-1.372***
	ADF Fisher Chi-Square	194.275*	238.053*	NCFO/Avg Capital Employ(ncac)	ADF Fisher Chi-Square	157.889*	141.153*
	PP Fisher Chi-Square	171.911*	134.568*		PP Fisher Chi-Square	268.845*	243.322*
	Hadri	10.959*	16.062*		Hadri	7.310*	13.280*
Non Promoter Institution(npi)	LLC	-102.491*	-83.348*		LLC	-7.262*	-12.306*
	IPS	-14.225*	-6.778*	PBDIT-DEP/avg capital employed (pbac)	IPS	-1.944*	-1.189
	ADF Fisher Chi-Square	126.929*	172.030*		ADF Fisher Chi-Square	138.987*	137.319*
	PP Fisher Chi-Square	133.058*	159.734*		PP Fisher Chi-Square	222.457*	222.715*
	Hadri	10.555*	15.228*		Hadri	8.258*	12.963*
Non PromoterNon institution(npni)	LLC	-39.069*	-42.178*		LLC	-4.497*	-5.887*
	IPS	-9.081*	-6.499*	PAT/Average net-worth (paan)	IPS	-1.908**	-0.023
	ADF Fisher Chi-Square	209.700*	232.173*		ADF Fisher Chi-Square	128.245**	114.699
	PP Fisher Chi-Square	208.581*	202.633*		PP Fisher Chi-Square	244.132*	233.862*
	Hadri	9.090*	17.558*		Hadri	7.826*	13.954*
Sales/Net Fixed Assets(Snf)	LLC	-3.672*	-5.973*		LLC	-6.083*	-8.854*
	IPS	-0.223	-0.465		IPS	-3.018*	-0.570

Variables	Type	intercept	Trend and intercept	Variables	Type	intercept	Trend and intercept
	ADF Fisher Chi-Square	99.097	120.880**	NCFO/Average net worth(ncan)	ADF Fisher Chi-Square	146.906*	117.981***
	PP Fisher Chi-Square	102.609	142.604*		PP Fisher Chi-Square	257.496*	232.962*
	Hadri	9.191*	8.946*		Hadri	5.195*	11.612*
Sales/Net Working capital(snw)	LLC	-5.576*	-5.690*		LLC	-12.536*	-15.729*
	IPS	-2.549*	-0.160	Debt to equity ratio (times)(de)	IPS	-4.949*	-2.322*
	ADF Fisher Chi-Square	144.904*	103.362		ADF Fisher Chi-Square	163.196*	164.411*
	PP Fisher Chi-Square	251.252*	263.745*		PP Fisher Chi-Square	237.111*	225.657*
	Hadri	5.436*	14.993*		Hadri	2.721*	15.896*
Sales/Total Assets(sta)	LLC	-9.699*	-12.402*		LLC	-9.107*	-20.602*
	IPS	-2.663*	-0.631	TOL/TNW (totn)	IPS	-2.164*	-0.545
	ADF Fisher Chi-Square	139.381*	125.604**		ADF Fisher Chi-Square	126.717**	114.756
	PP Fisher Chi-Square	176.878*	177.975*		PP Fisher Chi-Square	172.461*	200.774*
	Hadri	8.643*	10.333		Hadri	7.113*	15.144*
	Hadri	2.721*	15.896*				

Fixed effect vs. Random effect

In this study, the dependent variable is the financial performance and the independent variable is ownership structure. The study run both fixed effects and random effect models to examine our objectives of study. We employ the Hausman (1978) test to choose between these two effects. The null hypothesis for the Hausman test is that Random effect model is appropriate and if null is rejected than the fixed effect model is suitable. The regression equations from the ownership structure to financial performance are as under.

$$snf = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

$$snw = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

$$sta = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

$$totn = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (iv)$$

$$int = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (v)$$

$$ncac = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (vi)$$

$$pbac = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (vii)$$

$$paan = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (viii)$$

$$ncan = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (ix)$$

$$de = a_0 + \beta_1 p + \beta_2 npi + \beta_3 npni + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (x)$$

We run ten different models to capture fixed as well as a random effect. Results have been given in Tables 5 and 6. Based on Hausman test, we find fixed effect model is appropriate for models 1, 4 and 8 and Random effect model is appropriate for rest of the models (models 2, 3, 5, 7, 6, 9 and 10). For the overall significance of the models; we employ Wald Chi-square test for random effect models and F statistics for fixed effect models. F statistics for fixed effect models of 1 and 4 are insignificant, and for model 6, it is significant. This indicates the overall significance of model 6. The Wald Chi^2 is significant in the case of model 2, 3, 7, 8, and 9. Overall these models are significant.

Our dependent variables are the financial performance, and independent variables are ownership structure. From fixed effect models of 1 and 4, we find no significant impact of ownership structure on financial performance, but in case of model 6, we find promoter positively impacts financial performance and non-promoter non-institutions negatively impact financial performance, but non-promoter institution dose does not impact financial performance. Table 7 and Table 8 present the regression model for all variables under consideration.

Table 7. *The panel OLS results: fixed effects (FE) vs. random effects models*

Dependent Variable-Financial Performance										
	Fixed Effects (FE) Model Results					Random Effect Model Results				
Regressor	Model-1	Model-2	Model-3	Model-4	Model-5	Model-1	Model-2	Model-3	Model-4	Model-5
C	4.978 (2.583)**	10.661* (5.601)	0.504 (0.217)**	0.464 (0.368)	-0.212* (0.557))	3.528 (2.542)	9.612*** (5.469)	0.552 (0.212)*	0.424 (0.366)	0.201 (0.543)*
P	2.752 (2.782)	-2.339 (6.034)	0.783 (0.234)*	0.319 (0.396)	-0.011 (0.060)	4.175 (2.748	-1.305 (5.911)	0.737 (0.229)*	0.358 (0.392)	-0.000 (0.587)
NPI	3.560 (3.482)	-15.971** (7.552)	0.783 (0.294)	0.450 (0.496)	0.457 (0.751)	2.219 (2.903)	-14.625** (7.404)	0.726 (0.287)**	0.501 (0.491)	0.059 (0.074)
NPNI	0.712 (2.583)	-7.898 (6.376)	-0.214 (0.248)**	-0.043 (0.419)	0.078 (0.634)	3.528 (2.543)	-6.897 (6.244)	-0.264 (0.242)	-0.001 (0.414)	0.090 (0.062)
R^2	Within: 0.003 Between: 0.567 Overall: 0.005	Within: 0.011 Between: 0.145 Overall: 0.010	Within: 0.068 Between: 0.079 Overall: 0.067	Within: 0.005 Between: 0.085 Overall: 0.005	Within: 0.007 Between: 0.364 Overall: 0.007	Within: 0.003 Between: 0.634 Overall: 0.006	Within: 0.012 Between: 0.142 Overall: 0.010	Within: 0.068 Between: 0.064 Overall: 0.067	Within: 0.004 Between: 0.089 Overall: 0.005	Within: 0.007 Between: 0.373 Overall: 0.007
F Test/ Wald Chi^2	0.69	2.05***	12.86*	0.81	1.26	3.38	5.73	38.47*	2.63	4.17
Hausman Test Statistic:- H0: Random Effects Model is Appropriate, H1: Fixed Effects Model is Appropriate										
Chi^2	159.965*	1.042	2.984	13.664*	3.468					

Note: The co-efficient for Fixed Effect model is t-statistics, and for random effect model, it is z-statistics, Wald Chi^2 for RE model and F test for fixed effect model; * Significant at 1% level, ** at 5% level, *** at 10% level, Numbers in the parenthesis are standard errors.

From the random effect models, in the case of model 2, non-promoter non-institution negatively impacts financial performance, in the case of model 3, promoter and non-promoter institutions positively impact on financial performance. From models 5 and 9, we find ownership structure is not impacting financial performance. In the case of model 7,

the promoter is impacting financial performance, and other ownership variables are not impacting. From model 8, we find promoter positively impacts financial performance and non-promoter non-institution impact negatively on financial performance. The R^2 which implies that how many independent variables impact on dependent variables in all models is very low indicate even if there is the impact of ownership structure on financial performance in some cases, but the impact is very low. This result also supports the view of existing literature.

Table 8. *The panel OLS results: fixed effects (FE) vs. random effects models*

Dependent Variable-Financial Performance										
	Fixed Effects (FE) Model Results					Random Effect Model Results				
Regressor	Model-6	Model-7	Model-8	Model-9	Model-10	Model-6	Model-7	Model-8	Model-9	Model-10
C	0.131* (0.059)	0.220* (0.065)	0.160* (0.068)	0.160*** (0.096)	0.273 (0.308)	0.144* (0.054)	0.213* (0.064)	0.169* (0.068)	0.150 (0.096)	0.254 (0.299)
P	0.103*** (0.059)	0.187** (0.070)	0.163** (0.073)	0.127 (0.104)	0.067 (0.331)	0.091 (0.059)	0.193* (0.069)	0.156** (0.073	0.137 (0.102)	0.087 (0.324)
NPI	0.051 (0.075)	-0.009 (0.089)	0.001 (0.092)	0.136 (0.130)	0.115 (0.414)	0.034 (0.074)	-0.005 (0.087)	-0.010 (0.091	0.144 (0.129)	0.143 (0.406)
NPNI	-0.106*** (0.063)	-0.187 (0.075)	-0.220* (0.078)	-0.146 (0.109)	0.468 (0.349)	-0.119** (0.062)	-0.181* (0.073)	-0.229* (0.078)	-0.135 (0.109)	0.483 (0.343)
R^2	Within: 0.038 Between: 0.030 Overall: 0.037	Within: 0.078 Between: 0.015 Overall: 0.078	Within: 0.076 Between: 0.108 Overall: 0.075	Within: 0.026 Between: 0.015 Overall: 0.025	Within: 0.005 Between: 0.005 Overall: 0.005	Within: 0.037 Between: 0.006 Overall: 0.037	Within: 0.077 Between: 0.023 Overall: 0.077	Within: 0.076 Between: 0.124 Overall: 0.075	Within: 0.025 Between: 0.008 Overall: 0.025	Within: 0.005 Between: 0.007 Overall: 0.005
F Test/ Wald Chi^2	6.91*	14.71*	14.36*	4.57*	1.03	20.58*	44.72*	43.52*	13.63*	3.15
Hausman Test Statistic:- H0: Random Effects Model is Appropriate, H1: Fixed Effects Model is Appropriate										
Chi^2	2.451	2.224	6.771*	1.366	1.234					

Note: The co-efficient for Fixed Effect model is t-statistics, and for random effect model, it is z-statistics, Wald Chi^2 for RE model and F test for fixed effect model; * Significant at 1% level, ** at 5% level, *** at 10% level, Numbers in the parenthesis are standard errors.

Section 5. Conclusion and implications

Table 9. *Summary results of panel regression*

Financial Performance	Model	P	NPI	NPNI	R^2	F Test/Wald Chi-Square	Hausman Test
Sales/Net Fixed Assets	1	+	+	+	0.005	ins	F
Sales/Net Working Capital	2	-	-**	-	0.01	ins	R
Sales/Total Assets	3	+*	+**	-	0.06	sig	R
Total Outsiders Liability(TOL)/Total Net Worth (TNW)	4	+	+	-	0.005	Ins	F
Investment/Total Assets	5	-	+	+	0.007	Ins	R
Net Cash Flow from Operation/Average Capital Employed	6	+	+	-**	0.037	Sig	R

Financial Performance	Model	P	NPI	NPNI	R^2	F Test/Wald Chi-Square	Hausman Test
PBDIT-Depreciation/Average capital employed	7	+*	-	-*	0.078	Sig	R
PAT/Average Net Worth	8	+**	+	-*	0.075	Sig	F
Net Cash Flow from operation/Average Net Worth	9	+	+	-	0.025	Sig	R
Debt to equity ratio (times)	10	+	+	+	0.005	Ins	R

Note: + & - represents positive and negative relationships, * Significant at 1% level, ** at 5% level, *** at 10% level. Ins and sig represent insignificant and significant of the F test or Wald Chi-square test. R and F represented random effect and fixed effect, respectively.

The study examines the relationship between ownership structure and corporate performance over eleven years ending in the financial year 2016 for two important sectors (IT and Oil & Gas) in the Indian context. The summary of panel regression results has been presented in Table 9. It reveals the relationship between ownership and performance exists across the ownership categories; however, with low significance. Broadly, it reveals a positive relationship (in majority cases) between the ownership of promoters. A negative impact is observed in case of non-promoter non-institutional investors, while the mixed impact has been found in case of non-promoter institutional ownership. The study concludes and reinforces alignment of interest effect.

The results have many implications. A positive relationship with the dominant ownership of the promoter suggests devising and encouraging possible alternative ownership structures in the companies that facilitate alignment or convergence of the interest. This threshold will be different for a different size, age, and nature, for example, small and medium-sized company, family managed company, large size, and professionally managed company. However, pursuing this may limit and restrict raising large scale funds and long horizon investment decision which may be carefully avoided. A second important implication of the results is that non-promoter ownership has shown either no impact or negative relationship with performance. This questions established policy postulate that we should encourage wider public ownership in companies. The result implies weaker monitoring and sub-optimum participation of institutional investors' and the weaker collective strength of retail investors in corporate decision making. Negative impacts in case of non-promoter non-institutional investors suggest the weak ability of retail investors to exert collective pressure on the management for higher performance. It advocates policy research driven reforms to devise a strategy for institutional investors' role in the overall management of the company and an effective scheme for public participation and mechanisms to guard and enhance their interests and effective monitoring. Besides, the political process of interactions, inter se, regulations need to encourage and facilitate shareholders' collective mechanisms to participate in corporate decision making and prevent oppression of the minority. This could be in the form of shareholders' activism, class suits, representation of non-promoter non-institutional shareholders' director, etc. The evidence directs further inquiry into this domain to create an informed policy framework that helps to gain maximum benefits of the corporate form of organisation at the same time

avoiding adverse impact arising out of weak monitoring, lack of collective bargaining power of investors and possible entrenchment effects.

The study suggests further areas of research in this domain. Though there were adequately large data sets, in this paper, it focuses only on limited sectors. This can be made more comprehensive and informed by analysing the data across the sections and dividing and studying the total period into meaningful sub-periods. Results can be further improved by further analysing the impact of sub categories of ownership structures.

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Turkey's macroeconomic policy challenges in the aftermath of the 2018 crisis: A sectoral financial balances analysis

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Abstract. *In August 2018, Turkey experienced a major economic crisis when its exchange rate depreciated by around 40 percent in the course of just a few days. This led to a credit bust that soon dragged Turkey into a recession. This paper analysis Turkey's predicament using the stock-flow consistent sectoral financial balances (SFB) model to delineate and evaluate the policy options open to Turkey at a juncture where the private sector has commenced a process of deleveraging or in other words, reducing its net financial accumulation of liabilities. Since the crisis erupted, Turkey has tightened both monetary and fiscal policies to control accelerating inflation and the depreciating lira, which would then – it is hoped – revive investment and exports. However, prevailing uncertainties on account of deteriorating Turkish-US relations may prove a dampener on the success of these policies.*

Keywords: sectoral financial balances, Turkey, currency crisis, credit leveraging, deleveraging.

JEL Classification: E390, E650, E660, F310, F320.

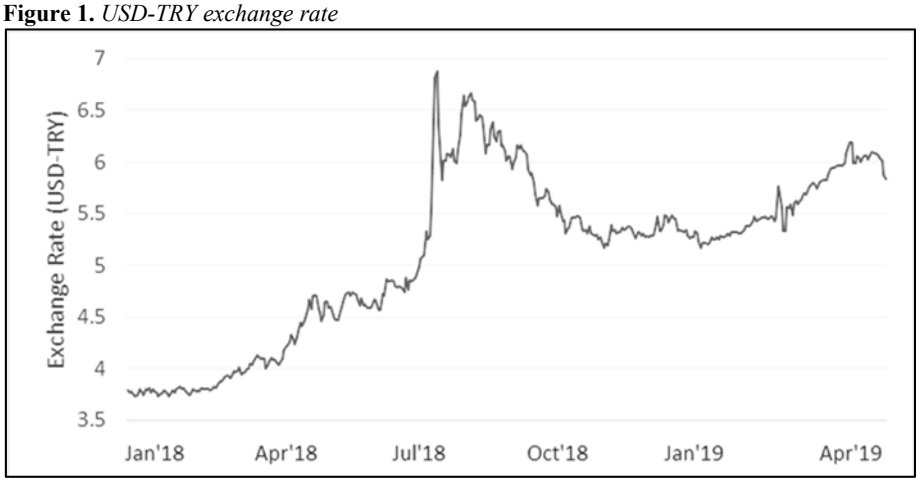
1. Introduction

Turkey, the seventeenth largest economy in the world, has been able to achieve spectacular growth rates in real GDP over the last two decades, doubling its per capita income, which now stands close to US$15,000 or US$27,500 in PPP terms. At the same time, Turkey has experienced periodical crisis in the 21st century; the dotcom burst of 2001, the global financial crisis (GFC) of 2008 and more recently, a currency crisis in 2018. What are the macroeconomic policy challenges that Turkey faces from the recent 2018 crisis with a depreciating currency that could disrupt its growth trajectory? Meanwhile, the strained political relations with the US and trade wars unleashed by President Trump may also pose serious macroeconomic implications for Turkey. This paper attempts to study the crisis from a Post-Keynesian perspective, in particular, the Sectoral Financial Balances (SFB) model to explore the impacts of these shocks on and policy challenges to ensure sustainability of Turkey's high GDP growth.

2. The Turkish crisis of 2018

2018 was a turbulent year for Turkey. The growing hostility with the US over the Syrian crisis, the dispute over the release of Pastor Andrew Brunson who had been detained by Turkey on terrorism charges and the decision of President Donald Trump to double tariffs on imports of steel and aluminum from Turkey sent the Turkish lira (official code TRY) into free fall. Between August 3 and the August 13, 2018, the lira fell by some 40 percent to an all-time low of 6.9 lira/$. As seen in Figure 1, although the lira has made a partial recovery since then, it still remains significantly depreciated as compared to its rate before the crisis began.

Figure 1. *USD-TRY exchange rate*

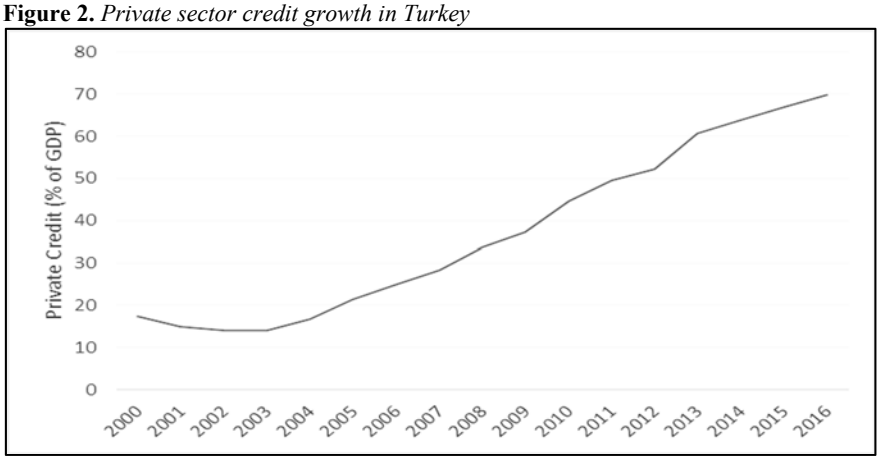


Source: available at https://tradingeconomics.com/turkey/currency

Currency depreciation *per se* does not qualify as a crisis, especially for a growing economy and more so ever depreciation triggered off by political circumstances rather than fundamental macroeconomic parameters. However, Turkey's appetite for credit and in particular, external credit denominated in dollar terms has put it in a rather precarious

situation that threatens to dislodge it from its high growth trajectory. The credit surge effectively began in Turkey in the early 2000s with private sector credit rising from just 15 percent of GDP in 2003 to 70 percent of GDP in 2016 (Figure 2).

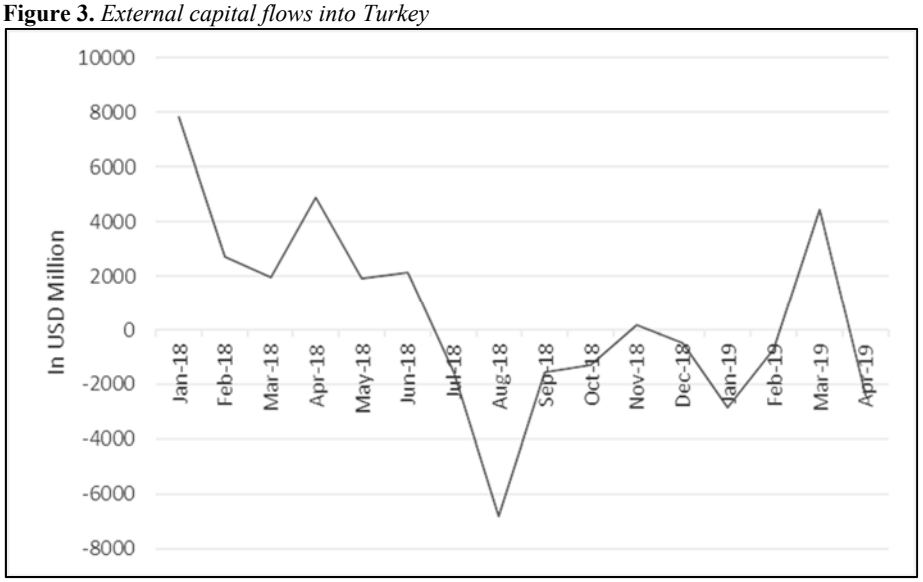
Figure 2. *Private sector credit growth in Turkey*



Source: available at https://tradingeconomics.com/turkey/domestic-credit-to-private-sector-percent-of-gdp-wb-data.html

Figure 3 presents inflow of foreign capital into Turkey. While demand (pull) for credit is an important factor, the supply (push) aspect cannot be undermined as a major contributor in driving this appetite for foreign credit.

Figure 3. *External capital flows into Turkey*



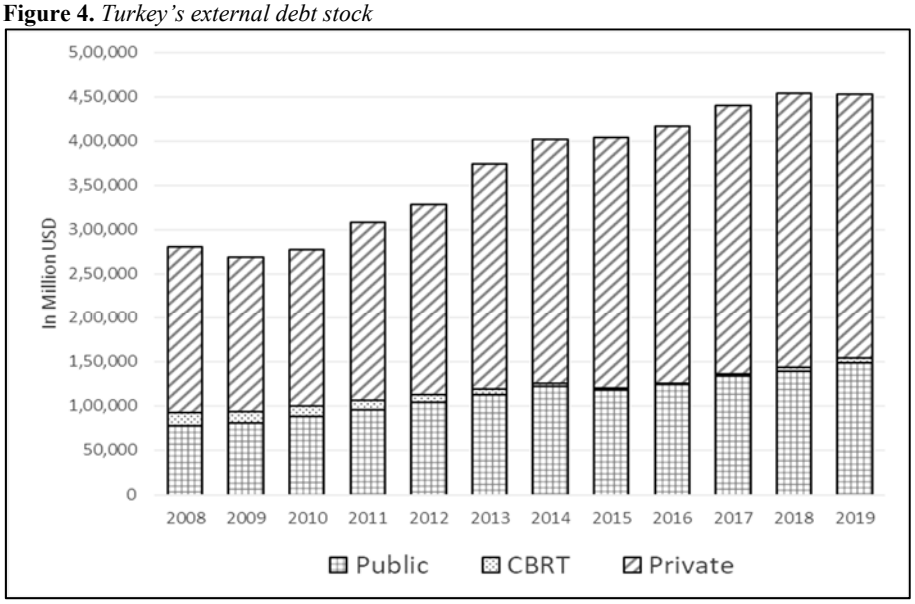
Source: available at https://tradingeconomics.com/turkey/capital-flows

With the adoption of expansionary monetary policy by the US Federal Reserve – more specifically, the quantitative easing program – in response to the global financial crisis of 2008-2009, interest rates across the developed countries touched historic lows making

external credit attractive for borrowers. At the same time, international investors too looked towards emerging markets and developing economies to earn greater yields on investment. Turkey was an appealing option for global capital owing to its high GDP growth rate at an average of 6.9 percent between 2010 and 2017 as opposed to 3.8 percent worldwide, economic reforms, its large and diverse national industry as well as a substantial high-middle income market out of its population of around 80 million.

The increased capital flows led to a massive increase in Turkey's external debt, particularly of the private sector while public sector foreign debt grew just marginally throughout this period (Figure 4). Turkey's dependence on external financing renders it prone to crisis. Several factors ultimately contributed to what *post facto* seems an inevitable predicament; increasing financing costs rising with the U.S. Federal Reserve raising interest rates since 2016, growing concerns over Turkey's creditworthiness with expansionary fiscal and monetary policies in the months leading up to presidential and parliamentary elections in June 2018 and increased political conflicts between Turkey and the US. The hike in import tariffs in August 2018 by the Trump Administration was the final nail in the coffin – depreciating the lira and inflating the lira value of dollar-denominated debt.

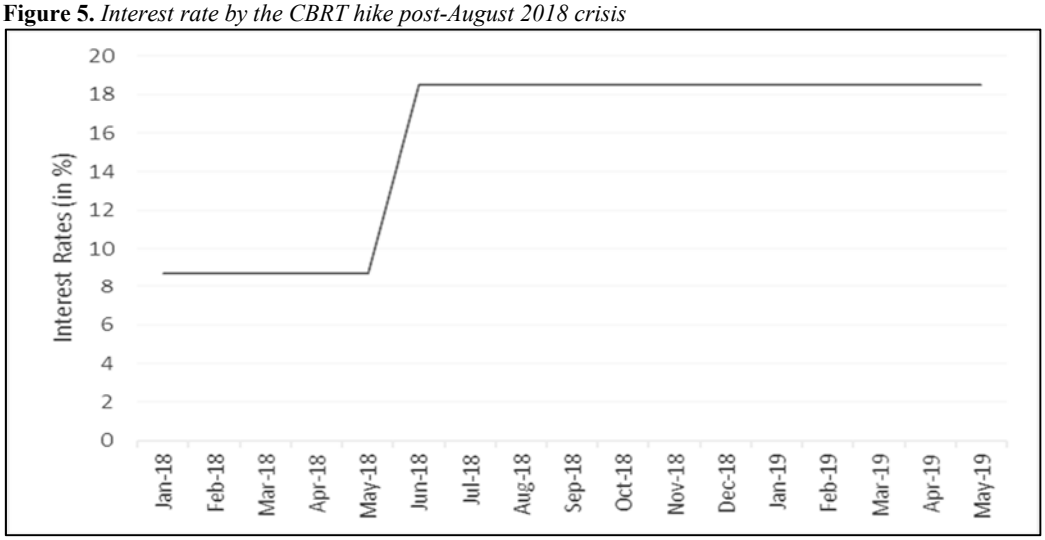
Figure 4. *Turkey's external debt stock*



Source: Central Bank of the Republic of Turkey (CBRT).

Although initially defiant on increasing interest rates to quell the fall the lira, President Erdogan ultimately relented by allowing the Central Bank of the Republic of Turkey (CBRT) to raise interest rates sharply in September 2018 (Figure 5).

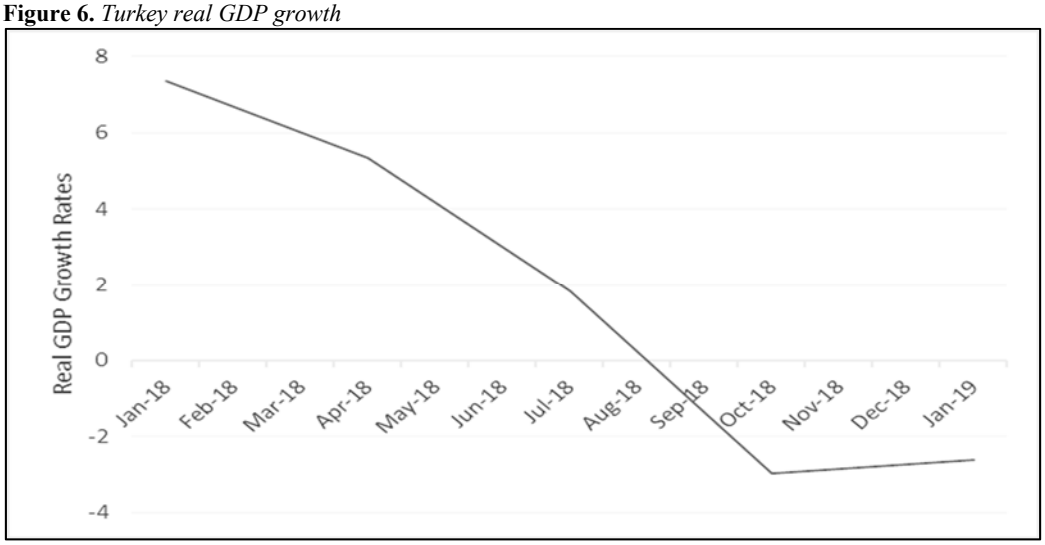
Figure 5. *Interest rate by the CBRT hike post-August 2018 crisis*



Source: available at https://tradingeconomics.com/turkey/interest-rate

Rapid hikes in interest rates trigger explosions in loan bubbles, leading to loan busts and recession; credit growth stalled (Figure 2) and capital flows turned negative (Figure 3), taking Turkey's GDP down by 1.6 percent in the third and 2.4 percent in the fourth quarter of 2018 (Figure 6).

Figure 6. *Turkey real GDP growth*



Source: available at https://www.ceicdata.com/en/indicator/turkey/real-gdp-growth

Meanwhile, the lira depreciation threatened to generate a surge of defaults across Turkey's institutions and corporations. With the lira value of dollar-debt spiking, the immediate challenge was to control the fallout which was not only finding sufficient lira for interest payments by corporations but also decline of investor trust making it difficult for companies to restructure debt, in particular, its rollover. To avoid the repercussions of debt

default that could shatter investor confidence and the prospects of external funding in future, may pressurize the Turkish government to provide financial support to private corporations. This could, however, imply additional government expenditure that runs counter to its proclaimed stand of fiscal consolidation.

To analyze the current crisis in Turkey and to study the implications of the macroeconomic policies available to deal with it, we use the Sectoral Financial Balances (SFB) model developed by the heterodox economist, Wynne Godley. Although the SFB model does not establish cause-effect relationships, it does ensure stock-flow consistency across sectors, allowing a more critical evaluation of the macroeconomic policies exhorted by economists and international institutions.

3. An overview of the Sectoral Financial Balances (SFB) model

Following Sivramkrishna (2016), we present the SFB model developed by the heterodox economist, Wynne Godley. It is based upon fundamental axioms of double entry book keeping; for every debit there must be a corresponding credit and for every financial asset there must be a corresponding financial liability. In this model, the economy is divided into three sectors, namely, the domestic private sector, government sector and the external sector which consists of both foreign private sector and foreign governments. The underlining rule is that the summation of the net financial asset accumulation of all the three sectors should add up to zero. In other words, if one sector is accumulating financial assets then at least one of the other sectors must be accumulating financial liabilities, making net accumulation by all sectors at the same time impossible so that:

$$(S_a - I_a) + (T_a - G_a) + (X_a - M_a) = 0 \quad (1)$$

or

$$(S - I) + (T - G) + (X - M) = 0 \quad (1')$$

where
\S = domestic private sector savings,
I = domestic private sector investment,
G = government expenditure,
T = tax revenues, M = imports and
X = exports, all as percentages of GDP.

T, the subscript “a” for each component in equation (1) denotes absolute values and the components without the subscript “a” in equation (1’) are values as a percentage of GDP.

In equation (1’), (S – I) refers to the net financial asset accumulation by domestic private sector, (T – G) refers to the net financial asset accumulation by domestic government sector and (M – X) refers to the net financial asset accumulation by external sector, as percentages of GDP. Note that (X – M) < 0 or current account deficit (CAD) necessitates a net financial inflow from abroad or the accumulation of financial liabilities (assets) by domestic sector (foreigners).

Rewriting equation (1), we get:

$(S_a - I_a) = (G_a - T_a) + (X_a - M_a)$

or from equation (1'),

$(S - I) = (G - T) + (X - M)$ (2)

To reiterate, net asset accumulation of the private sector entails a corresponding accumulation of liabilities by at least one of the two sectors; the government sector and/or the external sector.

It must be understood that although the equations hold in absolute terms as well as a percentage of GDP, there are important differences. For instance, a CAD as percentage of GDP may show an "improvement"; however, this could be happening as a result of both, exports and imports falling as GDP declines. Consider the following example:

M = 25 percent of GDP; X = 20 percent of GDP

Therefore, (M – X) = 5 percent of GDP

Now suppose GDP falls domestically as well as internationally so that both, X and M fall, so that:

M = 15 percent of GDP, X = 12 percent of GDP

Therefore, (M – X) = 3 percent of GDP.

The question, however, is whether the second situation can be considered as an improvement in CAD.

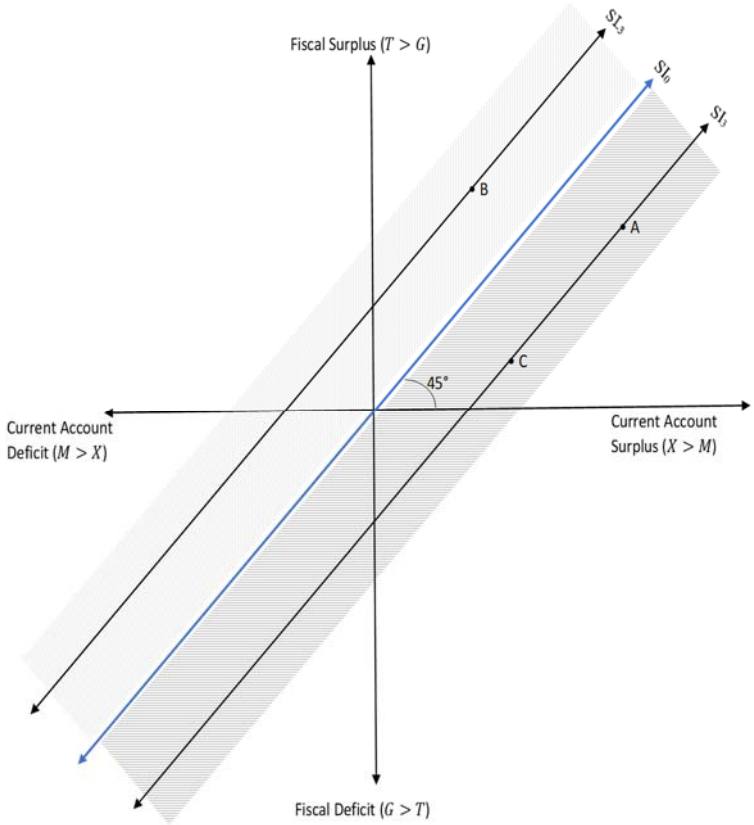
The SFB equation can be plotted on a coordinate plane (Figure 7). Any point on the 45° line (SI_0) shows S – I = 0 where CAS must be equal to a fiscal surplus as in quadrant 1 or CAD is equal to the fiscal deficit as in quadrant 3. Any point to the right of the 45° line represents the (shaded) region where S – I > 0 as for instance point A where the domestic private sector is accumulating a positive quantity of net financial assets. If at Point A, (X – M) is (say) +5 and – (G – T) = 2 i.e. fiscal surplus is +2, then (S – I) = +3. At point C, if (X – M) = – 2 and the fiscal deficit (G – T) = +5, then once again (S – I) = +3. Therefore, the line SI_3 is a locus of points with a positive net financial accumulation by the private sector of 3 percent of GDP. Similarly, any point to the left of the SI_0 is the (dotted) region S – I < 0. Point B shows the domestic private sector is accumulating a positive quantity of net financial liabilities. Moreover, the line SI_{-3} is a locus of points with a net financial accumulation of liabilities by the domestic private sector is 3 percent of GDP.

Although the domestic private sector can accumulate financial liabilities by being indebted to a sector outside itself (leveraging) in the short-run, it would have to, at some point of time, begin to pay back its debt, and move in the direction of the shaded region where S – I > 0. This process is called deleveraging, which entails accumulating net financial assets or reducing net financial liabilities by the domestic private sector so that, all else constant, consumption (as savings increase) and/or investment spending decline and consequently, GDP too. This, however, sets off an adverse chain reaction on other macroeconomic

parameters including the *post facto* quantum of savings that could further induce changes in the marginal propensity to save.

We have seen that for accumulation of net financial assets by the domestic private sector *outside itself* either the government sector (by running fiscal deficits) and/or the foreigners (by allowing the domestic economy to run CAS) must accumulate liabilities. Several questions arise here; first, why does the private sector accumulate financial assets? Savings accumulated as physical assets are neither physically safe nor financially secure. Assets like gold, land, property, and so on can lose value and could be stolen (gold) or face legal issues (land, property). Financial assets are therefore included in the savings portfolio of the private sector. The next question is why would the domestic private sector want to accumulate financial assets *outside itself*? Financial liabilities of the private sector are not secure; they may lose value – for instance, corporate bonds, equity shares, fixed deposits at banks – since these are ultimately backed by physical assets, like property, plant and equipment, and so on. The private sector would therefore want to include in its portfolio of financial assets, liabilities of foreigners (including foreign governments) or the domestic government, the liabilities of sovereign governments being the only liabilities not backed by physical assets but rather by the ability of the state to issue currency.

Figure 7. *The SFB template*



The appetite of the domestic private sector for net financial asset accumulation may vary depending on the state of the economy and outlook of private sector stability. When an economy is booming, the domestic private sector may not be averse to holding other private sector financial liabilities, usually in expectation of high returns. The government (through credit) and external sector too may hold such liabilities of the domestic private sector (by allowing the domestic economy to run CAD). On the other hand, in times of economic recessions and crisis, households and even private sector households and firms may prefer to hold their savings in government debt when private sector financial assets become risky.

A necessity for domestic private sector to accumulate government liabilities may also arise when private sector investment plummets – it stops issuing new liabilities – with savings increasing or remaining unchanged. In such situations, the government must accommodate the private sector's increased desire to net save through accumulation of financial liabilities, i.e. the government must issue its own liabilities by running larger fiscal deficits. In an open economy, the foreign sector may also afford an opportunity for the domestic private sector to accumulate financial assets; this, however, would happen only when the CAD decreases or CAS increases.

While the SFB model is useful in maintaining stock-flow consistency and is based on fundamental axioms of double entry book keeping, it is not a cause-effect model. It is only through a critical understanding, interpretation and analysis of economic parameters that deeper insights into state of the economy can be unearthed.

4. Turkey's SFB since 2012

Table 1 summarizes SFB components as a percentage of GDP for Turkey.

Table 1. *Turkey's SFB Components as a percentage of GDP*

Year	(G-T)	(X-M)	(S-I)
2012	-1.9	-5.5	-7.4
2013	-1	-6.7	-7.7
2014	-1.1	-4.7	-5.8
2015	-1	-3.7	-4.7
2016	-1.1	-3.8	-4.9
2017	-1.5	-5.6	-7.1
2018	-1.9	-3.5	-5.4

Source: available at https://data.worldbank.org
Note: Following Koo (2011), (S – I) has been computed as the sum of (G – T) and (X – M). Since data for S is usually not available and given that the SFB is an accounting identity it is better to compute it in this way.

Beginning with the government sector, Table 1 shows the Turkish government has been running a deficit over the last decade which has, however, been rather low and well below the benchmark target of 3 percent. This has also kept public debt low, which presently stands at just about 35 percent of GDP.

On the external front, as can be seen in Table 2 below, apart from import of fossil fuels, a substantial portion of Turkey's imports consists of industrial intermediate goods as well as capital goods. For several years now until the crisis of 2018, these large imports of

industrial goods have been driven by the domestic private sector's strong investment demand, leveraged through the inflow of foreign capital.

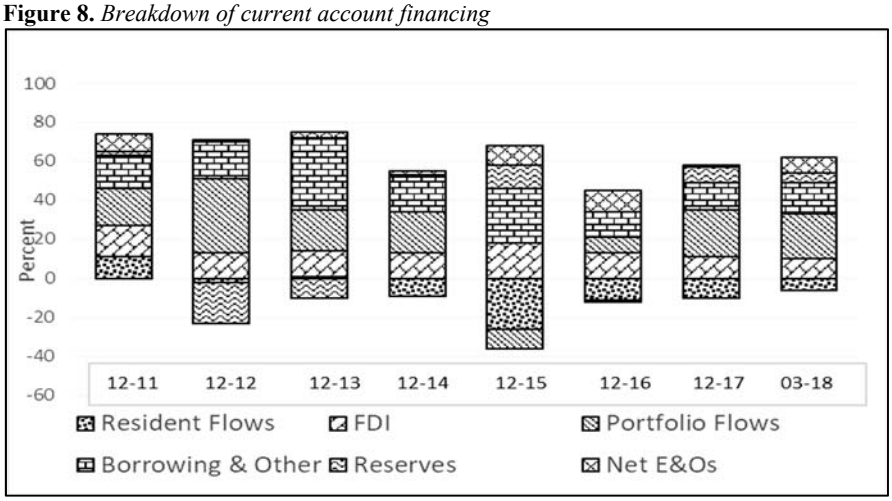
Table 2. *Turkey's top ten imports by category*

Particulars	Value	Percent
Mineral fuels, oils, distillation products	$37.19B	18.32
Machinery, nuclear reactors, boilers	$27.16B	13.38
Electrical, electronic equipment	$21.15B	10.42
Pearls, precious stones, metals, coins	$17.44B	8.59
Vehicles other than railway, tramway	$17.43B	8.59
Iron and steel	$16.76B	8.26
Plastics	$13.27B	6.54
Organic chemicals	$5.39B	2.66
Optical, photo, technical, medical apparatus	$5.00B	2.46
Pharmaceutical products	$4.45B	2.19

Source: available at https://tradingeconomics.com/turkey/imports

Figure 8 shows the funding sources of Turkey's CAD; a substantial portion is through the bond issuances and borrowing rather than the other components like portfolio investment, foreign direct investment (FDI) and change in reserves. In other words, the domestic private sector has been accumulating financial liabilities while the foreign sector has been acquiring corresponding financial assets in Turkey.

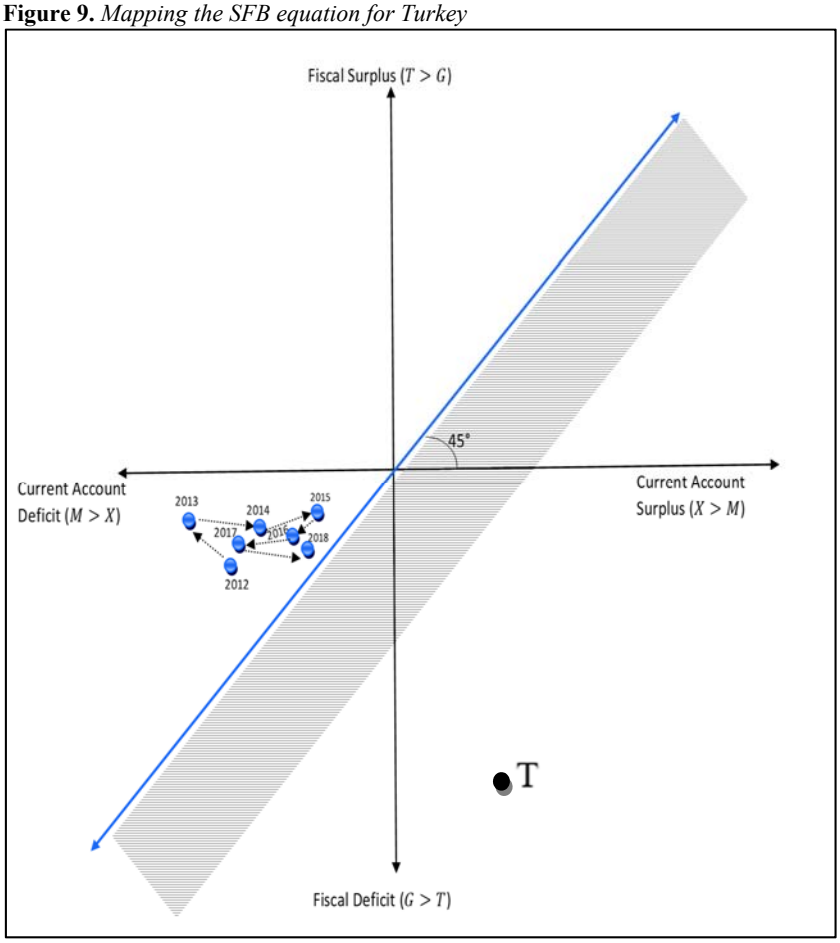
Figure 8. *Breakdown of current account financing*



Source: available at https://think.ing.com/articles/turkish-current-account-deficit-widens/

Drawing from Table 1, the SFB equation for Turkey has been shown graphically in Figure 9 for the period 2012-2018. The situation until about a year ago in Turkey was clearly one of leveraging by the domestic private sector. However, post-crisis of August 2018, the situation has reversed with CAD falling and the domestic private sector reducing its net financial accumulation of liabilities. A naïve reading of the SFB equation may lead to a misreading of the ongoing crisis in Turkey. A contraction in CAD (leftwards on X-axis in Figure 9) along with a modest increase in the fiscal deficit (downwards on the Y-axis in Figure 9), it would seem from the SFB equation, allows a readjustment towards a reduction in accumulation of net financial liabilities by Turkey's domestic private sector (movement towards the shaded region in Figure 9).

Figure 9. *Mapping the SFB equation for Turkey*



However, a more nuanced reading into the situation, constrained by the need to maintain stock-flow consistency as delineated by the SFB equation, is required to unravel the challenges to policy strategies being implemented by Turkey.

5. A critical analysis of Turkey's SFB changes in the aftermath of the 2018 Crisis

As seen earlier, the immediate impact of the August 2018 crisis was a sharp depreciation in the lira and repayment of external debt. As businesses began deleveraging, investment spending declined sharply, by almost 22 percent between July 2018 and end of 2018 (CEIC[(1)]), pulling Turkey into a recession – the GDP forecasts are rather dismal with an overall contraction forecasted for 2019 (Devranoglu, 2019).

While, the depreciated lira stimulated exports (Anadolu Agency, 2019), the currency depreciation as well as the recession have reduced imports more severely. Between May 2018 and May 2019, exports increased by some 12 percent of GDP while imports saw of drop of almost 20 percent in the same period (Trading Economics)[(2)]. With these changes,

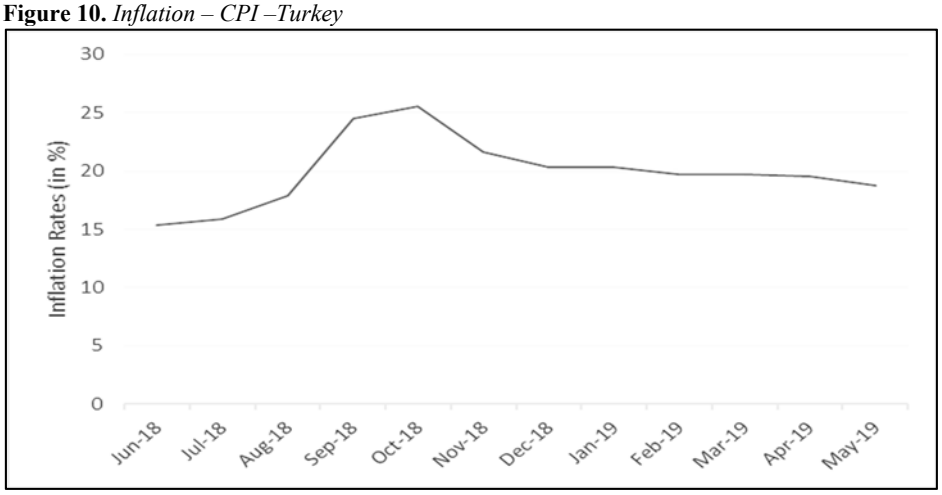
the CAD is expected to decline significantly and is estimated to be just 2.6 percent of GDP in 2019 (Daily Sabah, 2019a).

With investment spending and GDP declining, a rising value of net financial asset accumulation by the private sector as a percentage of GDP is consistent even with a declining quantum of savings; more precisely, any decline in S_a/GDP must not exceed the decline in I_a/GDP for $(S_a - I_a)$/GDP or (S – I) to show an increase. However, S_a/GDP and I_a/GDP) could even show increases even if S_a and I_a are decreasing since GDP (the denominator) is also decreasing. In such a case, any increase in S_a/GDP must exceed the increase in I_a/GDP for an increase in net financial asset accumulation by the private sector, i.e. for $(S_a - I_a)$/GDP or (S – I) to show an increase.

Although it is difficult to obtain data on private sector savings, our analysis points to a situation in which Turkey's quantum of savings (S_a) could be declining along with a contraction of GDP, (paradoxically) driven by a higher propensity to save. Several macroeconomic variables are generally acknowledged to play a role in the savings decisions of the private sector, which include inflation and inflation expectations, unemployment, interest rates, consumer confidence and the level of consumer spending. For Turkey, a look at these parameters would point towards a higher propensity to save.

1) Inflation rates remained high in Turkey, although they have showed a declining trend since October 2018 (Figure 10).

Figure 10. *Inflation – CPI –Turkey*



Source: available at https://www.inflation.eu/inflation-rates/turkey/current-cpi-inflation-turkey.aspx

2) Inflation expectations continue to remain high (Ahval, 2019).
3) Households final consumption expenditure decreased by 8.9% in the fourth quarter of 2018 (Turkish Statistical Institute, 2019).
4) In April 2019, Turkey's unemployment was the highest in a decade at 14.7 percent with youth unemployment rate at an alarming 26 percent). Arthur Okun's misery index, which considers inflation and unemployment, shows that between April 2018 and April 2019, Turks are 60 percent more miserable (ibid.).

5) The consumer confidence index has shown a steep decline from 72.7 in July 2018 to a low of 55.3 in May 2019.

As one commentator recently put it, for the man on the street, "the situation is fast becoming intolerable." (Tonak, 2019). This state of affairs must mean increasing insecurity over the future, driving households to thrift.

The falling consumption levels, partially propelled by the higher desire to save, can take Turkey into a vicious circle or what John Maynard Keynes termed as "paradox of thrift"; the desire for additional savings causes consumption and sales to fall, GDP to contract and unemployment to rise. In fact, the signs of falling sales are stark.

> … the institute's [state-run Turkish Statistical Institute] own data showing a fall in retail sales, a 10 percent contraction in Turkey's construction sector, a 4 percent decline in manufacturing, a fall of between 20 percent and 50 percent in white goods and automobile sales despite months of tax discounts, … (Dogan, 2019).

Accumulation of non-financial assets (especially buying of gold as a safe haven asset) that are not reflected in the SFB equation (which only considers financial asset accumulation) but which would dampen consumption of manufactured goods and services, and therefore sales of businesses, may also be worsening the situation in Turkey.

Turkey faces a further challenge in accommodating its private sector's rising desire to save in safe financial assets; the availability of such assets to park their savings. Turkish stock markets have been volatile, sliding almost 20 percent after the 2018 crisis (Trading Economics[3]), bankruptcies are on the rise (Financial Times, 2019) and non-performing liabilities of banks are expected to double by 2020 (Schmidt, 2019). The fallout of these trends is unequivocally impacting asset quality adversely:

> According to S&P, such concerning estimates were based on expectations of an "economic slowdown, deleveraging, continued lira depreciation, and increased interest rates", all of which will exert pressure on asset quality over the next 12 to 18 months (ibid.).

So even if the marginal propensity to save increases, the opportunity to save in safe instruments is limited. The only available options would be physical assets like gold or government securities. The latter would, however, necessitate larger fiscal deficits, which is, as we shall see, in direct contradiction to the government's austerity measures.

To summarize; the recession could lower the absolute quantum of savings (S_a) in spite of or rather, because of the increased propensity to save, which then cascades into a vicious cycle of further inducing a rise in the desire to save. However, even as the quantum of savings decline there could even be an upward movement in the *post facto* savings rate (S_a/GDP) if GDP is declining by even more than S_a. Given the massive decline in I_a and consequently, I_a/GDP, the net financial asset accumulation by the private sector may show an improvement when computed as a percentage of GDP, i.e. an increase in (S – I). And this could be precisely what is observed in the SFB diagram (Figure 9) where there is a deceptive "improvement" in the financial asset accumulation of the private sector along with a decline in the CAD (which is declining from falling imports – M_a – on account of

depreciating lira and falling GDP) and only a marginal increase in the fiscal deficit (G – T), which continues to remain well below the 3 percent of GDP threshold.

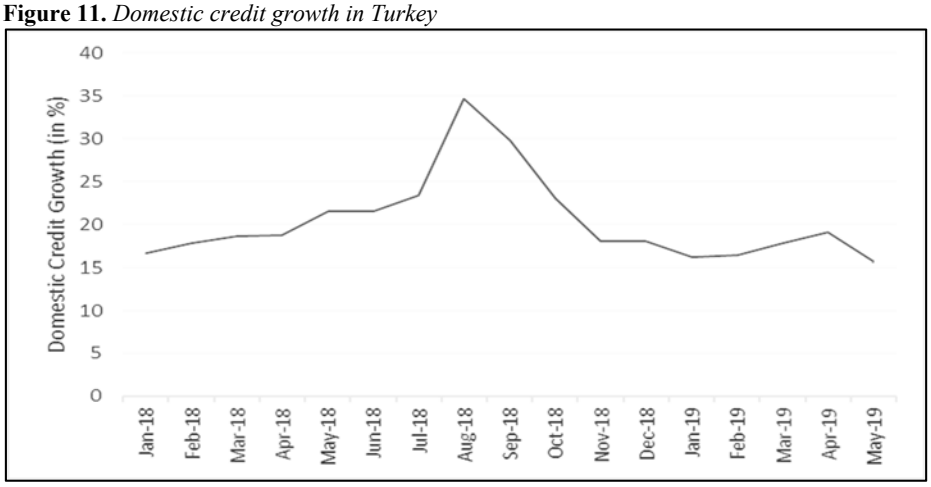
6. Policy Interventions in Response to the 2018 Crisis

Monetary Policy

One of the first policy steps adopted by the CBRT was to raise interest rates sharply in September 2018 by 6.25 percent, from 17.75 to 24 percent. For several years, President Erdogan had influenced the Central Bank to pursue a policy of low interest rates to stimulate investment and growth, maintaining negative real interest rate policy. However, with the lira hammered during the crisis of 2018, the Central Bank had no other option available to stem a complete collapse of the lira but with a substantial hike in interest rate. The immediate repercussions of tightening monetary policy were fall in investment and lower GDP; however, the sliding lira and acceleration in inflation were reined in within a short period of time.

With inflation remaining stubborn and lira beginning to slide once again in 2019, the CBRT continued to tighten interest rates as well as availability of liquidity in the domestic economy. In May 2019, it announced the suspension of repo auctions at the stipulated 24 percent interest rate; instead, liquidity (central bank reserves) was available in the overnight money markets at 25.5 percent or the late liquidity window at a much higher 27 percent. Commercial banks were also allowed to hold a proportion of their lira reserve requirements in foreign exchange, called the Reserve Options Mechanism (ROM). By decreasing the upper limit for the foreign currency maintenance limit from 40 to 30 percent, the CBRT was able to increase foreign currency liquidity in the market while decreasing lira liquidity (Maqsood, 2019). With these steps, the lira now trades at 5.75/US$ from 6.20/US$ on the day of revised ROM announcement, i.e. 9 May 2019. The downside to this move has, however, led to a lira crunch in the banking system and slowing down credit expansion (Figure 11).

Figure 11. *Domestic credit growth in Turkey*



Source: available at https://www.ceicdata.com/en/indicator/turkey/domestic-credit-growth

Questions, however, remain as to how Turkey will manage the recession and growing unemployment. After all, a high inflation rate in the context of falling GDP and rising unemployment – what is being called "slumpflation" (Aliriza, 2019) – can have adverse political implications too. For years, Erdogan's policies pumped Turkey on to a high growth trajectory based on private sector investment from overseas borrowing, which came at the cost of unmitigated inflation, supported by a low interest rate policy and credit guarantees. With monetary policy targeted at the inflation and exchange rate, the Turkish government looked at fiscal policy to address the issues of growth and employment.

Fiscal Policy

Soon after the crisis in August 2018, the Ministry of Treasury and Finance of the Turkish government (Ministry of Treasury & Finance, 2019) unveiled a fiscal plan for the battered economy. The focus was to support tightening of monetary policy measures with austerity policies – or fiscal discipline – so as to check the acceleration in the inflation rate and a depreciating lira. The inflation target was brought down to just 6 percent by 2021 while the deficit was to remain below the 2 percent level during this period. While the plan mentioned cancelling of several new investment projects, it also called for financing of mega investment projects through external borrowings rather than through government deficit spending. The hope, which is discernible from the plan, is to first stabilize the economy in particular, inflation and depreciating lira, and then put it back on a high growth path with high value-added manufacturing (investment) and substantially increased exports.

To analyze the viability of this fiscal policy plan while maintaining stock-flow consistency, we once again revert to the SFB model. To maintain or decrease the level of fiscal deficit as a percentage of GDP in the context of the present recessionary trend requires the Turkish government to substantially reduce the quantum of the deficit ($G_a - T_a$). To achieve this, the fiscal program announced cancellation of several large projects, which implied a further contraction of the economy in addition to that caused by reductions in private sector investment spending.

However, as we have seen with contraction of CAD, reducing fiscal deficits as a percentage of GDP could be a race to the bottom – like austerity policies across the world have shown. This is essentially because the fiscal deficit acts as an automatic stabilizer; cuts in government spending leads to declining output and incomes, thereby reducing tax collections and increasing transfer payments (unemployment benefits). This could even cause the absolute level of ($G_a - T_a$) to rise or at best, not decrease substantially. With falling GDP, a rising fiscal deficit as a percentage of GDP or ($G_a - T_a$)/GDP may be the outcome of the futile exercise. This would then induce the government to call for greater austerity measures even as the economy witnesses severe contraction.

So what does the SFB model tell us about the fiscal policy options open to Turkey? The context is clear – the private sector's desire for net financial asset accumulation (deleveraging) is driving the economy to a point on an SI line to the right of SI_0 and into the shaded portion. If the fiscal deficit as a percentage of GDP is be maintained around its present level as GDP contracts (so that in absolute terms a strong dose of spending cuts is implemented), then with a reduction in CAD, Turkey could move to point T in Figure 9.

It is, however, critical to understand that while net financial asset accumulation can be achieved by the domestic private sector, the process entails pushing the economy into a recession. The government's austerity plans to reduce the fiscal deficits as a percentage of GDP only adds fuel to the raging fire. With stagnant or marginal increase in exports, reduction in CAD is achieved through falling imports coming from falling GDP and the fiscal deficit is kept low through massive cuts in expenditures. This indeed seems the plan; contract the economy to control inflation, stabilize exchange rates and reduce interest rates that will then hopefully, stimulate private sector investment (in value-added manufacturing) and exports.

The hope for Turkey's revival then is not austerity but reversing the trend in the current account balance through a massive increase in exports rather than contraction of imports. From equation (2), it can be seen that increased exports will drive positive GDP growth, larger tax receipts and smaller deficits even with increasing of government expenditure. In other words, (G – T) may fall even though (G_a – T_a) may be larger since GDP is larger. This will also support a larger quantum of financial asset accumulation by the private sector, ensuring its deleveraging objective is met.

7. Summary and conclusion

Turkey is clearly undergoing a deleveraging cycle, wherein the private sector is attempting to reverse its position from an accumulation of financial liabilities to the accumulation of financial assets. To do so it cuts consumption spending and with private investment and government spending declining, a severe contraction in Turkey can be expected. This could actually raise the fiscal deficit as government transfers and other unemployment allowances rise along with falling tax receipts (the fiscal deficit as an automatic stabilizer). To counter this possibility, the government may implement large cuts in spending with a severe and adverse impact on GDP.

This contraction in GDP could, however, be countered with a steep increase in Turkey's exports, something which the government is hoping would happen once the lira and inflation are quickly brought under control.

Two possible scenarios from analysis of the SFB equation:

In the first situation, exports witness a tepid increase while imports fall, which does lower the CAD significantly. Moreover, the pursuit of austerity with a cut in government expenses adds to the recessionary trend. If with this, the government is able to reduce the fiscal deficit (G – T) then any movement to the shaded region in Figure 9, i.e. a reduction in accumulation of net financial liabilities by the domestic private sector will come about due to a "improvement" in CAD induced by falling imports on account of a contracting economy.

The second scenario is the one that augurs well for Turkey with its present set of policies that focus on disinflation and stabilizing the lira – steep increase in exports that reverses the recessionary trend and boosts GDP. This could mean higher tax collections (T_a) and increases in quantum of savings. Government spending (G_a) could be raised even as the

deficit (G – T) remains within reasonable bounds. Supported by larger government spending and the reduced CAD (or if possible a CAS), the private sector could end up with a higher financial net asset accumulation or a lower quantum of financial liabilities.

The question is now which of the above two scenarios is likely to play out for Turkey. The current account is no doubt likely to see an unequivocal "improvement" with rising exports due to the depreciation of the lira and falling imports induced by the recession. The contraction in the economy and the equilibrium (where SFB readjust to new levels of GDP) is therefore dependent on how soon and by how much exports increase. Put differently, will the increase in exports be substantial enough to reverse the recessionary trend as in the second scenario described above? Although there has been some good news for Turkey on the export front (Daily Sabah, 2019b) doubts remain about the sustainability of such export growth (Sonmez, 2019) – especially in the context of US protectionism, trade penalties likely to be imposed by the US on account of Turkey's S-400 missile defence system procurement from Russia and sluggish global economic growth.

Notes

(1) Sourced from https://www.ceicdata.com/en/indicator/turkey/investment--nominal-gdp
(2) Sourced from https://tradingeconomics.com/turkey/imports and https://tradingeconomics.com/turkey/exports
(3) Sourced from https://tradingeconomics.com/turkey/stock-market

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Main aspects on the nature of dynamic models

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Abstract. *The dynamic models used in the micro or macro-economic analyzes appeared as a necessity to correlate the statistical variables divided into the resultant variables and the factorial variables, in order to be able to estimate, by the parameters calculated using statistical-econometric methods and to be able to deduce the correlative influence between those two categories of variables.*
Macroeconomic models are static or equilibrium, meaning that the static model refers to the data up to the moment, and the equilibrium model is a special case, especially of a dynamic system. The situation of tomorrow is established by investigating how the result variables considered under the influence of factors (statistical variables considered) evolved. Based on the agreed static or dynamic models, the differential equations are established (this starts from the term of the use of derivatives), so as to justify the way in which the relations between the two variables are expressed and their evolution over time.
Dynamic models are used at the macroeconomic level to determine the National Income, as the net result indicator that is distributed, redistributed and used to meet the needs of those interested.
Dynamic models must be considered as a system in which differential equations refer to two successive periods that can be represented graphically. After all, the dynamic models used in the analyzes must start from the fact that a study was carried out previously based on the statistical data series and then on their graphical representation.
A number of elements are considered important in agreeing on dynamic macroeconomic models, such as the evolution of the anticipated price cycle that changes the value, but not the content, most of the times, the structural content of the macroeconomic aggregates.

Keywords: models, balance, dynamic process, forecast, differential equations, national income.

JEL Classification: C50, C62, E01.

Introduction

In the article the main aspects regarding the nature of dynamic models, the authors went from simple to complex, to define and specify the notion of dynamic models used in macroeconomic studies.

It started from the simple fact that models can be static or equilibrium, and not lastly, forecast models that are based on a future evolution of the indicators (statistical variables) considered.

The system of equations based on which the estimation parameters are determined, represents a determining element in the use of dynamic models in the analysis of macroeconomic evolution.

The authors or referred, one by one, to establishing the differential equations that constitute the system of equations based on which the parameters are determined, then resorted to applying a model to the national income level, taking it as the only macroeconomic indicator of net results that it can contribute both to the allocation for investments and to the allocation to increase the standard of living of the population.

Next, a graphical solution of the dynamic models was used, starting from the fact that this dynamic model must highlight on the basis of the considered data, the way in which the economic evolution can be foreseen in a future period. In fact, the authors summarize the fact that, analyzing the situation of a macroeconomic indicator or the macroeconomic situation as a whole, it can be done after a study has been performed previously on the statistical data series and then on the graphs drawn up based on these data series. Last but not least, the authors express some points of view in relation to the anticipated price cycles, thus aiming to suggest the evolution perspective during the forecast or forecast period considered.

The article is accompanied by graphical representations, data and representative tables that justify the views expressed by this article.

1. Literature review

Anderson, Breedon, Deacon, Derry and Murphy (1992) are concerned with the estimation and interpretation of the yield curve. Anghelache and Anghel (2019) addresses in their work theoretical and practical aspects regarding economic statistics. Anghelache and Anghel (2019) it addresses the problems of economic modeling. Anghelache (2018) makes a thorough analysis of the financial statements of Romania over the last one hundred years. Anghelache, Mitruţ and Voineagu (2013) addresses issues of macroeconomic statistics, focusing in particular on the System of National Accounts. Anghelache and Anghel (2019) analyze the position of Romania in the European context. Anghelache (2019) analyzes in his work the evolution of industrial activity in Romania. Anghelache, Anghelache and Bârsan (2019) analyzes models used in dynamic series analysis. Bollerslev are Wooldridge (1992) are concerned with estimating the probabilities and interference of dynamic models that are time-varying.

Hansen and Lunde (2006) addresses issues related to forecasts for volatile models. Iacob (2019) approaches methods of statistical-econometric analysis of economic phenomena. Ledoit and Wolf (2003) are concerned about estimating stock returns with a portfolio selection request. Ruth and Hannan (2012) turn their attention to their analysis of dynamic economic systems. Scaillet (2004) addresses in this article problems related to non-parametric estimation and analyzes the degree of sensitivity of the predicted deficiency.

2. Research methodology, data, results and discussions

Static or equilibrium models, with only incidental reference to the dynamic properties of these systems, are a particular element. Each equilibrium model is a special case of a dynamic system, but there are many dynamic systems that do not lead to any equilibrium position. All the systems of the real world are dynamic systems and, very rarely, in the social or economic systems we find a real case of equilibrium in which the variables of the system remain at the same level for successive periods of time. Therefore, the equilibrium mode is mainly valuable because if the equilibrium position is stable, we know that within limits, the system will move towards it. Therefore, if we are offered the equilibrium state of a system and its current state, at least we can predict the direction of change by the fact that the near future states will be somewhere between the present state and the equilibrium state. However, we cannot know for sure whether a steady state is stable or not until we have specified the dynamic properties of the system.

We can appreciate that a state of a system consists of its description at one point, and a dynamic process consists of a succession of states, such as successive frames on a drum. If there are stable relationships between moments, which are a constant distance apart in sequence, we have a dynamic system. Thus, if today he has a constant relationship with yesterday, tomorrow he will have the same relationship with today. The forecast can only be made if we know the dynamic system that underlies a process. So, if we know a stable relationship between yesterday and today and at the same time we know the state of the system today, we can predict the situation tomorrow. Knowing the situation of tomorrow allows us to predict the situation of tomorrow and thus we can continue for an unlimited period in the future.

Suppose that S_t represents the state of the system at any time, t. If there is a stable relationship, of the form:

$$S_t = F(S_{t+1}) \quad (1)$$

we have a dynamic system of degree one. If we are specified S_0, $S_1 = F(S_0)$, $S_2 = F(S_1)$ and so on, the whole sequence, S_0, S_1,…, it can be generated at any time S_t. If there is a stable relationship, of the form:

$$S_t = F(S_{t+1}, S_{t+2}) \quad (2)$$

we have a dynamic system of the second degree. S_t depends not only on yesterday, S_{t-1} but also S_{t-2}. If we are given two successive states, we can predict all the other states in the

sequence. Similarly, in a ninth-grade dynamic system, S_t is a stable function of n previous states and we must know n successive states before the system can be defined.

A balance system is one in which $S_t = S_{t+1} = S_{t+2} \ldots S_e$, S_e being the equilibrium value of the system. Thus, a dynamic system is in balance if today is such that tomorrow is the same as today.

- **Differential equations**

If the state of the system can be described by the value of a unique variable, the dynamic system can be described by a simple difference equation. A difference equation expresses a stable relationship between two or more successive positions of the same variable. Suppose that the value of an interest rate loan doubles over a certain period, say ten years. Then if x_t is the value of the loan at any time, and x_{t+1} is the value ten years after this date, we can write $x_{t+1} = 2x_t$. This is a very simple difference equation. If we are given the value of x at any date, then we can deduce the value at any other date. So if $x_0 = 100$, from the above equation results $x_1 = 200$. Also if $x_1 = 200$, then x_2 must be 400. Similarly x_3 it is 800, x_4 is 1600, x_5 is 3200, and so on, each value being double as compared to the previous value. If the value of the variable is initial so that the same value is repeated period after period, the initial value is said to be the equilibrium value of the system. I mean $x_0 = x_1 = x_2,\ldots, x_n$ and so on $x_0 = x_e$, the equilibrium value. The equilibrium value is found by placing $x_{t+1} = x_t = x_e$ in the equation of difference. In the above case, the only balance value is $x_e = 0$. However, this balance is not stable in the above case. A slight variation above zero (or below zero) will set the system off balance. It is considered, by contrast, the system $x_{t+1} = 0.5\ x_t$. If $x_0 = 1$, $x_1 = 0.5$, $x_2 = 0.25$, $x_3 = 0{,}125$ and so on. A disturbance certainly results in an inverse movement at the equilibrium position towards zero.

- **Application to the basic national income model**

These concepts can now be applied immediately to a simple national income system. Suppose that a linear consumption function, of the form: $C_{t+1} = C_0 + cY_t$. We consider consumption in any year dependent on the revenues of the previous year. The linear form of the equation means that the graph of this consumption function is a straight line. The tendency to consume, "c", is a constant and it is assumed that there will be a certain consumption, C_0, even at zero income. Then we assume that the investment will be a constant "A". We know from the identity of the economy-investments that $Y_{t+1} = C_{t+1} + A$. By correlating the consumption function and the identity of the investment-economy, we obtain an equation of difference in national income, of the form:

$$Y_{t+1} = C_0 + A + cY_t \qquad (3)$$

The equilibrium value is determined by considering equality $Y_{t+1} = Y_t = Y_e$. We introduce this equality in equation (3) and thus we obtain:

$$Y_e = C_0 + A + cY_e \ sau \ Y_e = \frac{C_0 + A}{1 - c} \qquad (4)$$

An arithmetic example clarifies the dynamics of this system. To suppose $C_0 = 40$, $A = 20$, $c = 0.8$. The equilibrium value is $Y_e = 60 / (1\text{-}0.8) = 300$. Table 1 shows first the national income rate if we start from a point under equilibrium, suppose 200 and the evolution of

the national income rate if we start from a point above the value of the equilibrium, supposed 400.

Table 1. *Model of the dynamics of National Income*

National Income	Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
$C_0 + A$		60	60	60	60	60	60	60	60	60
$0.8(Y_t)$		160	176	189	199	207	214	219	223	226
Y_{t+1}	200	220	236	249	259	267	274	279	283	286
$C_0 + A$		60	60	60	60	60	60	60	60	60
$0.8(Y_t)$		320	304	291	281	273	266	261	257	254
Y_{t+1}	400	380	364	351	341	333	326	321	317	314

It will be observed that the equilibrium position is stable. A divergence from equilibrium, either above or below the equilibrium value, is established in moving forces to restore the equilibrium position. It will be observed that there is no cyclical movement. The national income is constantly approaching its equilibrium value at a diminishing rate.

Figure 1. *Balance curve*

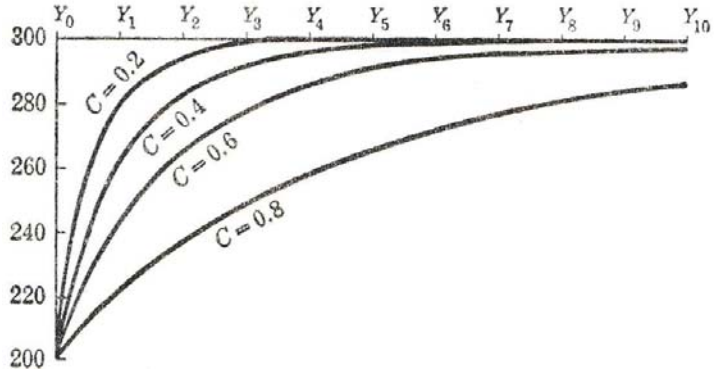
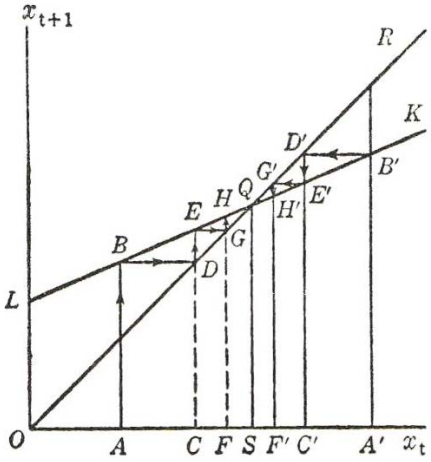


Figure 1 shows the curve towards a balance of 300 with a consumption ratio of 0.8, 0.6, 0.4 and 0.2. It is obvious that the lower the consumption trend, the faster the balance approach.

- **Graphical solution of dynamic models**

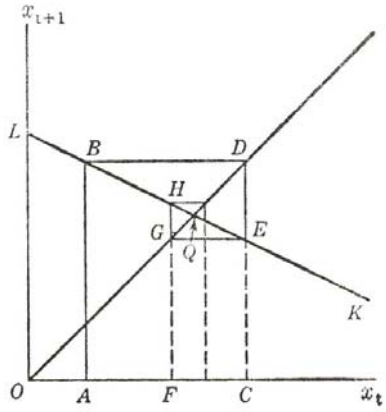
Systems where the difference equations refer to only two successive years can be solved by a simple graphical technique. Suppose we measure x_t horizontal and x_{t+1} on the vertical axis of Figure 2. The difference equation regarding these two quantities can be represented as a line on this graph. Suppose that in Figure 2, LK is such a line.

Figure 2. *The solution of the dynamic model with the slope of the positive line*



We will draw the 45 degree line from the origin, OR, which intersects HK in Q. Q is clearly the equilibrium value, because by the construction OS = SQ, then $x_t = x_{t+1}$. Now suppose that OA is the initial value x_0. If AB is drawn vertically to intersect HK in B, AB = x_1. If BD is drawn horizontally to intersect OA in D, we have by construction OC = CD = AB = x_1. If CD is drawn up to intersect HK in E, CE = x_2. Similarly, FH – x_2 and so on to the equilibrium at Q. Similarly, starting from a position superior to the equilibrium in A' successive positions x_0, x_1, x_2, x_3 are OA', A'B', C'E', F'H', and so on. The balance in Figure 2 is clearly stable. If the LK curve is steeper than 45 degrees where the right SA intersects, the balance is unstable.

Figure 3. *The solution of the dynamic model with the slope of the negative line*

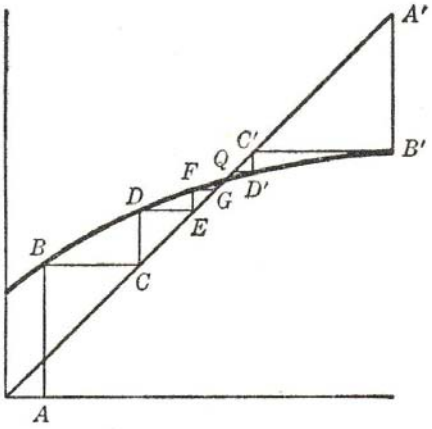


A curve expressing a differential equation can be called a differential curve. If the slope of the differential curve is negative, as shown in Figure 3, the movement towards or away from equilibrium follows a cyclical path.

Starting from an initial position x_0 = OA, we x_1 = AB (= OC), x_2 = CE (= OF), x_3 = FH and so on in a "cobweb" around the equilibrium point, Q. The famous "cobweb" theorem in price theory is just a special case of this kind of dynamic system. If the inclination of

the line LK is 45 degrees, then G it will intersect the right AB, and the cycle will repeat endlessly. If the inclination is higher than 45 degrees, then the cycle will be explosive and the balance will be unstable.

Figure 4. *Nonlinear dynamic model*



The graphical technique has the advantage that it can be applied as easily to differential linear equations. Thus, in Figure 4, we assumed that the differential curve has a downward slope. Regarding our economic model, this would mean that the marginal consumer slope has diminished with the increase of the income, considered an unpleasant hypothesis. Under these conditions, the lower balance approach, following the ABCDEF course, is slower than the higher approach, A'B'C'D. This suggests that the shortcomings of the system would be dynamic and rapid, as the resolution would be slow and prolonged. There is some evidence that business cycles tend to follow this pattern.

Also, from the analysis it turns out that a simple "multiplier" system cannot, by itself, produce a truly cyclical fluctuation about a balance unless the inclination to absorb it is negative, which is also an excessively low hypothesis.

- **Expected price cycles**

Accelerator models that show the evolution of market prices over time can be built along lines similar to those presented above. Suppose we change the market identity p in shape p_t , where $K = M / A$ is constant and $r_t = r_a / r_m$ is an intensity of the demand for net money for the goods. Suppose further that this coefficient of demand, r_t, is equal to a certain normal level of, r_0, plus a factor that is higher if the price is rising, lower if the price is falling. That is, suppose that people are projecting the price trend, so that the price increase will ensure the expectations of further growth, and thus an increase in demand, while the decrease of prices leads to a further expectation of decrease, and thus a demand decline. If these functions are linear, we can formalize the relationship:

$$r_t = r_0 + \alpha(p_t - p_{t-1}) \tag{5}$$

from where we deduce:

$$p_t = Kr_t = Kr_0 + K\alpha(p_t - p_{t-1})$$

or

$$p_t(1 - K\alpha) = Kr_0 + K\alpha p_{t-1} \quad (6)$$

This is a first degree differential linear equation. Therefore, the price course over time can be analyzed by a scheme similar to Figures 5 and 6.

Figure 5. *Price cycles*

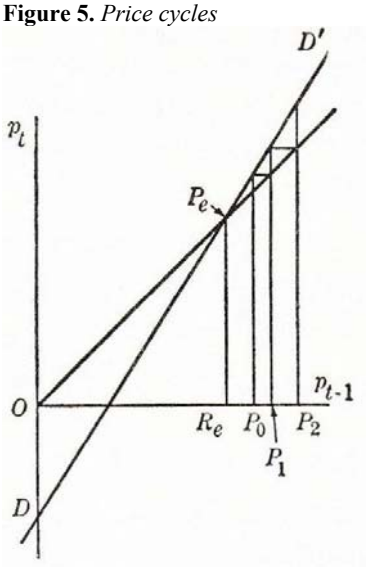
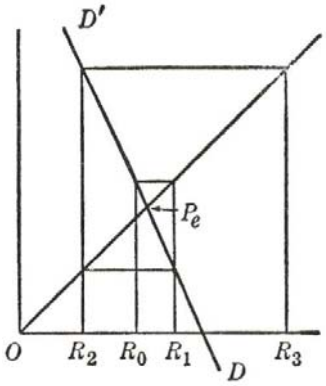


Figure 6. *Price cycles*



Thus in Figures 5 and 6 the line DD' is the curve of the difference corresponding to the equation (2). Kα > 1, the slope of the difference curve DD', -Kα / (1-Kα') will be positive, but less than 1, as in Figure 5. Therefore, the equilibrium at Pe will be unstable. If we start from a price above the equilibrium price, OR_e, to say, OP_0, further prices will be OP_1, OP_2, etc., so the price increases at an accelerated rate. Similarly, if we start from a price below equilibrium, the price will fall at an accelerated rate. As much as Kα is approaching 1, the line DD' becomes steeper, and the movement from equilibrium becomes faster, until Kα = 1 and DD' is vertical, and the balance is unstable. The price influences the change to infinite plus or minus, if it is disturbed at the equilibrium level.

With Kα < 1 a cyclic model will be configured, as in Figure 6. If Ka is between 0.5 and 1, the cycle will be explosive, as in the graph. The course from OR_0 is up to OR_1, beyond OR_0 up to OR_2, beyond OR_1 as far as OR_3 and so on. If Kα = 0.5, the cycle will be perpetual. Kα is between 0 and 0.5, the cycle will be amortized, as in Figure 2. As Kα the smaller, the faster the depreciated cycle. If Kα is zero, the price moves immediately into the equilibrium position, pe = Kr_0. If α is negative, so that rising prices lead to a drop, DD' will have a positive slope of less than 1, i.e. less than 45 degrees, and the price will move steadily to equilibrium, as in Figure 1. The sudden transition from high prices to low prices as in Figure 6, it is not particularly realistic. However, this is only the result of expressing the model in the form of a differential equation of the first degree. If we assume that r_t is a function α (p_{t-1} - p_{t-2}), and we say the relationship:

$$r_t = r_0 + \alpha(p_{t-1} - p_{t-2}) \quad (7)$$

we get a second degree difference equation,

$$p_t = Kr_0 + K\alpha(p_{t-1} - p_{t-2}) \quad (8)$$

One can test that this relationship produces a perpetual cycle if Kα = 1, an amortized cycle if Kα < 1 and an explosive cycle if Kα > 1.

Conclusions

From the study that was the basis of the present article, a number of theoretical and practical conclusions are drawn. From a theoretical point of view, it is suggested that these models are in fact a series of statistical-econometric relations systems, which suggest suggestively the correlation between the macroeconomic variables, divided between the resultant variables and the factorial variables, in a period of time.

The constitution of the model used is particular and it is based on an in-depth study of the data series and their graphical representations regarding the considered statistical variables. Also, from the analysis and the study carried out, it is concluded that these models should be well agreed, so as to provide successive stages of the path to reach a certain objective, but at the same time, allow the micro or macroeconomic management to correct the correlations of the variables so that they are subordinate to the purpose pursued.

From the examples given in this article, it is necessary to take measures to maintain the macroeconomic balance, context in which, the calculated regression parameters, as well as the calculated estimators to be real and applied to the concrete data, in order to be able to forecast for future evolution trends.

In other ideas, the conclusion is drawn that the problem of price cycles for the perspective are those that give additional essence to the statistical-econometric models used in macroeconomic analyzes. Of course, the analysis shows that a single multiplier system cannot produce a cyclical fluctuation, but it must be considered as a hypothesis of probable evolution in the next period.

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An analyses model of the Romanian privately managed pension system

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Abstract. *The Romanian privately managed pension system (Pillar II) is a system financed though the allocation towards the privately managed pension funds of a certain percentage from the contributions due by the participants to the public social insurance system. The main advantage of the system is represented by the fact that the amounts received by the pension funds will be better used, being invested by the pension management companies, which will ensure that he amounts saved by the participants will increase on the long run. Pillar II is compulsory for employees under 35 years old and optional for those between 35 and 45 years old, at the moment of enrolment. By contributing month after month until retirement, assets will be accumulated and will be multiplied through investments, ensuring a supplementary pension beside the public system one. The pension management companies are only authorized companies, in that way the investments will be made in a professional environment, towards profitable areas, ensuring the accumulated assets profitability. The number of participants at Pillar II is increasing since the inception of the system and this trend will continue at least on medium term. From the start of the system to the moment of the first pension payments, there were and there will only be a small number of participants, which received or will receive the assets accumulated in their accounts. Until the first participants enrolled will reach the legal retirement age, the amounts in their accounts will continue to grow, while efficiently invested, will offer a guarantee for a higher supplementary pension.*

Keywords: Pillar II, private pensions, participants, analysis, returns, contribution.

JEL Classification: J32, J11, C61.

Introduction

In this article we conducted a study regarding the Romania privately managed pension system, using different statistical instruments. We have analyzed the evolution of the number of participants, the participants age, the number of the participants automatically enrolled, the number of participants which opted to transfer from one pension fund to another, the total assets and the net assets value, as well as the average rate of return of the pension funds. We used pictures, tables as well as a series of statistical instruments such as dynamic series, indexes, etc.

In 2018, the international markets were characterized by a relative increased volatility, being affected by the Chinese market turbulences and in by the numerous discussions regarding Brexit. In Romania, the financial markets had positive evolutions based on an economic growth higher than the European Union average. The foreign exchange market and the stock exchange market had a volatility lower than the south-eastern and central European markets.

The evolution of the Romanian financial sector (assets over GDP), was positive in the last year. On the same trend was one of the main components of the non-banking financial sector, namely the private pension sector. This sector, with its main component – the privately managed pension funds (Pillar II) – aims to offer a private pension supplementary to the one offered by the public system. The implementation of the privately managed pension system represented a very important stage of the pension reform process in Romania, increasing the possibility to obtain a supplementary pension, also bearing in mind the unfavourable perspective of the demographic evolution, the birth rate decrease and the reduction of the active work force share in the total population. Moreover, the increase of the retiree number and the decrease of the employee number will result in lower amounts paid by the last category to the public pension system, while the payments made to the retirees will grow. In addition, the life expectancy is on a positive trend making the decision factors more aware with respect to the life standard of the elderly, idea underlined at the level of the European Union as well.

The Romanian privately manage pension system is a defined contribution system, meaning that the participants will benefit at the legal retirement age from a supplementary pension computed based on total assets accumulated in their accounts. The amounts found in the personal accounts are composed from the share transferred to Pillar II from the social insurance contribution and the results of the investments made with these amounts. Pillar II is organized as an accumulation and investment system, through individual accounts managed by authorized pension management companies. In that way, supplementary funds are accumulated in each participant account. The money found in the personal accounts will return to the participant, at the legal retirement age. All the amounts won as investment return will go back to the participants at the retirement moment. All these amounts will the used by the participants to buy a supplementary pension, which will be computed based on the amounts transferred as well as on the investment return produced by the pension management companies.

1. Literature review

Ambachtsheer (2007) have analysed the way in which could be crated well-governed pension fund. Barr and Diamond (2009) approached a series of aspects related to private pension reforms. Bauer, Cremers and Frehen (2010) conducted a study regarding the investment structure and performance of the pension funds. Chybalski (2011) pointed out the necessity of the diversification of the pension systems in the European Union for a better reaction against the economic crisis. Colomeischi (2014) analysed the evolution of the Romanian private pension system. Cristea and Thalassinos (2016) have highlighted the role of the private pensions on the financial markets. Heijdra and Romp (2008) investigated the impact of the demographic changes and of the private pensions on the macroeconomic trends. Hill (2007) investigated a similar subject. Naczyk and Domonkos (2015) presented the main characteristics of the private pensions systems. Nemény i (2011) analysed the economic effects of the ageing process in Romania. Orenstein (2011) studied the individual savings accounts. Stancu, Hașegan and Darmaz-Guzun (2019) conducted simulations of the Romanian pension system. Stewart (2014) analysed the investment activity of the pension funds. Yan (2008) studied the correlation between the size of the pension fund and their investment performance.

2. Research methodology, data, results and discussions

The evolution of the privately management pensions system in Romania had a positive trend during the period analyzed, namely 2008-2019, the number of participants and the net total assets increasing from one year to the other. Pillar II aims to ensure a tradeoff between the safety and the performance of the investment, to the benefit of the participants. Meanwhile the pension management companies have the purpose to protect the interest of the participants as well as to mitigate the potential risks, which could appear related to the investment process. Today, the Pillar II system has 7 pension management companies, each managing one pension fund, 3 authorized depositary and 5 authorized financial auditors.

At the end of June 2019, there were 7.34 million participants, an increase of 1.26% from the end of December 2018. At the end of June 2019 Pillar II net assets value was 55.14 billion lei, representing a share of 5.6% of the GDP, increasing from 5.12%, the percentage registered at the end of 2018. The annual rate of increase of the net assets value was 26.11% (June 2019 compared with June 2018), while the average monthly contribution of a participant in June 2019 was 182.2 lei. At the end of June 2019, the average value of a personal account in the Pillar II was 7,631 lei (1,621 euro), a jump of 14.36% from December 2018 value, while 5.52 million participants (76% from the total) had less than 10.000 lei in their accounts, the remaining 24% having more. From the former ones, 0.41 million had more than 25.000 lei accumulated, representing only 5.71% from the total. When we analyze the rate of return, it we observed that it increased to 3.5575% at the end of June 2019 from 2.7204% at the end of December 2018. Thus, on the short run, the pension management companies should intensify their efforts in their quest of finding better assets in terms of rate of return, in order to provide investments that are more efficient. More than half of the assets are invested in Romanian state bonds, which did perform reasonably well, yet new assets are to be found for an increase of the pension funds' average rate of return.

In the Pillar II system, it is compulsory to participate for all employees under 35 years old, while the participation is optional for those aged between 35 and 45 years old. In the table below, we present the number of participant, which increased every year, with a relatively constant rate.

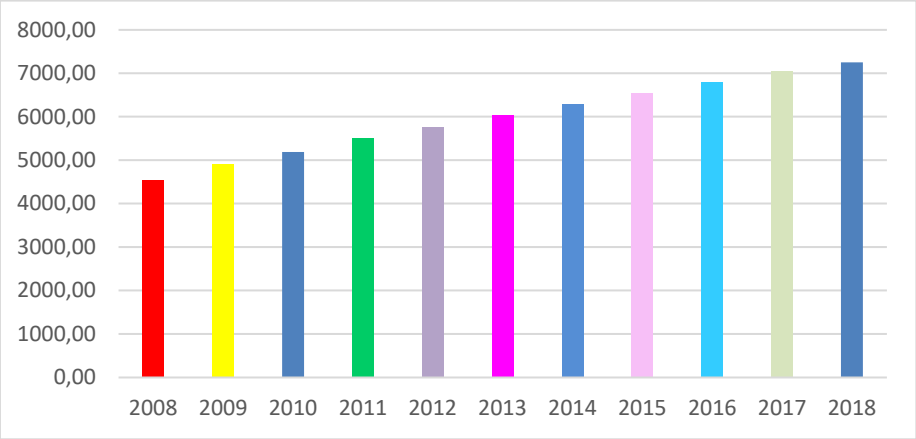
Table 1. *The number of participants and evolution in Pillar II between 2008 and 2018*

End of year	Number of participants (billions)	Rate of increase		Dynamic index		Modification rhythm	
		Fixed base	Year over Year	Fixed base (billions)	Year over Year (millions)	Fixed base	Year over Year
2008	4.53	-	-	-	-	-	-
2009	4.91	108.41	108.41	0.39	381.29	8.41	8.41
2010	5.19	114.44	105.56	0.655	273.22	14.44	5.56
2011	5.52	121.72	106.36	0.984	329.67	21.72	6.36
2012	5.77	127.38	104.65	1.241	256.47	27.38	4.65
2013	6.30	133.26	104.62	1.507	266.75	33.26	4.62
2014	6.29	138.86	104.20	1.761	253.88	38.86	4.20
2015	6.56	144.67	104.18	2.024	263.24	44.67	4.18
2016	6.80	150.01	103.69	2.267	242.06	50.01	3.69
2017	7.04	155.39	103.59	2.51	243.74	55.39	3.59
2018	7.25	159.99	102.96	2.718	208.12	59.99	2.96

Source: Romanian Financial Supervisory Authority, 2019, own computation.

From 2008 to 2018, the number of participants steadily increased. From the initial 4,531,800 participants registered at the end of 2008 (the first year of the Pillar II system), the number of participants increased to 7,250,300 at the end of 2018.The rate of increase calculated with a fix base (the index of 100% being set for 2008), ranging from 108.41% in 2009 to 159.99% in 2018. When we analyse the increase in a year over year perspective, we can observe that between 2009 and 2015 the increase was between 4.62% and 8.41%, while in the last 3 years it decreased, ranging from 3.69% to 2.96%. The evolution of the number of participants in also presented in the picture below.

Figure 1. *The evolution of the total number of participants at Pillar II between 2008 and 2018*



Source: Romanian Financial Supervisory Authority, 2019, own representation.

In the table below we analyses the distribution of the number of participants on age groups in the last 10 years. We observed that in both categories the number of participants increased, yet the percentage of people aged above 35 years old increased.

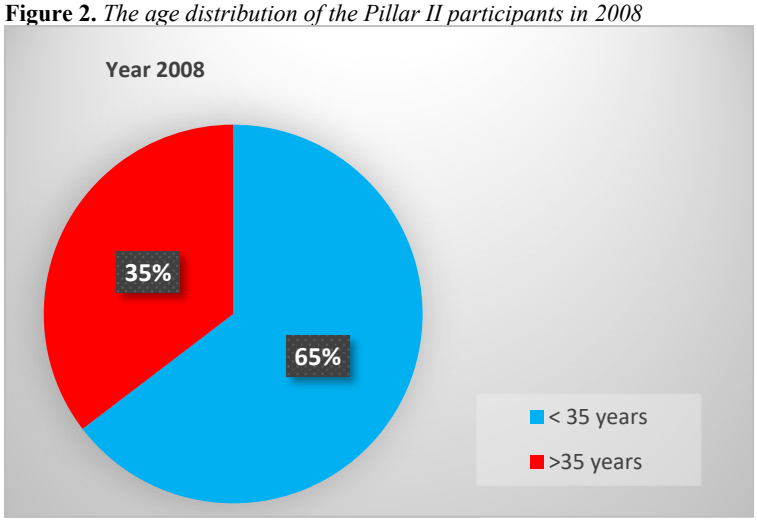
Table 2. *The distribution of the number of participants on age groups between 2008 and 2018*

End of year	< 35 years (billions)	> 35 years (billions)
2008	2.929	1.603
2009	3.063	1.850
2010	3.084	2.103
2011	3.161	2.355
2012	3.180	2.592
2013	3.190	2.849
2014	3.193	3.100
2015	3.206	3.351
2016	3.209	3.589
2017	3.226	3.816
2018	3.218	4.032

Source: Romanian Financial Supervisory Authority, 2019, own computation.

We also compare in a graphical way the age structure of the participants for 2008 and for 2018.

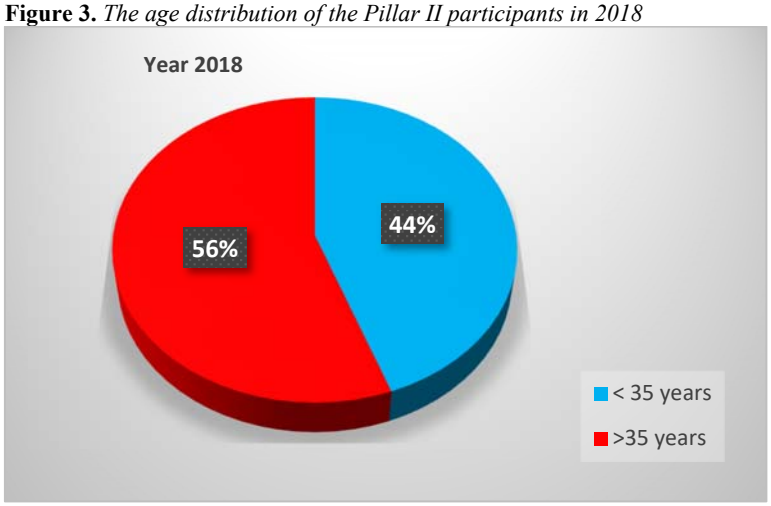
Figure 2. *The age distribution of the Pillar II participants in 2008*



Source: Romanian Financial Supervisory Authority, 2019, own representation.

We observed that compared with 2008, in 2018 the shares of person aged under 35 decrease from 65% to 44%.

Figure 3. *The age distribution of the Pillar II participants in 2018*



Source: Romanian Financial Supervisory Authority, 2019, own representation.

Another indicator that we analysed is the number of participants who were automatically enrolled in Pillar II every December between 2008 and 2018. This indicator shows a possible issue of the system, because the number of automatically enrolled participants being relatively large. We presented the data in Table 3.

Table 3. *The number of automatically enrolled participants between 2008 and 2018*

December	The number of automatically enrolled participants
2008	53,596
2009	20,949
2010	18,860
2011	29,400
2012	29,668
2013	35,626
2014	37,846
2015	45,519
2016	35,276
2017	41,740
2018	33,591

Source: Romanian Financial Supervisory Authority, 2019.

A fair indicator regarding the stability of the participant's choices on enrolment is the number of participants, which chose to switch the pension fund. We present the data in Table 4, and we observed that although there are some participants who decided to switch the fund, the level is very low compared with the total number of participants.

Table 4. *Pension fund transfers between 2009 and 2018*

December	Total
2009	124
2010	115
2011	246

December	Total
2012	372
2013	101
2014	94
2015	78
2016	107
2017	94
2018	107

Source: Romanian Financial Supervisory Authority, 2019.

The evolution of the total assets and of the net assets value is highly important. We present the data for the period 2008-2018 in Table 5. We noticed that the net asset value increased from 0.83 billion lei in 2008 to 47.58 billion lei at the end of 2018.

Table 5. *Total assets and net assets value in Pillar II from 2008 to 2018*

End of year	Total assets (billions)	Net assets (billions)
2008	0.832	831.9
2009	2.386	2.384
2010	4.504	4.332
2011	6.420	6.416
2012	9.642	9.637
2013	13.946	13.939
2014	19.127	19.118
2015	24.686	24.674
2016	31.481	31.466
2017	39.760	39.741
2018	47.601	47.577

Source: Romanian Financial Supervisory Authority, 2019.

We also analyzed the value of the total contribution in the last month of each year between 2008 and 2018, as well as the average contribution per participant in the same month for Pillar II. At the beginning of the system, both indicators were relatively low, yet after 10 years, the increase is enormous: over five times both for the total contribution and for the average contribution per employee. In Table 6, we present the data for the whole period.

Table 6. *The total contribution and the average contribution per participant in December between 2008 and 2018*

December	Total contribution to the system (millions lei)	Average contribution per participant (lei)
2008	110.6	32.2
2009	107.2	31.6
2010	132.4	39.57
2011	173.53	50.11
2012	217.40	60.85
2013	299.62	80.61
2014	339.22	89.41

2015	446.08	113.21
2016	513.55	128.45
2017	624.03	153.97
2018	656.10	159.75

Source: Romanian Financial Supervisory Authority, 2019.

Another paramount indicator of the Pillar II pension system is the rate of return of the pension funds. The pension management companies have as one of their main objective the increase of the participant assets' value. In the table below we present the weighted average rate of return of the Pillar II, computed for the last 24 months, in accordance with the legal requirements, thus this indicator is only available starting with 2010. In the first 5 years, the returns delivered by the pension fund management companies were encouraging, with a peak of 15.1% in 2010. Yet, starting with 2016, the results were relatively low, with a very disappointing result (2.72%) in 2018.

Table 7. *The weighted average rate of return of the Pillar II pension funds computed for the last 24 months*

End of year	%
2010	15.0991
2011	8.5636
2012	6.7106
2013	10.4535
2014	9.2276
2015	6.1493
2016	3.7338
2017	3.9543
2018	2.7204

Source: Romanian Financial Supervisory Authority, 2019.

In our analyzing model of the efficiency of Pillar II in Romania we studied the following statistical indicator: the number of participants, the increase of the number of participants (computed with a fixed based and year over year), the distribution of the participants on age groups, the number of participants who chose to transfer, the number of participants who were automatically enrolled, the total assets and the net assets value, the average contribution per system and per participant, and the weighted average rate of return. The series of data analysed were 10 years long (the age of the system), which are long enough to provide relevant evolution trends, especially for the future. All this statistical indicators studied revealed to us the soundness of the Pillar II pension system in Romania, as well as its efficiency. Thus, we can argue that the participants will have in their personal accounts the amounts needed for a supplementary pension at age of retirement.

Conclusions

In this article, we have used an analysing model based on the dynamics of a series of relevant indicators for the Pillar II pension system. Studying the data, we can conclude that the assets accumulated in the privately managed pension funds have experienced a constant

increase in the analysed period (10 years), due to increase of the contribution and to good investment results. Thus, if the decision factors will analyse in the future the increase of the percentage transferred to Pillar II, the participants could benefit from a better supplementary pension when reaching the retirement age.

The privately manage pension system is now in the accusation phase, thus the actual effect of pension payments will have to be analysed based on empirical data at a future time. On the other hand, one of the component of the assets accumulated in the pension accounts is the investment results. Thus, the analysis of the efficiency of the returns delivered by the pension management companies is crucial. The level of the returns have to be compared with market returns and have to ensure the participants that the assets are invested in a proper manner, in order to increase the value of the personal accounts.

This study could be extended by using a series of regression, considering that in the privately manage pension system some variables could be correlated and evolving in the same direction. Thus, in the future studies we can build a multiple regression analysis for computing evolution parameters, for anticipating the development of the Pillar II pension funds.

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Dynamic models used in analysis capital and population

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Abstract. *From the production function of Cobb-Douglas, we know that production is based on three essential factors. These are the population, capital and financial-material resources. In this article, the authors are concerned about the possibility of establishing a dynamic macroeconomic model in order to analyze the evolution and especially the role of capital and population in the development of the economy. When we speak of development of the economy we apply the general principle that it is a goal of the whole economic activity regardless of countries, geographical areas, development level of each country, the objectives of international bodies and so on.*
The model used in the study of capital is one that has to be established taking into account the trend up to this moment of the analysis, which according to the factors considered to ensure an increase consequently for the next period. This model must take into account the effect of capital, how it is constituted and especially the harmonized way in which capital is distributed within a national economy, based on the strategy of sustainable or complex economic development in each case.
The study of capital is a basic element that ensures an increase in correlation with the other two factors that we talked about future development conditions.
As far as the population problem is concerned, this is a defining one in terms of securing the labor force reserve, securing the reserves for the active or employed population. The population increases or decreases according to the birth rate. Natality in turn increases or decreases depending on the existing socio-economic conditions or other aspects to be considered.
In the dynamic models used we have to take into account how the population of a country, continent or world population has evolved in order to be able to predict what will happen in the next period. Of course, the change of population is made through inputs (births) and exits (deaths or emigration in the case of a study located in a country or continent).
We assume that in order to ensure a proper balance and evolution of the population, it is necessary to take a series of stimulatory measures to ensure the direction of this future evolution. Of course, population growth is determined by a series of statistical variables that taken and included in the analysis model give the perspective of identifying the future evolution trends of this very important indicator at the level of a nation.

Keywords: dynamic models, capital, production, goods, cycle, oscillations, birth, death.

JEL Classification: C52, J10, J13.

Introduction

In the case of this article, the authors have departed from the general principles for substantiating the dynamic models and their use at the macroeconomic level. Of course, by saying at the macroeconomic level, this means that dynamic models can be used in the study of capital and population to establish the evolution strategy at the country level.

The article progressively went by identifying the resultant variable that is capital and trying to suggest certain variables, measures that can lead to the increase of the resultant variable. At the same time, short series of data, easy-to-understand and interpreted examples were used to suggest how dynamic models can be used in capital analysis.

As we said before, capital must be correlated with resources and labor. We realize that if the forecasts are made randomly, it results either the insufficiency of a factor of the three mentioned ones, or an excess of one of them that by non-use bring any decreases or negative elements of evolution.

The dynamic model of capital analysis must be correlated with the dynamic analysis model of labor (population) and material and financial resources. Permanently in the models constituted and analyzed on the basis of the parameters (regressive coefficients) of evolution, we will ensure a balanced growth of the economy.

We paid attention to this factor, the capital, because even in the case of Romania, the problem arises that some distortions within the national economy are based on the fact that we do not have investment capital that ensures the increase in the number of jobs, the quality of jobs, the quality of the personnel used, the increase of wages, the increase of the tax base on the basis of the national wage fund and many others.

In the article on the dynamic models used in the analysis of capital and population, the authors started the study regarding the population starting from its genesis at some point, the pyramid of ages represented by the population at any time, from a static analysis and a dynamic analysis.

The population study is a very important one that should not be lacking in any macroeconomic forecast, because by the way the population evolves new contingents (cohorts) of population are created. It depends first and foremost on female birth. It is clear that the analysis can be directed on the basis of a model that takes into account the resultant variables population and factors including female fertility in a country, an organized structure, a continent or worldwide.

There are in the evolution of the population and other factorial variables that the authors have studied concretely and have highlighted the way in which this problem is put.

After all, the article looks at how these dynamic models are constructed and then how these dynamic models are used in population study. As factorial variables besides birth, which is the most important, we also consider others, income, health, climatic conditions and all other causes, including female psychology, couples psychology in the sense of wanting to increase or decrease the population.

From the article it is very clear that the dynamic model used in the population analysis must be constructed after a precise study has been done on the previous evolution of the resultant variable, the population, according to the determining factors. This, together with graphical representations, gave the possibility of a quicker understanding of the correlation that exists between the variables considered, the resultant one and the factorial one, so that the forecast is carried out in the future to cover and ensure a population growth in the considered terms.

This study can be used for static analysis of population structure but also for forecasting analysis in which to identify trends of population evolution in a country, on a continent or worldwide.

In this article, the authors considered some short examples that validate the considered considerations and constitute a basis for the dynamic models that can be used in the population study.

1. Literature review

Andersen, Borgan, Gill and Keiding (1993) approache the analysis of statistical models that are based on counting processes. Anghelache and Anghel (2018) approaches in their work some methods and models for analyzing the quality of life in Romania. Anghelache and Anghel (2019) addresses issues related to economic modeling. Anghelache, Anghel, M.G. et al (2018) are studying the population with indicators of residence and residence. Anghelache and Anghel (2018) approaches the econometric modeling of various economic phenomena. Anghelache, Anghelache and Bârsan (2019) analyzes models used in dynamic series analysis. Anghel, Anghelache, Avram, Burea and Marinescu (2018) addresses some aspects regarding the natural circulation of the population, the labor force and the vacancies in the economy. Barndorff-Neilsen, Hansen, Lunde and Shephard (2008) analyzes in their work the ex-post variation of equity prices in the presence of noise. Black (1972) analyzes the balance of the capital market under the conditions of restricted loans. Iacob (2019) approaches various methods and models of statistical-econometric analysis of economic phenomena. Linton (2016) is concerned in his work with probabilistic statistical-econometric analyzes. Stambaugh and Yuan (2017) raises the issue of factors not taken into account that influence the various economic phenomena.

2. Research methodology, data, results and discussions

The analysis of capital and population is important not only for the perspective of the evolution of human populations, but because it can be applied to all kinds of populations. In economics, the analysis is of particular importance in the theory of capital, because all capital goods of all types can be considered populations. This means that it must be reasonable to assume stable, or moderately, stable relationships between the age of the goods and their rates of consumption or survival. In most cases, this assumption is by no means unjustified. Thus, cars form a population, in which the age of each car can be

determined with some precision and in which "life tables" or "survival tables" can be constructed and show what proportion of cars produced in any year will survive in others. years or will "die" in other years.

- **The functions of capital creation**

Commodity populations differ from biological populations, especially in the totally different nature of their birth functions. In biological populations, as we have shown, it is reasonable to assume that the number of births in any given year is a function of the numbers in the different age groups of the population.

Simple birth functions can be considered in the case of physical capital, producing patterns of population movement that throw away much of the processes of the real world. Suppose, for example, that the production of any good fulfills two functions: one to replace those items that were used during the period, and the other to add the total stock in response to increased demand. The first can be called "replacement production", the second "expansion production". The total production in any year will be the sum of these two quantities, the second of them, of course, will be negative in case of a diminished demand. If the demand for the good in question is constantly assumed, so that the total stock is kept at a constant level, the number of births in any year will be equal to the number of disposals in that year.

Table 1. *Cycle of goods*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	5–6	Total	Production
0								100
1	100						100	100
2	100	100					200	100
3	100	100	100				300	100
4	100	100	100	100			400	100
5	100	100	100	100	100		500	100
6	100	100	100	100	100	0	500	200
7	200	100	100	100	100	0	600	100
8	100	200	100	100	100	0	600	100
9	100	100	200	100	100	0	600	100
10	100	100	100	200	100	0	600	100
11	100	100	100	100	200	0	600	200
12	200	100	100	100	100	0	600	100
13	100	200	100	100	100	0	600	100

Table 1 presents an interesting model of a population of goods, i.e. goods that are used up to a given lifespan (five years in the table) and then classified. In terms of analysis, the function of use is given by $k_1 = k_2 = k_3 = k_4 = k_5 = 1$, $k_6 = 0$. Suppose the production is 100 units per year for the first six years. It is obvious that until the fifth year a population of

equilibrium has been reached and that, if the total population is maintained at 500 units, this equilibrium will continue endlessly, with 100 units to be used and 100 to be produced in each year. We will assume an increase in demand for this item in year 6, which leads to an increase of the total population from 500 to 600. This can only be obtained by increasing the production in that year from 100 to 200. This cohort of 200 passes gradually through the age distribution, being 0-1 years in year 7, 1-2 years in year 8 and so on, until it is finally used in year 11. Every year, between 7 and 10, 100 units are classifies and, since the population is only maintained as a number, there must be 100. In the year 11, however, 200 are worn out and 200 must be produced. every fifth year and 100 in the intervening years. Similar cycles will be created wherever there is a distortion in the age distribution, regardless of the cause.

- **Distortions follow a too rapid increase**

Table 2. *The cycle of goods with a constant growth*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	5–6	Total	Production
6	100	100	100	100	100	0	500	120
7	120	100	100	100	100	0	520	120
8	120	120	100	100	100	0	540	120
9	120	120	120	100	100	0	560	120
10	120	120	120	120	100	0	580	120
11	120	120	120	120	120	0	600	120
12	120	120	120	120	120	0	600	120

It should be noted that the distortion results from the attempt to increase the total stock too quickly. If instead of producing 200 in year 6, every year 120 would have been produced, in year 11 a new equilibrium position would be reached which would be permanent and there would be no cycle of establishment. This is illustrated in Table 2. The number in each age group is increased by an equal amount, and the relative age distribution (the proportion of total stock in each age group) remains the same.

- **Damaged oscillations**

The conclusions are substantially modified if we relax the assumption that the commodity is a certain product that lasts a certain number of years and then disappears immediately from the spot. Just as in human life, not everyone lives within the allotted range and some go beyond it, as in the case of some goods, some are out of existence after a short time, while others last longer.

Cars, like people, have a life of use, some have worn out in the first year of their existence, others are still on the road after 20 years. It is not difficult to show that the result of this modification of the initial assumption is to give us not a perpetual cycle, but a damped oscillation, that is, a cycle in which the amplitude decreases continuously as time passes. If there were no other distortions, then the use would gradually change back into balance. Probably, there are new distortions, causing new cycles.

- **The principle of acceleration**

The effect of distortions on the age distribution of goods is accentuated by another principle that underlies the "acceleration principle". If a commodity, B, is necessary for the production of another commodity, A, then the fluctuations of production A will be reflected by the intensified fluctuations of the production of B. Let us refer again to the previous example. Suppose that to produce 10 units of this commodity we must have a machine, B.

Table 3. *Accelerator*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	5–6	Total	(Idle)	Pro-duction
4	2	2	2	2	2	0	10	(0)	2
5	2	2	2	2	2	0	10	(0)	12
6	12	2	2	2	2	0	20	(0)	0
7	0	12	2	2	2	0	18	(8)	0
8	0	0	12	2	2	0	16	(6)	0
9	0	0	0	12	2	0	14	(4)	0
10	0	0	0	0	12	0	12	(2)	20
11	20	0	0	0	0	0	20	(0)	0
12	0	20	0	0	0	0	20	(10)	0

According to Table 1, when 100 units of product A are produced, a stock of 10 machines is required. However, when 200 are produced in year 6, 20 cars are required. If we assume that the machine also has a life of 5 years and that it had an age distribution in equilibrium, it is easy to see in Table 3 that there will be a very large distortion in the age distribution and a consistent recurring cycle. In year 4, everything is in balance. Then, in year 5, the number of cars must increase from 10 to 20, waiting for the increase of the production of goods A from 100 to 200 units in year 6. The production in that year must therefore be 12 cars - 2 for substitutes and 10 to extend the number from 10 to 20. Then, in year 6, the number of machines is 20, but no production is needed at all, because in year 7 only 10 machines will be needed to produce those 100 units of freight A Therefore, there will be no production of cars in years 7-10. In year 7 there will be 18 cars. In year 8 there will be 16 machines, 2 being classified, with 6 inactive, and so on until year 10, when 20 cars have to be manufactured, as the 12 products in year 6 disappear, the stock being zero. In year 11, 20 machines must produce the 200 units of freight A. Here again, a perpetual cycle is configured with 20 machines produced every five years, not produced at all in the intermediate years and on average 4 cars.

If we assume that the production of the goods A is distributed as in Table 2, so that it does not result in the distortion of its age distribution, however, there will be a distortion in the age distribution of the machine, B, as shown in Table 4.

Table 4. *Second accelerator*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	Total Stock	Pro-duction
4	2	2	2	2	2	10	2
5	2	2	2	2	2	10	4
6	4	2	2	2	2	12	2
7	2	4	2	2	2	12	2
8	2	2	4	2	2	12	2
9	2	2	2	4	2	12	2
10	2	2	2	2	4	12	4
11	4	2	2	2	2	12	2
12	2	4	2	2	2	12	2

Now a stock of 12 machines is required each year to produce the 120 units of freight A. In year 5, therefore, the production of cars will increase from 2 to 4 units, and this will be repeated every five years. In this case, the fluctuation is not as intense as in Table 3. However, if we now assume that a machine tool, C, is required to produce machine B, the fluctuations at the output of the machine tool will be much greater than fluctuations at the output of the machine.

The smoother life tables of reality work to cushion and smooth these oscillations. It is true, even in the general case, that machine tool output fluctuations are greater than machine output fluctuations, and machine output fluctuations are greater than the production fluctuations of the goods they perform. This principle is called the acceleration principle, because the demand for cars depends not only on the demand for their product, but also on the rate of change in demand for the product. It is clear that the problem of adjusting the growth rates of stocks of various types of commodities, is necessary in order to avoid changing the age distributions. In this sense, a certain fluctuation of economic activity is a necessary cost of economic progress, which will be greater as we try to move faster.

- **Age distribution distortions**

In the case of both human populations and goods populations, distorting the age distribution for any cause can take a long time. The sudden drop in infant mortality in many tropical countries around the 1950s creates a youth problem in the 1960s; even in the United States, rising births in the 1940s creates a problem of unemployment among young people in the 1960s, as an unusual number of young people reach a labor market that is adjusted to a smaller number of participants. The fact that virtually no cars were produced in the United States in the years 1942-45 due to the war created difficulties in Detroit in 1958-60, when there were no cars in the age groups with the highest rate. disposal.

Distribution distortions over time sometimes produce what is called the “shadow effect” in the second generation; thus, high birth rates in the 1940s in the United States produced high rates of marriage and high birth rates in the 1960s-70s, when children in their 40s were fertile. At present, the United States has balanced in terms of birth, but also of production, as well as of international trade.

In Europe, the evolution of production as well as population growth raises a number of problems. The European Union aims at increasing production and population. In the last decade of the 21st century, the fertility rate decreased. Europe is facing a high wave of immigration that seems to be changing the population structure on the old continent.

Models of population analysis and production of goods are topical despite the distribution distortions.

- **The Austrian theory of capital**

The analysis of capital as a population of goods has importance in interpreting the Austrian theory of capital, mainly associated with the name Bohm-Bawerk. According to this conception, capital is created when the "original factors of production" (labor and land) are incorporated into goods and is destroyed when the services of these factors are finally realized. Therefore, capital is considered as a value population, where values are created when the factors of production are employed and disappear when the services are provided. The average production period is then the age of disappearance of the values, that is, the average time that elapses between the employment of a production factor and the final consumption as a utility. Thus, the bread I eat today represents the services of delivery people this morning, yesterday's bakers, last month's millers, farmers last year and so on. The average age of the services incorporated in bread is the average period of production.

In a population with a stable equilibrium, the average age at the exit is equal to the ratio of the total population to the annual number of inputs or outputs. Thus, if 100 units appear and disappear from a population every year, and the average age at death is 30 years, the total population will be 3000. In the steady state, therefore, the ratio between total capital (total population of value) at the annual income (the income of the factors or the consumption of the product) is equal to the average period of production (the average life of the considered values).

If the average production period is extended, this must mean either an increase of the total capital, if the income is constant, or a decrease of the income, if the capital is constant. It has been tried to interpret the depressions with regard to a decrease of the income required by an over-expansion of the production period with an inadequate capital stock. The possibility of such difficulties cannot be ruled out. However, the normal depressions of the business cycle seem to be quite different. The basic difficulty regarding the analysis of the production period is that it is valid only in the steady state and is an analytical device too crude to cope with the complex movements of the dynamic systems.

- **Dynamic models and risk factor**

The models of differential equations are useful to draw attention to certain possible patterns in the dynamic systems of the economy. However, we should be careful not to place too much importance on them, as predictors, because the parameters of social systems can change in quite unpredictable ways. Thus, many years ago, many predictions were made about the future population that proved to be inaccurate, mainly due to a rather unexpected increase in fertility. In addition, purely mechanical dynamic systems, which are very successful in describing and predicting the solar system, where second- or third-degree

differential equations are necessary, but inadequate to describe the complex processes of social systems, where current behavior may depend of the memories and recordings that go back many years in the past.

Human history is a dynamic system of almost infinite degree and, for this reason, it has a great element of unpredictability. However, it is not entirely unpredictable, and the analysis can at least give us some conditional predictions of the form. In addition, the overall dynamic process of the company can usually be interpreted in terms of stress adjustments. Here we see that mechanical dynamics does not shift the analysis of equilibrium to the extent that precipitation can be interpreted as a divergence between the current state of a system and its equilibrium state. Until a moment, the precipitation cannot produce any change, the resistance to a change is too high for the precipitation to be exceeded. At one point, precipitation exceeds resistance and change occurs. Such systems are sometimes called resistive systems, because the voltage must reach a certain stage before any change occurs. After it has been achieved a certain adjustment of the system must be made, and the principle here is that what is adjusted is adjustable, that is, those parts of the system that have the least influence will adjust the first.

For example, in a competitive market, prices are adjustable and any concern in the form of a deficit or surplus will change prices. In monopoly or organized markets, prices are not easy to adjust and can produce adjustments of preferences or from a technological point of view. A deflation of income will lead to a fall in prices and wages if they are adjustable and a decrease in output and employment if prices and wages are not adjustable. Pressure for change sometimes results in increased resistance to change, and sometimes low resistance. Given these complexities and uncertainties, it is clear that mechanical dynamic models should be treated as solutions rather than predictors.

A very important area of dynamic analysis covers the theory of movements of a population. A population can be defined as any aggregate that can be measured in a common unit and in which the age of each unit can be identified or at least defined. The age of a unit is the length of time that has elapsed between a certain “current” date and the “birth” date or entry of the unit into the population. In all ordinary populations, it is generally defined that each unit has a finite age of “death” or exit from the population. Birth and death in this sense does not necessarily mean the creation or destruction of the unit in question, but refers to the dates on which the unit begins to conform or ceases to conform to the definition of the aggregate that constitutes the population. Thus, if our aggregate is the human population from a finite area, the entry of an immigrant is a “birth” and the exit of an emigrant a “death” in that population, as much as the physiological births and deaths, with one important difference: births naturally result in individuals of zero age, while immigrants can add members of any human age to the population.

The dynamic analysis of population movements is based on the postulate of certain stable equations of difference. We can determine a stable “survival function”, which shows how many units survive to each age from a certain number of births. Thus, out of 100 births, 90 can survive for up to one year, 85 for two years, 81 for three years and so on until the last survivors. The survival function is thus constructed from a series of differential form equations:

$$a_1 = k_1 a_0, a_2 = k_2 a_0, \dots, a_n = k_n a_0 \quad (1)$$

where a_n is the number that survives until the year n from a total number of births, B_0, in year 0. In the simplest form of the function, the survival coefficients, k_1, k_2, ..., k_n they are constant. The number that dies or leaves the population, outside the group that is r in year t, between the year t and $t+1$ it is at $a_r - a_{r+1}$ or $k_r a_0 - kr_{+1} a_0$ or $(k_r - k_{r+1} / k_r)\, a_r$.

- **Dynamics of a stable population**

If we consider a "birth function" regarding the number of births in a given year with the number or structure of the population, the whole evolution of the population can be sketched. The process can be illustrated by mathematical examples.

We will consider the situation presented in Table 5. Each row in this table represents the numbers in a population divided into five age groups. We consider that in year 1 there are 100 units between 0 and 1 year, 96 between 1 and 2.66 between 2 and 3.56 between 3 and 4, 30 between 4 and 5, and none older than 5 years. The arrows marked by the arrows show the survival distributions of each cohort or group in the population that has the same year of birth. Thus, suppose that out of 100 people aged 0 to 1 at the end of the year, 1.80 survive to the end of the year 2, 60 to the end of the year 3, 40 to the end of 4, 20 to the end of year 5, and none until the end of year 6. If the "net births", B, are defined every year between 0 and 1 year at the end of the year, then suppose that the survival function in the above table is given by $k_1 = 1$, $k_2 = 0.8$, $k_3 = 0.6$, $k_4 = 0.4$, $k_5 = 0.2$, $k_6 = 0$. The figures in parentheses at the top of the table show the net births from which age groups from year 1 are descending, if the survival function is assumed to be constant. Thus, if in year 1 there are 96 units between 1 and 2 years, they must be the survivors of a cohort of 120 births in the previous year: 96 = 120 (0.8). In year 2, then, the numbers between 2 and 3 years must be 72 [= 120 (0.6)], and in year 3, the numbers between 3 and 4 must be 48 [= 120 (0.4)] and so on.

Table 5. *Stable population*

	Age (Years)						
Year	0–1	1–2 (120)	2–3 (110)	3–4 (140)	4–5 (150)	5+	Total
1	100	96	66	56	30	0	348
2	100	80	72	44	28	0	324
3	100	80	60	48	22	0	310
4	100	80	60	40	24	0	304
5	100	80	60	40	20	0	300
6	100	80	60	40	20	0	300

The same process can also be described using a death function. Thus, if a number (0.6) 8 ages 2-3 becomes (0, a) B by the end of the following year, (0.2) B died during that year – that is, one third of the number 2 – 2 years 3. Thus, of the 66 2-3 years in year 1, 22 will die in the following year, leaving 44 survivors aged 3-4 years in year 2. In Table 6 we

assumed that the number of net births after the year 1 is constant at 100 per year. In this hypothesis it is evident that the population is soon established at a balance value of 300, in which the same age group is repeated year by year. A population of equilibrium can be defined as one in which the number of births and deaths per year is equal and constant and in which the numbers in each age group are also constant.

- **Population dynamics: population growth**

Suppose now that the number of births each year is not constant, but is a function of the numbers of different age groups. As long as this function is known and stable, it is still possible to track the course of any population over time, so suppose (Table 5) that after year 6, the number of births in each year was equal to the number total of units in the age groups 2-3 and 3-4 years. In year 7, the number of births would still be 100 [= 60 + 40], and the population will be in balance. So the number of births was equal to the number of units in the age groups 1-2 and 2-3. The population would follow the course in Table 6.

In this table, the first figure in each row (after the first) is equal to the sum of the age groups 1-2 and 2-3 of the previous year. Thus 140 = 80+ 60, 172 = 112 + 60 and so on.

Table 6. *Population expansion*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	5+	Total
6	100	80	60	40	20	0	300
7	140	80	60	40	20	0	340
8	140	112	60	40	20	0	372
9	172	112	84	40	20	0	428
10	196	138	84	56	20	0	494
11	222	157	103	56	28	0	566

It is assumed that all those born during one year are between 0 and 1 in the following year. The survival function is assumed to be the same as in Table 6. It is obvious that, based on these assumptions, the population will grow endlessly. Each birth increase offers a larger age group as the basis for births and more.

- **Decreasing population**

Suppose that the number of births in each year is equal to the numbers in the 3-4 and 4-5 age groups. The population will follow the course in Table 7. In this case, each birth cohort produces less than its own number to replace it, and the population will decrease continuously.

Table 7. *Decreasing population*

Year	Age (Years) 0–1	1–2	2–3	3–4	4–5	5+	Total
6	100	80	60	40	20	0	300
7	60	80	60	40	20	0	260
8	60	48	60	40	20	0	228
9	60	48	36	40	20	0	204
10	60	48	36	24	20	0	188
11	44	48	36	24	12	0	164
12	36	35	36	24	12	0	143

- **Algebraic solution**

It is not difficult to formulate the conditions in which the populations will expand, contract or stay under stable functions of birth or survival. May it be a_1, a_2,..., a_n, be the numbers in the nine age groups of a population. Then the birth function can be described by a series of constants, b_1, b_2,..., b_n, the relationship results:

$$B = b_1a_1 + b_2a_2 + \cdots + b_na_n \quad (2)$$

This is the simplest useful form of the function. Some of the variables may be zero, and in a biological population they will be the largest in the most fertile age groups. The complication introduced by the necessity of the cooperation of two sexes is neglected here. In these conditions we define a survival function, as a set of constants, k_1, k_2,..., k_n. Therefore, we have the relationship:

$$a_1 = k_1B_{t-1}, a_2 = k_2B_{t-2}, \dots a_n = k_nB_{t-n} \quad (3)$$

It follows, combining equations (2) and (3), that

$$B_t = b_1k_1B_{t-1} + b_2k_2B_{t-2} + \cdots + b_nk_nB_{t-n} \quad (4)$$

If the population is stable, it results:

$$R = b_1k_1 + b_2k_2 + \cdots + b_nk_n = 1 \quad (5)$$

- **The net reproduction report**

The quantity, R, is a measure of the net reproduction ratio. In a balanced population, the survival distribution of each birth group is the same as the age distribution in any year. We see this in Table 5, where it is clear that the distribution of survival, once the population has a balance (the series on the marked diagonals), is the same as the age distribution: 100, 80, 60, 40, 20, 0. In a population of balance, R measures the number of net births at which each cohort of the population is born. If R = 1, the population reproduces only: each generation as it dies leaves a new generation of equal size. If the net reproduction ratio is higher, the population will grow continuously, as in Table 6, for each generation, as it dies, leaving behind a cohort of larger dimensions than itself. Similarly, if R < 1, the population will eventually decrease, for each generation it leaves behind a smaller cohort than itself.

A dynamic equilibrium of the population at a constant growth rate is possible only under predetermined conditions.

The basic difference equations behind this table are derived from the survival distribution coefficients, 1, 0.8 and 0.4, and the birth function coefficients, $B_t = 3a_2 + 8a_3$. Thus, in year 1 the number of births is 40 x 3 + 10 x 8 or 200; of these 200, 200 survive to be the first age group in year 2, 160 survive to be the second age group in year 3, and 80 survive to be the third age group in year 4.

Table 8. *Balance with a constant growth rate*

Year	Age (Years) 0–1	1–2	2–3	Total
1	100	40	10	150
2	200	80	20	300
3	400	160	40	600
4	800	320	80	1200

It is observed in Table 8 that the population grows at a constant rate of 2 per year and that the number of births and the number of each age group increase at the same rate.

Conclusions

Some theoretical and practical conclusions are drawn from the presentation and the data used. Of these, the first would be that when making the macroeconomic forecasts, the study of the evolution of the capital up to a moment and of the prospect of its growth is essential. Therefore, dynamic models are those that show the tendency of the evolution of capital in a country and based on it the measures to be taken for the next period according to the strategy used, so that the growth will take place progressively.

On the other hand, it is clear that models of dynamic analysis of all three capital factors, labor resources and financial-material resources must be used in an economic forecast, so that the established parameters allow the possibility of harmonizing the three factors so that the effect is maximum.

Also, the article highlights the fact that when building a dynamic capital analysis cell, he has to do a very careful study of the principles underlying the growth of capital within a national economy and in order to identify statistical variables, in other words, extending the term slightly, the measures that must be taken for this social capital with national capital to evolve at a correlated rate to give the effect that it has to have on the macroeconomic evolution.

At the same time, it is necessary that when constructing a model used in the dynamic analysis of the population, one must carefully study the dynamic evolution until the static moment of the moment when we propose a forecast of population growth or change in the future.

The variables considered must be carefully analyzed in order to identify the evolutionary trend until the moment of the analysis and in this way by calculating the parameters of the coefficients and estimators it can be made an extension, a real forecast on the evolution of the population from the geographical area under analysis.

The final conclusion is that in any macroeconomic forecast at the state level, at the continental level or on a wider, global level, the factors (the factor variables) that can influence the population change must be carefully considered. These dynamic models can be successfully analyzed in the analysis of the forecast of the future evolution of the population in the considered geographical area.

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Poverty rate determinants in the Central and Eastern Europe member states

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Abstract. *This paper aims to provide an analysis of the determinants of poverty rate in ten member states of the European Union from the Central and Eastern Europe, and of the way how its influenced poverty in the 2009-2016 period. In order to estimate the impact, I used panel technique and Estimated Generalized Least Squares method with no effects, weighted by Period SUR option to provide more consistent estimators. To verify if the model is correctly specified and to confirm the maximum verisimilitude of the estimators, I tested the Gauss-Markov. The conclusion of the paper is that the unemployment rate, rural population, as well as the early leavers rate of people aged between 18-24, have a positive impact on the rate of people at risk of poverty rate after social transfers. On the other hand, the government spending on social protection has a negative impact on the used dependent variable.*

Keywords: poverty, panel, unemployment rate, rural, early leavers rate.

JEL Classification: C23, G01, G31, O47.

1. Introduction

Poverty reflects a situation in which people obtain lower incomes so that they cannot afford to achieve a decent standard of living, acceptable by the society. In the European Union (EU), the poverty risk rate after social transfers, was 17.3% in 2016. This indicator has been growing slightly since 2013, due to the global economic crisis, which appeared at the end of 2006 in the United States, affecting Europe since 2008, and later spreading worldwide.

The countries analysed in this paper are the following: Bulgaria (BG), Czechia (CZ), Estonia (EE), Hungary (HU), Lithuania (LT), Latvia (LV), Poland (PL), Romania (RO), Slovenia (SI) and Slovakia (SK). The Central and Eastern European states (CEE) of the EU have the highest levels of the population at risk of poverty rate, seven of the member states analysed recording a higher poverty rate than the EU28 average. In addition, Romania (25.3%) and Bulgaria (22.9%) are the countries for which were reported the highest rates of poverty in EU28. On the other hand, Czechia is the country recording the lowest poverty rate in 2016 (9.7%).

The reason I chose this theme is that the economy was born as a consequence of the growing need to reduce poverty and create well-being. Gradually, the economy has transformed into a wealth accumulation tool, which is not necessarily in line with the initial objective, which also argues the need of integrating the social objectives into the sustainable development policies. Also, one of the European Union objectives is the social inclusion and reduction of poverty, this being also highlighted in the Europe 2020 Strategy. I chose these countries because this grouping is geographically appropriate and reacts differently to the economic policy changes towards the Western European Union member states, the analysed states being even more socially vulnerable.

The main objective of this paper is to determine the impact of the factors that influence the poverty rate in Central and Eastern European member states. This objective can be achieved by reaching its specific objectives, as follows: identifying the impact of the determinants of poverty, testing the Gauss-Markov hypotheses and performing the economic analysis of the obtained results. Within this paper, poverty was analysed in terms of unemployment rate, rural population, government spending on social protection and early leavers rate of people aged between 18-24 years.

Regarding unemployment rate, the people included in this indicator are more exposed to poverty risk, given their low incomes hinder their capacity to afford a satisfactory life. The rural population is very high in the Central and Eastern Europe countries, the jobs occupied in this environment being generally in agriculture, which change unemployment rate according to the seasonal factors and generates new social challenges. Government spending on social protection has the role to reduce poverty, which also applies to the analysed countries. These kind of transfers are received by people in the form of social aid to help them benefiting from a satisfactory standard of living. The last indicator used in the paper is the early leavers rate of people aged between 18-24 years. Education is very important when it comes to finding a stable job and getting an average wage. In this country

group, the early leavers rate of people aged between 18-24 years is also high, which may have a positive effect on poverty.

The role of this study is to elucidate the directions that need to be taken to reduce poverty by establishing programs and measures favorable to inclusion in EU member states.

2. Literature review

The concept of poverty was analysed by several authors, including Akoum (2008), Lenagala and Ram (2010), Smith (2010), O'Boyle and O'Boyle (2012). Their results showed that poverty is a multidimensional socio-economic phenomenon that can be influenced by sex, age, culture, social and economic factors. Zamfir (2001) argued that the most vulnerable groups to poverty are children, single-parent families and those having more than three children, people living in rural areas and earning their living from subsistence agriculture, the unemployed, retirees, young people which are not included in the labour market and do not follow any educational training program (NEETs), respectively abandoned children.

In economics, there are a lot of studies assessing different ways of measuring poverty. In this context, Smith (2010) analysed two concepts: absolute poverty and relative poverty. The first concept is based on the required individual budget which can satisfy the minimum needs of physical, intellectual and social nature. On the other hand, relative poverty, which is set at 60% of median equivalised disposable national income, calculates the rates of people exposed to poverty risk. Decancq et al. (2013) argued that authors studying the dimension of poverty in a country, first must determine the level of well-being, the poverty threshold and poverty sensitivity to its drivers.

Šileika and Bekerytė (2012) analysed the theoretical aspects of the relationship between unemployment and poverty and found a positive relationship between them, but also stated that poor countries do not always face high unemployment. Nasar (2014) concluded that poverty is the result of high unemployment and chronic underemployment of the workforce.

Fiszbein et al. (2014) have shown that spending on social protection in European Union prevents millions of people from facing poverty. However, even if developing countries have the highest potential of benefiting from these expenditures, only half of them reduce the poverty rate through social protection expenditures. Moreover, Kiendebeogo et al. (2017) showed that the number of people at risk of poverty increased in financial crisis periods, and the countries allocating high amounts for social protection during these periods reduced the share of people at risk of poverty in total population. Socol et al. (2010) proved that there is an inverse correlation between the share of social protection spending in GDP and the poverty rate after social transfers. On the other hand, Deaton (2017) stated that social aid does not eliminate poverty, given that this tool have a different purpose.

Celikai and Gumus (2016) found that, in the short term, there is a negative relationship between poverty and social protection expenditure, while in the long run, they identified a positive relationship between them. The researchers previously mentioned proved also a

negative relationship between public spending on education and poverty, on long-term and short-term.

According to Klugman et al. (2002) rural households are more likely to be poorer because of the quality of education, health services and the undeveloped access to infrastructure. In addition, it is important to assess the impact of income sources, assets (social capital) and labour market participation rates on poverty. Also, Dreze and Khera (2013) calculated the impact of public spending on the rural area, and demonstrated that those reduce the rural poverty rate.

Khan et al. (2015) have shown that, as a consequence of some factors (the employment rate, remittances, employment in agriculture) poverty rate have a significant negative impact on the rural areas. Polanyi (2013) identified several factors that lead to an increase of poverty, as follows: cereals deficit, low wages in agriculture, disappearance of free farmers, reluctance of farmers to pay higher wages, the lack of internal savings. On the other hand, Christiaensen and Todo (2014) showed that the migration of the labour force from agriculture, respectively from the rural environment, leads to a sustainable growth model and to a faster reduction of the number of people at risk of poverty.

Lavrijsen and Nicaise (2015) showed that young people from disadvantaged families face high risks of school dropout, and the design of the education system (age, breadth of vocational education) and the characteristics of the socio-economic context (poverty rate, unemployment) have a positive impact on school dropout. Kingston and Webster (2015) showed that children who leave school early are more marginalized, having to take up jobs in the services (hospitality, catering), often half-time and low salaries, being more at risk of poverty.

Merce et al. (2015) analysed the issue of school dropout in Romania and found that its deepening depends on poverty (especially in rural areas). The analysis of the authors shows that school dropout start from secondary education, being also extended to post-secondary and university level.

3. Methodology

This section describes the techniques used to estimate the impact of exogenous variables on the people at risk of poverty rate after social transfers. In this context, I used the quantitative method, which strengthen the construction of the analysis.

The model performed examine the determinants of poverty rate in the analysed period (2009-2016). In order to analyse this phenomenon, I started from establishing and subsequently, verifying the hypotheses taken into account, as follows:

- the rise of unemployment rate influences positively the rate of people at risk of poverty rate after social transfers;
- the increase in government spending on social protection impacts negatively the rate of people at risk of poverty rate after social transfers;
- the rate of people at risk of poverty rate after social transfers is positively influenced by the increase of rural population in the respective country;

- the increase in early leavers rate of people aged between 18-24 from the previous year, leads to an increase in the people at risk of poverty rate after social transfers in the current year.

Most studies analysing the drivers of poverty rate used the panel technique, given that the poverty rate indicators are published annually. The panel technique is considered effective due to the fact that it helps to increase the degrees of freedom and to make the estimation more robust. However, it may bring new challenges regarding the manifestation of autocorrelation and heteroscedasticity between cross-sections. This technique was supported by the method Estimated Generalized Least Squers (EGLS) method, weighted by Period SUR option. The Period SUR option was used to correct the possible obstacles that may block the validation of the model, such as heteroscedasticity and the general correlation between the cross sections.

I did not use the fixed effects model because the Period SUR option is not compatible with this method. Regarding the random effects model, the Hausman test processed to verify the compatibility with it did not report consistent results at standard errors level. In this case, I used a model without effects and I applied the Period SUR option, which has the ability to provide more consistent estimators compared to the perspectives offered by the two models mentioned above. More details were provided in the empirical analysis section. I also checked the stationarity of the variables using the Summary test, which aggregates the results of the following tests: Lewin, Lin and Chu, Breitung T-Stat, Im Pesaran and Shin W-Stat, Augmented Dickey-Fuller, Fisher Chi- Square, PP-Fisher, Chi-Square.

In the impact assessment process, I used data with annual frequency for 2009-2016 period in the case of CEE countries. The reason I chose this group is that these countries react differently to changes in economic policy compared to the Western European Union member states, and are more vulnerable in social area. This assessment use statistical data published by Eurostat and the World Bank (Annex 1). Following the inclusion of the mentioned statistical data in the model, it has been resulted a number of 80 observations. The data proved to be stationary at the initial level and at the first level of difference, a situation generally compatible with Autoregressive Distributed Lag model (ARDL). However, the use of the autoregressive term may make the Durbin-Watson test inconsistent and increase the risk of autocorrelation and multicollinearity. Therefore, the Period SUR option applied to the following equation, which solved the problem of cross-section autocorrelation.

$$povertyrate = \alpha + \beta_0 unem + \beta_1 socialgov + \beta_2 rural + \beta_3 leavers_{(-1)} + \varepsilon_t,$$

where $povertyrate$ reflects the share of people at risk of poverty after social transfers (60% of the national median equivalised disposable income), $unem$ represents the unemployment rate (as a percentage of active population), $social\ gov$ is the government spending on social protection as a % of GDP, $rural$ represents the share of rural population in total population, $leavers_{(-1)}$ reflects the share of people aged 18-24 dropping out school early in the total pupils/students in education, and ε_t represents the error term.

In order to test the model for heteroscedasticity, I used the Breusch-Pagan Godfrey test, but considering that Eviews does not display the result of this test in panel, I estimated its specific equation manually in Microsoft Office Excel by the following function: "CHISQ.DIST.RT(n*R^2, Ω)", where n is the number of observations (in this case, 80), R^2 is the coefficient of determination and Ω as the number of degrees of freedom (in this case, 4).

To verify if the model is correct specified and to confirm the maximum verisimilitude of the estimators, I examined the Gauss-Markov hypotheses, as follows:

- the linearity of the model – R-squared must have a high value;
- significance of parameters – the estimators are statistically significant if the associated probability is less than 5%;
- including a large number of observations in the model;
- absence of autocorrelation. To test this hypothesis, the Durbin-Watson (DW) test was applied, using the following formula:

$DW = \frac{\sum_{t=2}^{n}(u_t - u_{t-1})^2}{\sum_{t=1}^{n} u_t^2}$, for n = 80 and k = 4.

- absence of multicollinearity – was verified using Klein's criterion, which confirm its absence if the correlation coefficient between exogenous variables is less than the coefficient of determination;
- absence of heteroscedasticity – the model is homoscedastic if the probability is greater than 5%;
- normal distribution of residuals – I used the Histogram of residuals and Jarque-Bera test, this hypothesis being confirmed if the probability associated with the test is greater than 5%;
- the absence of dependence between cross-sections – it was examined by Breusch-Pagan and Pesaran test, which accept the null (there is no dependence between cross-sections) if the associated probability is greater than 5%;
- standard errors non-zero, but close to 0;
- errors are independent of exogenous variables;
- the conditional mean error is zero.

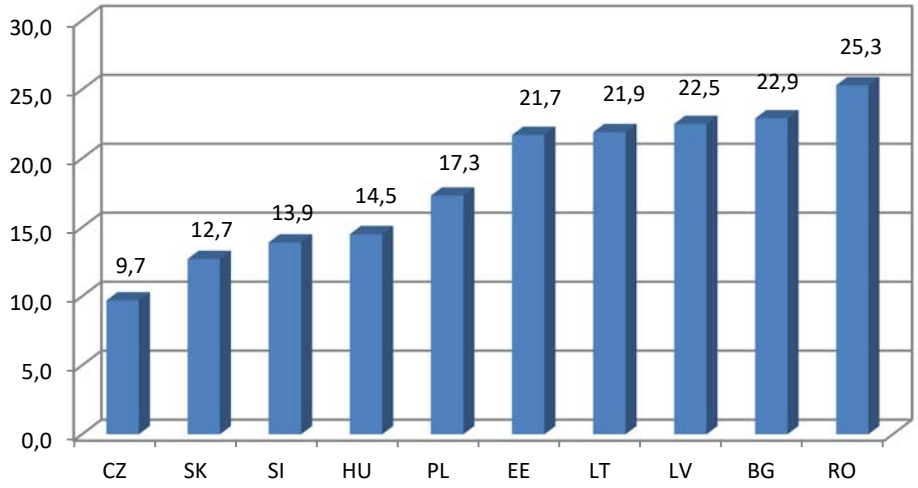
4. Results and interpretations

In this section I analysed the impact of the determinants of population exposed to the risk of poverty in the CEE countries, and I verified the verisimilitude of the obtained results.

Figure 1 shows the state of play in CEE countries in terms of *people at risk of poverty rate after social transfers*. As can be seen, the highest values were recorded in RO (25.3%), BG (22.9%), respectively LV (22.5%). On the other hand, the lowest values were registered in CZ (9.7%), SI (12.7%) and SK (13.9%). A key feature of these states is that they all belong to the former Soviet bloc. With the collapse of the Soviet Union in 1989, the transition (either by a shock therapy, as was the case of Poland, or by a gradual therapy, as was the case of Hungary, or a combination between them – the case of Romania) has led to a

decrease in the standard of living, increase of unemployment, and the reduction of social protection funding, which in turn led to an increase of the population at risk of poverty.

Figure 1. *People at risk of poverty rate after social transfers (60% of the national median equivalised disposable income) in 2016*



Source: Own calculations using Eurostat database.

Another event that led to the increase of the population exposed to the risk of poverty was the global economic crisis that began to make its presence felt in Europe from 2007-2008, affecting the whole European Union. One of the main causes of the economic crisis was the sharp rise in commodity prices (such as the increase in the price of oil and energy). With the increase of prices, the real incomes of the employees began to decrease, and the costs of companies increased, which led to a reduction in the aggregate demand. Another cause was the inequitable distribution of income from capitalist states, which was reflected in a high difference between the income obtained by the rich individuals and those obtained by the poor. The high-income population used their money not only on goods and services, but also to carry out financial speculation on financial markets, but the poor individuals had to borrow money from financial institutions to maintain their standard of living.

Figure 2 shows the comparison between the rate of people at risk of poverty rate after social transfers (60% of the national median equivalised disposable income) registered in 2009 and that recorded in 2016. In LV, the measures taken to reduce poverty were effective, which led to the decrease of the indicator with 4.6 pp, unlike the other states, where the rate of people at risk of poverty increased during the analysed period, the highest increases being recorded in RO (3.2 pp), SI (2.6 pp) and EE (2.0 pp). This shows that social challenges have intensified in these countries and new measures/efforts are needed to reduce the poverty rate.

Regarding the unemployment rate, with the spread of the economic crisis, the number of unemployed has started to increase in all the member states of the European Union. Since 2009, CEE countries have started to see successive increases in the unemployment rate,

with the highest values being recorded in LV (17.5%), LT (13.8%) and EE (13.5%). In 2016, unemployment rates decreased, with the highest drop being reported for LV (7.9 pp), EE (6.7%) and LT (5.9%). These decreases are due to the increased number of newly created jobs. However, in SI and BG, the unemployment rate increased in 2016 compared to 2009 with 2.1 pp, respectively 0.8 pp, which establishes the need to compensate for this evolution through measures to support the reduction of unemployment.

Government spending on social protection did not show significant differences in 2016 compared to 2009. The states that decided to increase their spending are Bulgaria and Slovakia, with 1 pp of GDP and 0.2 pp of GDP, this being also the cause of the increase in the number of unemployed. In the case of other CEE countries, they reduced their social protection expenses by less than 1 pp of GDP.

Figure 5 shows how early leavers rate of people aged between 18-24 from 2009 to 2016 has changed. LV, LT, EE, BG, SI and PL have taken appropriate measures to reduce school dropout. On the other hand, in SK, RO, CZ and HU, the indicator has increased and further measures are needed to improve the results in the educational system. Figure 6 shows that the rural population has increased in 8 of 10 analysed member states. In the other two countries, Slovakia and Poland, the share of rural population in total population increased by 1.15 pp and 0.82 pp. The largest decrease of the degree of ruralization was recorded in BG (2.37 pp), LV (2.31 pp) and SI (1.59 pp), in the other states, the reductions being below 1 pp, mainly due to the low mobility of the population.

Figure 2. *People at risk of poverty rate after*

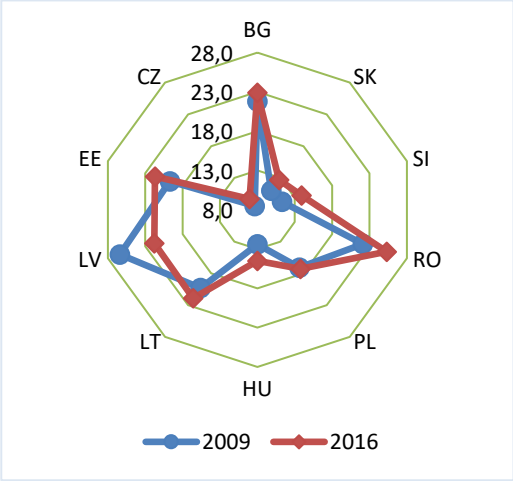


Figure 3. *Unemployment rate in CEE (%) social transfers in CEE (%)*

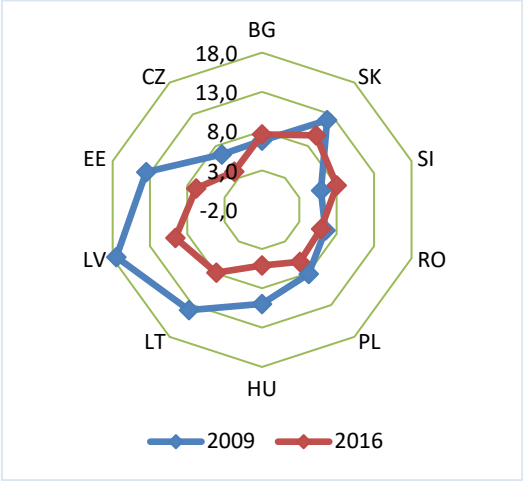


Figure 4. *Social protection government spending in CEE (% of GDP)*

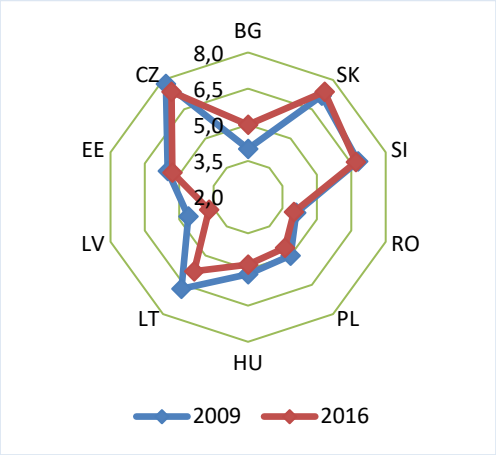


Figure 5. *Early leavers rate of people aged between 18-24 in CEE (%)*

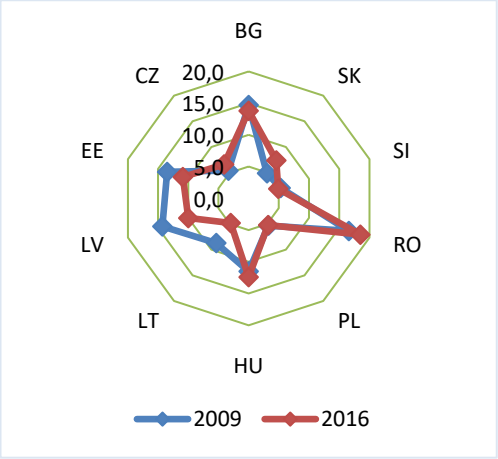
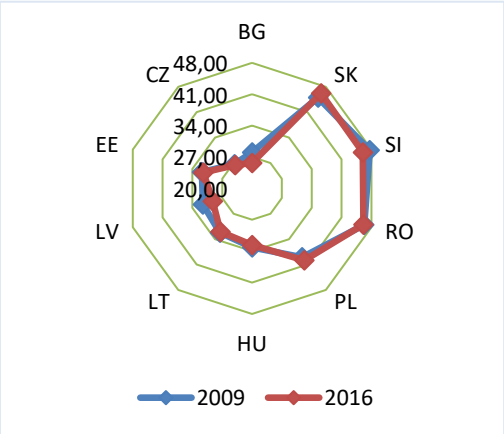


Figure 6. *Rural population (% of total) in CEE*



Source: Own calculations using Eurostat and World Bank database.

Next, I presented the correlations between the population exposed to poverty risk rate after social transfers and the exogenous variables used in the analysis.

Thus, the highest correlation was registered between the people at risk of poverty rate after social transfers and the early leavers rate of people aged between 18-24 (68.02%), indicating that the level and quality of the educational system have an important role in designing social developments within the analysed states. Also, the people at risk of poverty rate after social transfers has been found to be strongly correlated (in this case negative) with social protection government spending (-50.37%), suggesting that they are a relevant driver of poverty reduction. Between the people at risk of poverty rate after social transfers and the unemployment rate, respectively the rural population, the correlations are

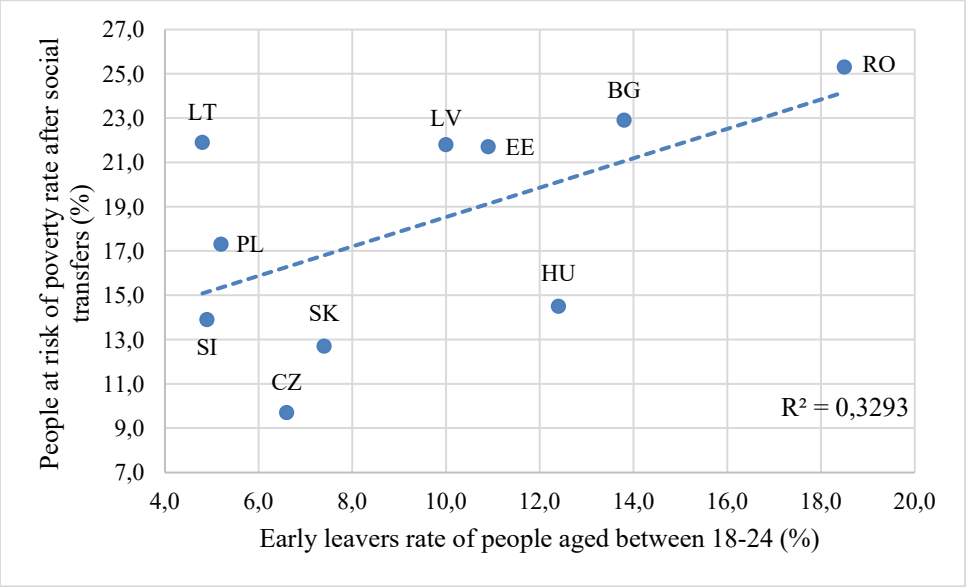
lower, their values being of 11.54% and 3.0%, indicating that the unemployment rate and the rural population did not have a similar evolution to that of the poverty rate. These correlations indicate a possible high influence of the mentioned indicators on the people at risk of poverty rate, according to the economic theory. The coefficient of determination from the four graphs designed record similar values to the Pearson correlation coefficients. However, the accuracy of their estimation may be affected by the low number of observations.

Within this section I presented the results of the estimation carried out in order to identify the impact of the determinants of the population exposed to the risk of poverty. The model was estimated using the EGLS method weighted by Period SUR option, the results being attached in the Figure 11. Also, all estimators are statistically significant, given that the probabilities associated with them are below the significance threshold of 5%. At the same time, errors are null, which indicates the possibility of very small deviations of the estimators. According to the Figure 11, the value of the coefficient of determination is 0.7346, which confirms the linearity of the regression, as well as the appropriate selection of the regressors, considering that their evolution explains 73.46% of the fluctuation of the endogenous. At the same time, the probability associated with the Fisher test which is less than 5% (in this case has a value of 0.00%) which confirmed the statistical validity of the model.

Figure 7. *Correlation between unemployment rate and people at risk of poverty rate after social transfers in CEE (2016)*

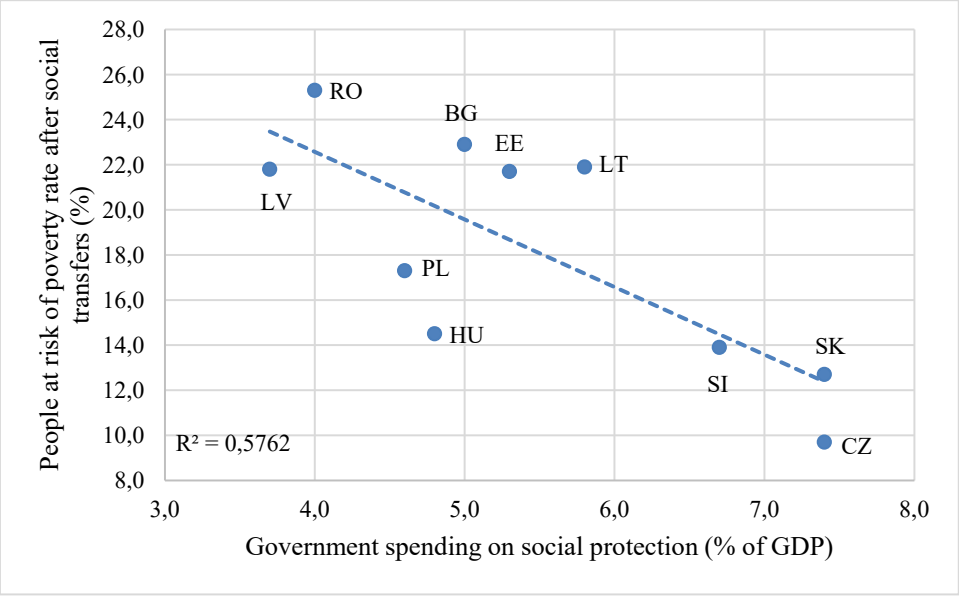
Source: Own calculations using Eurostat database.

Figure 8. *Correlation between early leavers rate of people aged between 18-24 and people at risk of poverty rate after social transfers in CEE (2016)*



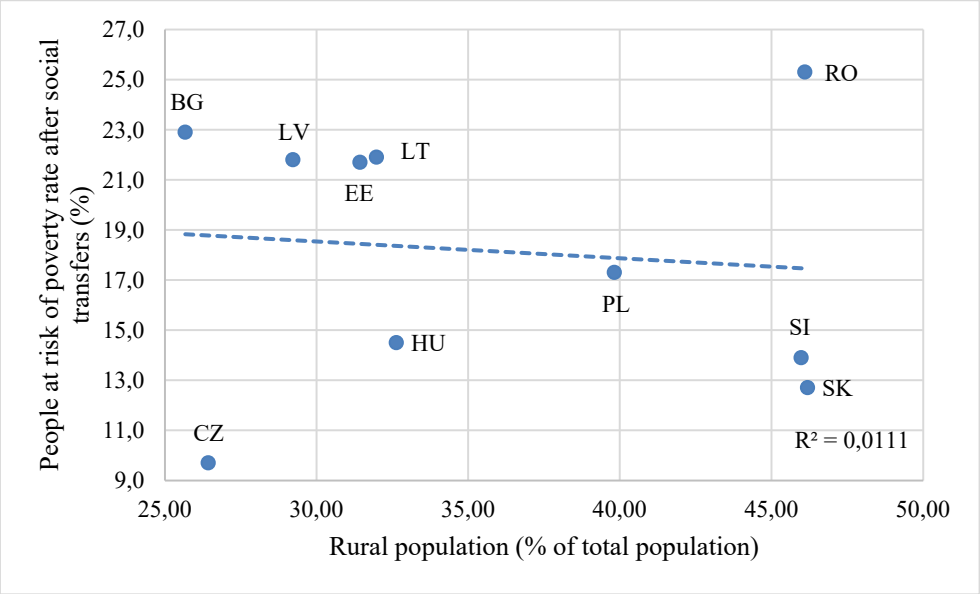
Source: Own calculations using Eurostat database.

Figure 9. *Correlation between government spending on social protection and people at risk of poverty rate after social transfers in CEE (2016)*



Source: Own calculations using Eurostat database.

Figure 10. *Correlation between rural population and people at risk of poverty rate after social transfers in CEE (2016)*



Source: Own calculations using Eurostat database.

In the initial form, I tested the stationarity of the variables. For this procedure, I used the tests mentioned in the methodology. The tests I had run indicated a stationary character for some variables (unemployment rate and social protection government spending), while other variables (people at risk of poverty rate after social transfers, rural population and the early leavers rate of people aged between 18-24) became stationary after processing the first difference. For a clear picture, I attached the result of the stationarity in Table 1.

Next, I presented the impact of the regressors on the dependent variable. According to the results of Figure 11, the increase of the unemployment rate by 1 pp leads to an increase in the people at risk of poverty rate after social transfers by 0.2149 pp in the CEE countries. When a person who is fit for work goes into temporary unemployment, will feel a drop in its disposable income which will increase the risk of entering into the category of vulnerable persons if the reintegration into the labour market will not achieved in an adequate time period.

Figure 11. *Model estimation using the EGLS Panel component with Period SUR option*

Dependent Variable: POVERTYRATE
Method: Panel EGLS (Period SUR)
Date: 11/30/19 Time: 10:27
Sample (adjusted): 2009 2016
Periods included: 8
Cross-sections included: 10
Total panel (balanced) observations: 80
Linear estimation after one-step weighting matrix
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEM	0.214941	0.037424	5.743457	0.0000
SOCIALGOV	-0.792148	0.073019	-10.84859	0.0000
RURAL	0.127519	0.040097	3.180246	0.0021
LEAVERS(-1)	0.535879	0.048671	11.01019	0.0000
C	16.33612	1.410677	11.58034	0.0000

Weighted Statistics

R-squared	0.734648	Mean dependent var	2.516954
Adjusted R-squared	0.720496	S.D. dependent var	5.859261
S.E. of regression	1.014457	Sum squared resid	77.18416
F-statistic	51.91082	Durbin-Watson stat	1.914611
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.548031	Mean dependent var	17.27625
Sum squared resid	775.2370	Durbin-Watson stat	0.245503

Source: Own calculations using Eviews 9.0, Eurostat and World Bank database.

On the other hand, according to the results, the increase by 1 pp of the social protection government spending leads to the decrease of the people at risk of poverty rate after social transfers by 0.7921 pp. The social assistance offered by the government, which aims to support people at risk of poverty, contributes to reducing the number of people at risk of poverty, because these incentives will increase the incomes of the individuals and will improve their standard of living.

Regarding the rural population, its increase by 1 pp leads to a growth of people at risk of poverty rate after social transfers with 0.1275 pp. The population living in the rural area is more exposed to the risk of poverty compared to those who are in the urban area. This can be argued by the fact that there are more rural residents working in agriculture and forestry, and the wages in these field are lower compared to those in the industry or services.

When the early leavers rate of people aged between 18-24 increases by 1 pp, people at risk of poverty rate after social transfers will increase by 0.5358 pp. Education is one of the most important pillars of development in a country, and the higher the level of education and qualification, the easier it is for the citizens to access better paid jobs, thus reducing the number of people exposed to poverty.

If all the dependent variables remain constant, people at risk of poverty rate after social transfers increases by 16.33612 pp, but this coefficient loses its statistical credibility given that the standard error is high.

Of the mentioned regressors, the government spending on social protection have the strongest impact on the dependent variable. Increases in spending on social protection lead to a reduction of people at risk of poverty, but it must also be borne in mind that social aid can create permanent social workers, never wanting to enter on the labour market. Therefore, the impact is likely to be moderated by this medium-term effect. The early leavers rate strongly influences the endogenous variable, which shows that education remains a significant factor for the social situation.

Table 1. *Summary test*

Variable	*Initial value*	*First difference*
	Tests that confirm the stationarity of total tests	
People at risk of poverty rate after social transfers	4 of 12	11 of 12
Unemployment rate	5 of 12	-
Social protection government spending	7 of 12	-
Rural population	6 of 12	5 of 12
Early leavers rate of people aged between 18-24 (-1)	4 of 12	11 of 12

Source: Own calculations using Eviews 9.0, Eurostat and World Bank database.

Another hypothesis to be fulfilled is the DW test. In this case, the result of the test (1.91) is found in the interval between the statistics of DU (1.74) and 4-DU (2.26), which confirms the hypothesis that the errors are not autocorrelated.

Also, I presented the test that verifies multicollinearity in Annex 2. According to Klein's criterion, the hypothesis of the absence of multicolinearity is confirmed when the correlation between two independent variables is lower than R-squared (in this case 73.46%). Annex 2 demonstrates the absence of multicollinearity given that the R-squared is higher than the correlations between the independent variables. Also, the correlations between the dependent variables and errors (according to Annex 3) are small, which attests that there are premises for accepting the hypothesis that there is no correlation between residuals and regressors.

The Breusch-Pagan-Godfrey test, processed according to the methodology, with a number of 4 degrees of freedom, provided a probability of 58.43%, which confirmed the null hypothesis (the model is homoscedastic), given that the probabilities of the variables have higher values than the significance threshold (5%), the result being also in accordance with Gauss-Markov's theory. The result of the Breusch-Pagan-Godfrey test can be found in Annex 4.

Moreover, I attached the results of the Jarque-Bera test in Annex 5. Given that the test probability is 28.52%, which is higher than 5%, I confirmed the hypothesis that residuals are normally distributed. In Annex 6, I observed the constant evolution of the errors towards 0, which confirmed the hypothesis that the mean of the residuals is zero. Following the tests performed, I have also confirmed that the model fulfills all the conditions required for accepting the maximum verisimilitude of the estimators (hypotheses of Gayss-Markov's theorem).

5. Conclusions

The analysis carried out showed that the unemployment rate, the rural population and the early leavers rate of people aged between 18-24 have a positive impact on the people at risk of poverty rate after social transfers. On the other hand, government spending on social protection has a negative impact on the endogenous. The coefficient of determination is statistically significant, and the model fulfilled all the assumptions of the Gauss-Markov theorem, required to validate the maximum verisimilitude of the estimators. Poverty is a major issue in Central and Eastern European countries, many of them facing high levels of poverty, which intensifies the challenges related to inclusion and therefore additional measures are needed to tackle this phenomenon. In this way, the analysed countries must take appropriate measures to reduce poverty, mainly by seeing its causes, and then applying the necessary solutions to reduce it.

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Annex 1. *Structure of the model*

Variable	Source
People at risk of poverty rate after social transfers (60% of the national median equivalised disposable income)	Eurostat
Unemployment rate (% of active population)	Eurostat
Social protection government spending (% of GDP)	Eurostat
Rural population (% of total population)	World Bank
Early leavers rate of people aged between 18-24 (% of total)	Eurostat

Source: Own calculations.

Annex 2. *Absence of multicollinearity – Klein's criterion*

Correlation	UNEM	SOCIALGOV	RURAL	LEAVERS1
UNEM	1.000000	0.035485	-0.039383	0.011449
SOCIALGOV	0.035485	1.000000	0.403756	-0.429479
RURAL	-0.039383	0.403756	1.000000	-0.107718
LEAVERS1	0.011449	-0.429479	-0.107718	1.000000

Source: Own calculations using Eviews 9.0

Annex 3. *Absence of correlation of residues with regressors*

Correlation	RESID01	UNEM	SOCIALGOV	RURAL	LEAVERS1
RESID01	1.000000	-0.140388	0.155535	0.223197	-0.055722
UNEM	-0.140388	1.000000	0.035485	-0.039383	0.011449
SOCIALGOV	0.155535	0.035485	1.000000	0.403756	-0.429479
RURAL	0.223197	-0.039383	0.403756	1.000000	-0.107718
LEAVERS1	-0.055722	0.011449	-0.429479	-0.107718	1.000000

Source: Own calculations using Eviews 9.0

Annex 4. *Heteroscedasticity – Breusch-Pagan-Godfrey*

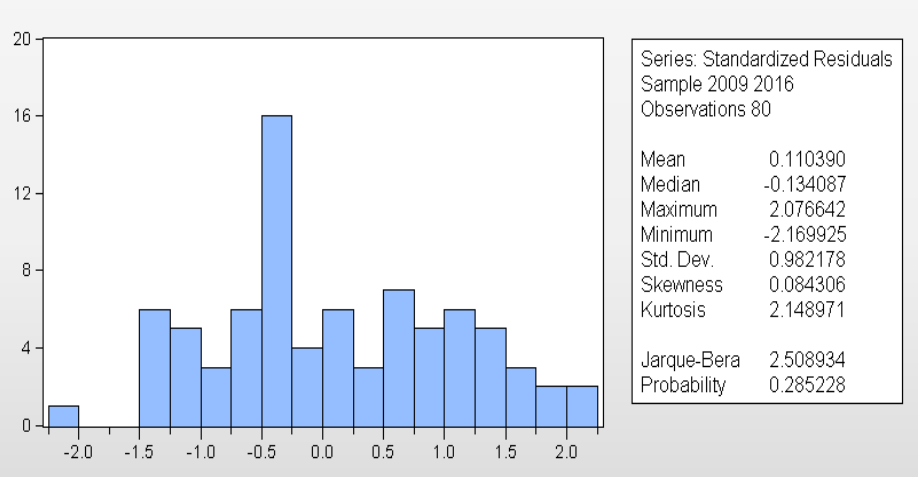
Dependent Variable: RESID01^2
Method: Panel Least Squares
Date: 11/30/19 Time: 14:55
Sample (adjusted): 2009 2016
Periods included: 8
Cross-sections included: 10
Total panel (balanced) observations: 80

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEM	0.049459	0.036708	1.347369	0.1819
SOCIALGOV	0.050289	0.067783	0.741918	0.4605
RURAL	0.002909	0.017464	0.166565	0.8682
LEAVERS(-1)	0.017302	0.031167	0.555147	0.5804
C	-0.503534	1.117347	-0.450651	0.6535

R-squared	0.035546	Mean dependent var	0.964802
Adjusted R-squared	-0.015891	S.D. dependent var	1.066741
S.E. of regression	1.075183	Akaike info criterion	3.043321
Sum squared resid	86.70141	Schwarz criterion	3.192197
Log likelihood	-116.7328	Hannan-Quinn criter.	3.103010
F-statistic	0.691057	Durbin-Watson stat	2.281626
Prob(F-statistic)	0.600433		

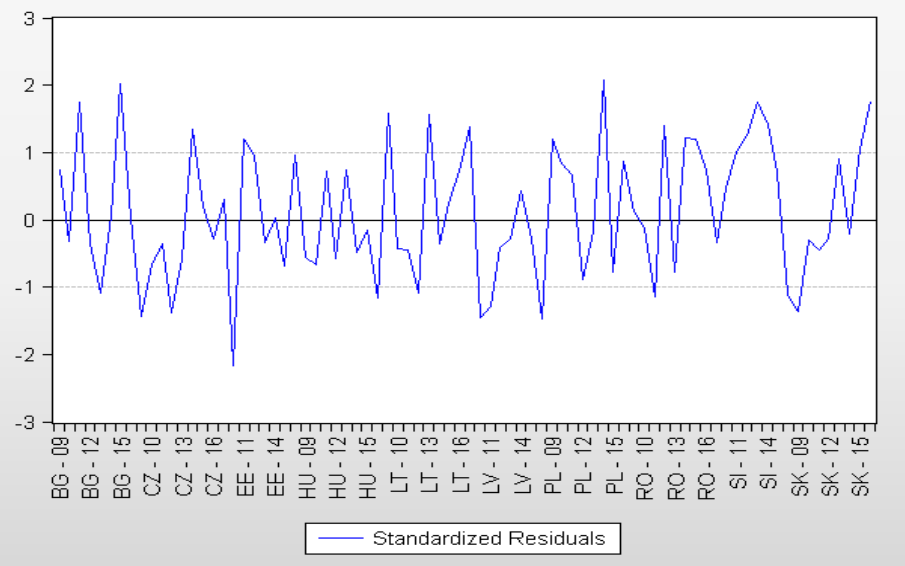
Source: Own calculations using Eviews 9.0

Annex 5. *Jarque-Bera Test*



Source: Own calculations using Eviews 9.0

Annex 6. *Residuals distribution*



Source: Own calculations using Eviews 9.0

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Wagner versus Keynesian Hypothesis: Role of aggregate and disaggregate expenditure in Pakistan

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Abstract. *The objective of this study is to examine the long run as well as short run relationship between government expenditure at aggregate as well as disaggregate level and economic growth in Pakistan. The study uses six functional forms of Wagner's law and further classify these forms to incorporate disaggregate expenditure. Study uses annual time series data of Pakistan from 1976 to 2015 and applies Engle and Granger cointegration test for long run relationship, while Granger causality test is employed for short run analysis. The study found that no long run relationship exists between GDP and total expenditure as well as its sub-components i.e. expenditure on current subsidies, defence expenditure, current expenditure, and developmental expenditure, while long run relationship exists among GDP and expenditure on social, economic and education services. Unidirectional causality in favor of Wagener's hypothesis exists from GDP to expenditure on current subsidies, expenditure on social, economic and education services, defence expenditure, and current expenditure, while unidirectional causality in favor of Keynesian hypothesis flows from developmental expenditure to GDP in the short run. Government has to invest more on human resource development to achieve sustainable economic growth in the long run. Government has to reallocate more resources towards developmental projects to achieve higher economic growth in the short run.*

Keywords: government expenditure, economics growth, cointegration, causality, Pakistan.

JEL Classification: C32, E62, H51, H52.

1. Introduction

The relationship between public spending and economic growth has been an important subject of discussion among economists for decades (Peacock and Wiseman, 1961; Gupta, 1967). Government attempts to stimulate economic growth through various policy instruments and one of the important instrument of fiscal policy is public spending which is used to influence economic growth (Lahirushan and Gunasekara, 2015). The government expenditure policy has a crucial role in functioning of the economy whether developed or underdeveloped. Till twentieth century government revenues were considered more important than government expenditure, while functions and activities of the state were confined to specific limits (World Bank, 1988). The thinking about functions of state has been changed over the years, now the state is considered to be a welfare state for the economy. The state increases welfare of nation through spending on developmental projects as well as social, economic and education services i.e. employment, health, agricultural and industrial development, fresh and clean water (World Bank, 1988). The rapid economic growth is not possible without state interference, whereas private institutes are only curious to earn profit and to survive in the economy.

There are two approaches in the literature regarding pubic spending and economic growth i.e. "Wagner's law" or "Keynesian hypothesis". The fundamental argument of these two approaches relies on causal link between public spending and economic growth (Samudram et al., 2009). Wagner (1883) argued that government expenditure tends to expand with an increase in per capita income of a nation, which indicates causality flows from output to public spending. On the other hand, Keynes (1936) postulated that government expenditure is an exogenous policy instrument which is used to accelerate economic growth as well as to correct short run and long run cyclical fluctuations, hence causality flows from public spending to national output (Ansari et al., 1997).

Relationship between public spending and economic growth is one of the most controversial issue in the literature (Montiel, 2010). Wagner's and Keynesian hypothesis have been tested for both developed and developing countries (Ansari et al., 1997; Biswal et al., 1999; Samudram et al., 2009). The literature in favor of Wagner's or Keynesian hypothesis is divided into three strands. First strand is based on validity of Wagner's hypothesis, where unidirectional causality flows from economic growth to public spending (Ansari et al., 1997; Faris, 2002; Montiel, 2010; Abdullah and Mamoor, 2010; Kumar et al., 2012; Barra, 2015; Thabane and Lebina, 2016). Second strand favors Keynesian hypotheses, where unidirectional causality flows from public spending to economic growth (Halicioglu, 2003; Babatunde, 2011). Third strand is based on the existence of both Wagner's and Keynesian hypothesis, where causality is bidirectional between public spending and economic growth (Biswal et al., 1999; Dritsakis and Adamopoulos, 2004; Ziramba, 2008; Katrakilidis and Tsaliki, 2009; Samudram et al., 2009).

Literature provides existence of mix relationship between public spending and national income for developed and underdeveloped countries as well as applicability of Wagner's or Keynesian hypothesis. However, there is limited work on the relationship between economic growth and government expenditure at disaggregate level in Pakistan. This study aims to fill this gap by analyzing the relationship between total public spending at aggregate

as well as disaggregate level and economic growth by employing six mathematical formulations of Wagner's law. The objective of this study is to examine the long run as well as short run relationship between government expenditure at aggregate as well as disaggregate level and economic growth in Pakistan from 1976 to 2015. The findings of this study will help policy makers and government to design appropriate policies to accelerate the pace of economic growth in Pakistan.

The rest of the study is organized as follows. Literature review on relationship between public spending and economic growth is discussed in section 2. Model, methodology and data are explained in section 3. Section 4 presents results of the study. Section 5 consists of concluding remarks and policy recommendations.

2. Literature review

Ansari et al. (1997) analyzed the relationship between national income and government expenditure for three African countries i.e. Ghana, Kenya and South Africa from 1957 to 1990. They found that unidirectional causality flows from economic growth to spending for Ghana, while unidirectional causality exists in favor of Keynesian hypothesis for South Africa, and no causality exists in Kenya. Biswal et al. (1999) examined the relationship between national income and total public spending and its subcomponents in Canada from 1950 to 1995. The results showed absence of cointegration between components of public spending and GDP. They found that unidirectional causality exists in favor of Wagner's and Keynesian hypothesis for different components of public spending. Faris (2002) investigated the relationship between public spending and output for GCC countries from 1970 to 1997. Results showed that cointegration exists between total government spending and economic growth. The causality test showed that Wagner's hypothesis is applicable in GCC countries except Bahrain, whereas both Wagner and Keynesian hypothesis exists in Bahrain.

Halicioglu (2003) examined the relationship between public spending and output in Turkey from 1960 to 2000. Results suggested that long run relationship exists between public spending and economic growth. The results of causality suggested that neither unidirectional nor bidirectional causality exists in favor of Wagner's or Keynesian hypothesis. Iyare and Lorde (2004) analyzed the association between public spending and national income for nine Caribbean countries from 1950 to 2000. Results indicated the absence of cointegration between public spending and output in Caribbean countries except Grenada, Guyana and Jamaica. Results of the causality were mixed, but in most of the countries, Wagner's hypothesis was applicable. Chang et al. (2004) examined the applicability of Wagner's hypothesis in seven industrialized and three emerging countries of Asia from 1951 to 1996. Cointegration results suggested that public spending and output have long run relationship in Japan, South Korea, Taiwan, UK and US. However, causality test showed that Wagner's hypothesis is applicable in Japan, US, UK, South Korea and Taiwan, while for remaining five countries neither Wagner's nor Keynesian hypothesis holds.

Dritsakis and Adamopoulos (2004) analyzed the relationship between public spending and output in Greece from 1960 to 2001. They found that unidirectional causality runs from output to government expenditure in the long run, while both Wagner's and Keynesian hypothesis holds in the short run in the Greek economy. Loizides and Vamvoukas (2005) examined the link between public spending, government size and output for UK, Ireland and Greece from 1960 to 1990. They found that causality flows from public spending to economic growth in favor of Keynesian hypothesis in UK and Ireland, while Wagner's hypothesis holds in Greece in short run. Ziramba (2008) analyzed the relationships between public spending and output in South Africa from 1960 to 2006. Results of the short-run causality indicated that both Wagner's and Keynesian hypothesis are valid, while long-run causality does not follow any direction.

Katrakilidis and Tsaliki (2009) analyzed the association between public expenditure and output in Greece from 1968 to 2004. They found that bidirectional causality exists between the variables, which support both Wagner's and Keynesian hypothesis in Greek economy. Samudram et al. (2009) examined the existence of Keynesian or Wagner's hypothesis in Malaysia from 1970 to 2004. Results indicated the existence of cointegration between GDP and spending on education, agriculture, defense, and development. They concluded that long run causality is bidirectional in favor of both Keynes and Wagner's hypothesis in case of Malaysia. Abdullah and Mamoor (2010) examined the existence of Wagner's hypothesis in Malaysia from 1970 to 2007. They found that long run relationship exists between government expenditure and economic growth, while Wagner's hypothesis holds true in four out of five version of Wagner's law.

Afzal and Abbas (2010) examined the existence of Wagner's hypothesis in Pakistan from 1960 to 2007. They found that unidirectional causality exists in favor of Wagner's law for total public spending, defense spending, interest payments and fiscal deficit. Montiel (2010) examined the relationship between public spending and output in Mexico from 1950 to 1990. Result showed that cointegration exists between public spending and output, while unidirectional causality exists in support of Wagner's hypothesis. Babatunde (2011) analyzed the existence of Wagner's hypothesis in Nigeria from 1970 to 2007. Result showed that there is no long run relationship between government expenditure and output, while causality test shows weak existence of Keynesian hypothesis in Nigeria.

Kumar et al. (2012) examined the Wagner's hypothesis in New Zealand by using ARDL bounds test from 1960 to 2007. They found that Wagner's hypothesis holds in long run, while Keynesian hypothesis holds in short run. Magazzino (2012) analyzed the relationship between disaggregate public spending and aggregate income for Italy from 1960 to 2008. Study found that Wagner's hypothesis holds for passive interest spending in the long run, and for dependent labor income in the short run. Rauf et al. (2012) analyzed the relationship between government spending and output in Pakistan from 1970 to 2009. They found that there is no long-run relationship between government spending and output, while no causal link exists between public spending and output in the short run. Mahmoodi and Mahmoodi (2014) examined the relationship between government expenditure and economic growth for twenty Asian countries from 1970 to 2010. They found that long run relationship exists

in developing countries, while bidirectional causality exists in advanced and newly industrialized countries in short run.

Barra et al. (2015) analyzed the relationship between government expenditure and economic growth in Italy from 1951 to 2009. They found that long run relationship exists between the variables, while unidirectional causality holds in favor of Wagner's hypothesis in short run. Lahirushan and Gunasekara (2015) examined the impact of government spending on economic growth of Asian countries from 1973 to 2013. They found that long run relationship exists between government expenditure and output in Asian countries, while unidirectional causality holds in favor of both Keynesian and Wagner's hypothesis in short run. Muhammad et al. (2015) analyzed the relationship between government expenditure and economic growth in Pakistan from 1972 to 2013. Thy found that neither long run relationship exists nor causality exists in the short run between government expenditure and economic growth in Pakistan. Thabane and Lebina (2016) analyzed the relationship between government expenditure and economic growth in Lesotho from 1980 to 2012. Results showed that long run relationship exists between government expenditure and economic growth, while long-run and short causality confirms Wagner's hypothesis in Lesotho.

3. Model, methodology and data

3.1. Model

There are mainly two approaches regarding relationship between government expenditure and economic growth i.e. "Wagner's law" or "Keynesian hypothesis". Wagner (1883) did not present his ideas in the form of a law, later on his views called as Wagner's hypothesis or Wagner's law (Henrekson, 1993; Halicioglu, 2003). The law argues that government expenditure increases faster than economic growth and it is an endogenous policy variable. The government expenditure plays no role in generating economic growth, because government spending is a consequence rather than cause of economic growth. Therefore, causality flows from economic growth to public spending. On the other hand, Keynes (1936) views are opposite to Wagner's hypothesis. Keyens (1936) argued that government expenditure is treated as exogenous policy instrument which is considered to influence economic growth and correct short term as well as long term cyclical fluctuations. Public spending is a cause rather than effect of economic growth, hence casualty runs from government expenditure to national income. Keynesian analysis concludes that economic performance may improve by demand management policies. However, inefficiencies of market failure can also improve by government intervention.

A number of researchers have argued that it is not clear whether Wagner's law relates to absolute size of the government or relative size of the government in an economy. Peacock and Wiseman (1961) brought up with displacement effect idea by using political theory to elaborate consequences of political events on government expenditure. Musgrave and Musgrave (1984) argued that association between public and private goods is complementary instead of substitute in nature. Dutt and Ghosh (1997) argued that Wagner was neither explicit in hypothesis formulation nor presented his law in mathematical form.

Several mathematical specifications have been developed over time by researchers to prove Wagner's or Keynesian hypothesis since 1960s.

3.2. Methodology

3.2.1. Econometric model

There are different mathematical formulations of Wagner's law presented by different researchers. This study uses six functional forms of Wagner's law and further classify these forms to incorporate disaggregate expenditure.

3.2.1.1. Model I

The functional form of Model I is presented by Peacock and Wiseman (1961). In this model, total government expenditure (GE) is a function of national output (GDP). The econometric model of the Peacock and Wiseman (1961) can be written as:

$$\ln(GE_t) = \alpha_o + \alpha_1 \ln(GDP_t) + u_{1t} \quad (1)$$

Where, GE_t is total government expenditure, GDP_t is gross domestic product, and u_{1t} is error term.

If elasticity of GE with respect to GDP exceeds unity, Wagner's hypothesis is supported and reveals public spending grow at a faster rate than national output. The econometric model of Peacock and Wiseman (1961) can be extended through disaggregate government expenditure as:

$$\ln(ECS_t) = \beta_o + \beta_1 \ln(GDP_t) + u_{2t} \quad (1a)$$

$$\ln(ESEES_t) = \gamma_o + \gamma_1 \ln(GDP_t) + u_{3t} \quad (1b)$$

$$\ln(ED_t) = \delta_o + \delta_1 \ln(GDP_t) + u_{4t} \quad (1c)$$

$$\ln(CE_t) = \rho_o + \rho_1 \ln(GDP_t) + u_{5t} \quad (1c)$$

$$\ln(DE) = \Theta_o + \Theta_1 \ln(GDP_t) + u_{6t} \quad (1e)$$

Where, ECS_t is expenditure on current subsidies, $ESEES_t$ is expenditure on social, economic and education services, ED_t is expenditure on defense, CE_t is current expenditure, DE_t is developmental expenditure, GDP_t is gross domestic product, and u_{it} is error term. Wagner's hypothesis is supported if α_1, β_1, γ_1, δ_1, ρ_1 and Θ_1 exceed unity (> 1).

3.2.1.2. Model II

The functional form of Model II is proposed by Pryor (1968). In this model, government consumption expenditure (GCE) is a function of national output (GDP). Wagner's hypothesis is valid if elasticity of GCE with respect to GDP exceeds unity. The econometric model of Pryor (1968) can be written as:

$$\ln(GCE_t) = \alpha_o + \alpha_1 \ln(GDP_t) + u_{1t} \quad (2)$$

Where, GCE_t is government consumption expenditure, GDP_t is gross domestic product, and u_{1t} is error term. Wagner's hypothesis is supported if α_1 exceed unity (>1).

3.2.1.3. Model III

The functional form of Model III is presented by Goffman (1968). In this model, the total government expenditure (GE) is as a function of per capita output (GDP/N). If elasticity of GE with respect to GDP/N exceeds unity, Wagner's hypothesis is supported. The econometric model of Goffman (1968) can be written as:

$$\ln(GE_t) = \alpha_0 + \alpha_1 \ln(GDP_t/N_t) + u_{1t} \quad (3)$$

Where, GE_t is total government expenditure, GDP_t is gross domestic product, N_t is population, and u_{1t} is error term.

The econometric model of Goffman (1968) can be extended through disaggregate government expenditure as:

$$\ln(ECS_t) = \beta_0 + \beta_1 \ln(GDP_t/N_t) + u_{2t} \quad (3a)$$

$$\ln(ESEES_t) = \gamma_0 + \gamma_1 \ln(GDP_t/N_t) + u_{3t} \quad (3b)$$

$$\ln(ED_t) = \delta_0 + \delta_1 \ln(GDP_t/N_t) + u_{4t} \quad (3c)$$

$$\ln(CE_t) = \rho_0 + \rho_1 \ln(GDP_t/N_t) + u_{5t} \quad (3d)$$

$$\ln(DE_t) = \Theta_0 + \Theta_1 \ln(GDP_t/N_t) + u_{6t} \quad (3e)$$

Where, ECS_t is expenditure on current subsidies, $ESEES_t$ is expenditure on social, economic and education services, ED_t is expenditure on defence, CE_t is current expenditure, DE_t is developmental expenditure, GDP_t is gross domestic product, N_t is population, and u_t is error term. Wagner's hypothesis is supported if α_1, β_1, γ_1, δ_1, ρ_1 and Θ_1 exceed unity (> 1).

3.2.1.4. Model IV

The functional form of Model IV is introduced by Michas (1975) a modified version of Gupta (1967). The applicability of Wagner's hypothesis requires elasticity of GE/N with respect to GDP/N exceed unity. The econometric model of Michas (1975) can be written as:

$$\ln(GE_t/N_t) = \alpha_o + \alpha_1 \ln(GDP_t/N_t) + u_{1t} \quad (4)$$

Where, GE_t is total government expenditure, N_t is population, GDP_t is gross domestic product, and u_{1t} is error term.

The econometric model of Michas (1975) can be extended through disaggregate government expenditure as:

$$\ln(ECS_t/N_t) = \beta_o + \beta_1 \ln(GDP_t/N_t) + u_{2t} \quad (4a)$$

$$\ln(ESEES_t/N_t) = \gamma_0 + \gamma_1 \ln(GDP_t/N_t) + u_{3t} \quad (4b)$$

$$\ln(ED_t/N_t) = \delta_o + \delta_1 \ln(GDP_t/N_t) + u_{4t} \quad (4c)$$

$$\ln(CE_t/N_t) = \rho_o + \rho_1 \ln(GDP_t/N_t) + u_{5t} \quad (4d)$$

$$\ln(DE_t/N_t) = \Theta_o + \Theta_1 \ln(GDP_t/N_t) + u_{6t} \quad (4e)$$

Where, ECS_t is expenditure on current subsidies, $ESEES_t$ is expenditure on social, economic and education services, ED_t is expenditure on defence, CE_t is current expenditure, DE_t is developmental expenditure, N_t is population, GDP_t is gross domestic product, and u_t is error term. Wagner's hypothesis is supported if α_1, β_1, γ_1, δ_1, ρ_1 and Θ_1 exceed unity (> 1).

3.2.1.5. Model V

The functional form of Model V is developed by Mann (1980) a modified version of Peacock and Wiseman (1961). In this model, total government expenditure to national output (GE/GDP) is a function of national output (GDP). If the elasticity of government share in total output with respect to national output exceed zero, Wagner's hypothesis is validated. The econometric model of Mann (1980) can be written as:

$$\ln(GE_t/GDP_t) = \alpha_o + \alpha_1 \ln(GDP_t) + u_{1t} \quad (5)$$

Where, GE_t is government expenditure, GDP_t is gross domestic product, and u_{1t} is error term.

The econometric model of Mann (1980) can be extended through disaggregate government expenditure as:

$$\ln(ECS_t/GDP_t) = \beta_o + \beta_1 \ln(GDP_t) + u_{2t} \quad (5a)$$

$$\ln(ESEES_t/GDP_t) = \gamma_o + \gamma_1 \ln(GDP_t) + u_{3t} \quad (5b)$$

$$\ln(ED_t/GDP_t) = \delta_o + \delta_1 \ln(GDP_t) + u_{4t} \quad (5c)$$

$$\ln(CE_t/GDP_t) = \rho_o + \rho_1 \ln(GDP_t) + u_{5t} \quad (5d)$$

$$\ln(DE_t/GDP_t) = \Theta_o + \Theta_1 \ln(GDP_t) + u_{6t} \quad (5e)$$

Where, ECS_t is expenditure on current subsidies, $ESEES_t$ is expenditure on social, economic and education services, ED_t is expenditure on defence, CE_t is current expenditure, DE_t is developmental expenditure, GDP_t is gross domestic product, and u_{6t} is error term. Wagner's hypothesis is supported if α_1, β_1, γ_1, δ_1, ρ_1 and Θ_1 exceed zero (> 0).

3.2.1.6. Model VI

The functional form of Model VI is proposed by Musgrave (1969), later on modified by Ram (1986), Murthy (1993), and Henrekson (1993). In this model, total government expenditure to national output (GE/GDP) is a function of per capita output (GDP/N). Wagner's hypothesis is valid if elasticity of GE/GDP with respect to GDP/N exceed zero. The econometric model of Musgrave (1969) can be written as:

$$\ln(GE_t/GDP_t) = \alpha_o + \alpha_1 \ln(GDP_t/N_t) + u_{1t} \quad (6)$$

Where, GE_t is government expenditure, GDP_t is gross domestic product, N_t is population, and u_{1t} is error term.

The econometric model of Musgrave (1969) can be extended through disaggregate government expenditure as:

$$\ln(ECS_t/GDP_t) = \beta_o + \beta_1 \ln(GDP_t/N_t) + u_{2t} \quad (6a)$$

$$\ln(ESEES_t/GDP_t) = \gamma_o + \gamma_1 \ln(GDP_t/N_t) + u_{3t} \quad (6b)$$

$$\ln(ED_t/GDP_t) = \delta_o + \delta_1 \ln(GDP_t/N_t) + u_{4t} \quad (6c)$$

$$\ln(CE_t/GDP_t) = \rho_o + \rho_1 \ln(GDP_t/N_t) + u_{5t} \quad (6d)$$

$$\ln(DE_t/GDP_t) = \Theta_o + \Theta_1 \ln(GDP_t/N_t) + u_{6t} \quad (6e)$$

Where, ECS_t is expenditure on current subsidies, $ESEES_t$ is expenditure on social, economic and education services, ED_t is expenditure on defence, CE_t is current expenditure, DE_t is developmental expenditure, GDP_t is gross domestic product, N_t is population, and u_t is error term. Wagner's hypothesis is supported if α_1, β_1, γ_1, δ_1, ρ_1 and Θ_1 exceed zero (> 0).

3.2.2. Unit root test

The study conducts time series analysis in which the most important step is to check stationarity of the series to avoid spurious regression and misleading results. The study uses Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. Dickey and Fuller (1981) presented the Dickey-Fuller unit root test in which they assume that the error term are uncorrelated. But in order to address the situation when error terms are correlated, they presented ADF test by adding the lags of the dependent variable on the right hand side. Phillips and Perron (1988) dealt with serial correlation problem by proposing nonparametric statistical methods without adding the lag of the dependent variable.

3.2.3. Cointegration test

Engle and Granger (1987) two step procedure requires that order of integration of variables must be I(1). This test explores whether series under consideration has long run equilibrium relationship or not. The first step investigates long run association between two variables through employing ordinary least square (OLS) estimates. The general form of regression equation is as follow:

$$lnY_t = \alpha_0 + \alpha_1 lnX_t + \varepsilon_t \quad (7)$$

The residuals obtained from regression equation (7) are tested for stationarity through employing ADF unit root tests. If estimated residuals (ε_t) are stationary at level, then variables are cointegrated and moving together in the long run. After assessing long run association between variables, the second step analyzed the short run relationship by estimating ECM or dynamic model. If variables possessed a long-run relationship, the residuals (ε_t) obtained from estimated regression equation can be employed to estimate the ECM. Granger representation theorem states that association between X and Y can be expressed as ECM, if these variables are moving together in long run. The dynamic model (ECM) is estimated by the following equation:

$$\Delta lnY_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, \Delta lnY_{t-i} + \sum_{j=1}^{n} \alpha_j \, \Delta lnX_{t-j} + \alpha ECT_{t-1} + u_t \quad (8)$$

Where, ECT_{t-1} is the lagged estimated residual from equation (7). The speed of adjustment of short run equilibrium depends on the absolute value of the coefficient of ECT.

3.2.4. Causality test

The cointegration test confirms the existence or absence of long run relationship among the variables but it does not provide the direction of causality. For this purpose Granger causality test is used to determine the direction of causality. Granger (1988) stated that within the framework of ECM, causal relations among variables can be examined. The individual coefficients of the lagged terms captured the short run dynamics, while the error correction term contains the information of long run causality. So, to examine the relationship between variables, the study used VAR framework as follows:

$$\Delta lnY_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta lnY_{t-i} + \sum_{i=1}^{p} \alpha_{2i} \Delta lnX_{t-i} + \varepsilon_{1t} \quad (9)$$

$$\Delta lnX_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta lnX_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta lnY_{t-i} + \varepsilon_{2t} \quad (10)$$

3.3. Data

The study utilizes the annual time series data of Pakistan from 1976 to 2015. The data for total government expenditure (GE), expenditure on current subsidies (ECS), expenditure on social, economic and education services (ESEES), expenditure on defence (ED), current expenditure (CE), developmental expenditure (DE), government consumption expenditure (GCE) and GDP in is collected from Pakistan Economic Survey (various issues). The data for population (N) is also taken Pakistan Economic Survey (various issues).

4. Results

Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests are applied to check the order of integration of the variables. Schwarz Information Criterion (SC) and Akaike Information Criterion (AIC) are used for determination of appropriate lag selection for each test. The results of unit root tests indicate that all the variables are integrated of order I(1). Results of ADF and PP tests are reported in Table 1.

Table 1. *Results of ADF and PP Unit Root Tests*

Variables	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)		Order of Integration	
	At Level	At 1st difference	At Level	At 1st difference	ADF	PP
ln(GE)	-0.1875	-5.2303***	-0.1918	-5.2303***	I(1)	I(1)
ln(GDP)	-0.3207	-5.9141***	-0.3209	-5.9141***	I(1)	I(1)
ln(ECS)	0.4706	-7.7140***	-0.6834	-8.3410***	I(1)	I(1)
ln(ESEES)	-0.2589	-8.1814***	-0.1786	-8.2561***	I(1)	I(1)
ln(ED)	-1.3863	-5.2651***	-1.2026	-5.4714***	I(1)	I(1)
ln(CE)	-0.9336	-5.5032***	-0.9096	-5.6256***	I(1)	I(1)
ln(DE)	0.4232	-7.3820***	0.6650	-7.3820***	I(1)	I(1)
ln(GCE)	-0.3245	-6.5627***	-0.3245	-6.5497***	I(1)	I(1)
ln(GDP/N)	0.1923	-5.8259***	0.1895	-5.8273***	I(1)	I(1)
ln(GE/N)	0.1705	-5.0244***	0.1315	-5.0340***	I(1)	I(1)
ln(ECS/N)	1.4638	-7.3778***	-0.7756	-8.3270***	I(1)	I(1)
ln(ESEES/N)	-0.1248	-8.0810***	0.1690	-8.2652***	I(1)	I(1)
ln(ED/N)	-1.0532	-5.4084***	-0.9480	-5.5209***	I(1)	I(1)
ln(CE/N)	-0.6411	-5.6263***	-0.6276	-5.6263***	I(1)	I(1)
ln(DE/N)	0.4381	-7.1910***	0.7267	-7.1910***	I(1)	I(1)

Variables	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)		Order of Integration	
	At Level	At 1st difference	At Level	At 1st difference	ADF	PP
ln(GE/GDP)	0.3646	-6.3003***	0.5507	-6.4504***	I(1)	I(1)
ln(ECS/GDP)	-2.5038	-7.6862***	-2.5038	-8.2869***	I(1)	I(1)
ln(ESEES/GDP)	-2.5898	8.5435***	-2.4241	-15.755***	I(1)	I(1)
ln(ED/GDP)	0.0935	-5.0249***	-0.1337	-5.0897***	I(1)	I(1)
ln(CE/GDP)	-1.9322	-6.1397***	-03704	-6.2103***	I(1)	I(1)
ln(DE/GDP)	0.6139	-7.3348***	0.7373	-7.3348***	I(1)	I(1)

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

The results of cointegrating of Model I are reported in Table 2a. Total government expenditure has no long-run relationship with GDP in model 1. In model 1a expenditure on current subsidies and GDP have no long-run association. Expenditure on social, economic and education services in model 1b have long run and positive relationship with GDP. An increase in economic growth will increase the expenditure on social, economic and education services because more educated and healthy people would take active participation in labor markets. No long-run association exists between expenditure on defense and output in model 1c. Model 1d indicates absence of cointegration between current expenditure and output. Developmental expenditure and output shows no long run association in model 1e. The results of cointegration of Model II are also reported in Table 2a. Results show that null hypothesis of no cointegration in model 2 is accepted. No long run relationship exists between government consumption expenditure and GDP in Pakistan.

The results of cointegration of Model III are reported in in Table 2a as well. In model 3, total government expenditure has no long run relationship with GDP per capita. In model 3a, expenditure on current subsidies and GDP per capita shows no long-run association. Expenditure on social, economic and education services and GDP per capita have positive relationship and long run relationship in model 3b. No long run relationship exists between expenditure on defence and GDP per capita in model 3c. Results of model 3d showed that current expenditure and GDP per capita are not moving together in the long run. No long run relationship exists between developmental expenditure and output per capita in model 3e.

Table 2a. *Results of Engle-Granger Cointegration for Model I, Model II, and Model III*

Model	Dependent Variable	Constant	Coefficient of Explanatory Variable	Adjusted R-squared	CRDW	Calculated ADF Residuals Test
1	ln(GE)	-0.6438 (0.1424)	0.9402*** (0.0098)	0.9958	0.4395	-2.1140
1a	ln(ECS)	-3.8943 (0.8531)	0.9526*** (0.0586)	0.8743	0.5873	-2.5242
1b	ln(ESEES)	-3.5646 (0.1978)	1.0556*** (0.0136)	0.9937	0.8763**	-3.2156*
1c	ln(ED)	-0.0736 (0.2784)	0.7902*** (0.0191)	0.9777	0.1213	-1.4457
1d	ln(CE)	-1.8019 (0.1968)	1.0004*** (0.0135)	0.9931	0.3145	-1.9290
1e	ln(DE)	0.2393 (0.3696)	0.7774*** (0.0254)	0.9611	0.4374	-1.9134
2	ln(GCE)	-1.6021	0.9583 (58.8839)	0.9889	0.3107	-1.7839

Model	Dependent Variable	Constant	Coefficient of Explanatory Variable	Adjusted R-squared	CRDW	Calculated ADF Residuals Test
3	ln(GE)	1.8960	1.1439 (87.7827)	0.9950	0.4187	-2.20399
3a	ln(ECS)	-1.3439	1.6139 (16.4718)	0.8739	0.6085	-2.5756
3b	ln(ESEES)	-0.7138	1.2843 (73.63648)	0.9929	0.8002**	-3.1136*
3c	ln(ED)	2.0751	0.9599 (38.1109)	0.9738	0.1132	-1.5260
3d	ln(CE)	0.9076	1.2165 (65.1183)	0.9909	0.2789	-1.9289
3e	ln(DE)	2.3232	0.9475 (31.7432)	0.9627	0.4721	-2.0191

Note: The ln represents logarithm. ***, **, * shows significance at 1%, 5%, and 10% level, respectively. CRDW stands for Cointegration Regression Durbin-Watson. The 1%, 5% and 10% critical value for the CDRW is 1.00, 0.78 and 0.69, respectively (Engle and Yoo, 1987). The 1%, 5% and 10% critical value for the ADF residual test is -3.9001, -3.3377 and -3.0462, respectively (MacKinnon, 1991). Standard errors are in parenthesis.

The results of cointegration of Model IV are reported in Table 2b. Per capita total government expenditure has no long run association with per capita GDP in model 4. Per capita expenditure on current subsidies and per capita GDP have no long run association in model 4a. Per capita expenditure on social, economic and education services and per capita GDP have long run and positive relationship in model 4b. No long run relationship exists between per capita expenditure on defence and per capita GDP in model 4c. Model 4d shows that per capita current expenditure and per capita GDP have no long run relationship. Per capita developmental expenditure and per capita GDP have no long run relationship in model 4e

Results of cointegration of Model V are presented in Table 2b. Model 5 shows that no cointegration exists among total government expenditure as a percentage of GDP and output. Expenditure on current subsidies as a percentage of GDP and output do not have any long run relationship in model 5a. Model 5b shows that expenditure on social, economic and education services as a percentage of GDP and output have long run and positive relationship. Results of model 5c indicate that no cointegration exists among expenditure on defence as a percentage of GDP and output. Model 5d shows no long run association between current expenditure as a percentage of GDP and output. No long run relationship exists between developmental expenditure as a percentage of GDP and output in model 5e.

Results of cointegration of Model VI are reported in Table 2b as well. In model 6, total government expenditure as percentage of GDP has no long run relationship with per capita GDP. Model 6a shows that no long run relationship exists between expenditure on current subsidies as percentage of GDP and per capita output. Expenditure on social, economic and education services as percentage of GDP and per capita output have long run and positive relationship in model 6b. Model 6c suggests that no cointegration exists between expenditure on defence as percentage of GDP and per capita output. No long run relationship exists between current expenditure as percentage of GDP and per capita output

in model 6d. Model 6e represents that no long run relationship exists between developmental expenditure as percentage of GDP and per capita output.

Table 2b. *Results of Engle-Granger Cointegration for Model IV, Model V, and Model VI*

Model	Dependent Variable	Constant	Coefficient of Explanatory Variable	Adjusted R-squared	CRDW	Calculated ADF Residuals Test
4	ln(GE/N)	-0.8026	0.92691 (78.1484)	0.9936	0.4397	-2.1063
4a	ln(ECS/N)	-4.0424	0.94444 (13.2331)	0.8170	0.5863	-2.5218
4b	ln(ESEES/N)	-3.4124	1.06737 (64.4350)	0.99070	0.8736**	-3.2125*
4c	ln(ED/N)	-0.6235	0.74304 (32.5869)	0.9645	0.1243	-1.4407
4d	ln(CE/N)	-1.7909	0.99949 (60.7408)	0.9895	0.3144	-1.9353
4e	ln(DE/N)	-0.3754	0.73050 (23.3858)	0.9333	0.4277	-2.8927
5	ln(GE/GDP)	-0.6438	-0.0598 (-6.1182)	0.4830	0.4395	-2.1140
5a	ln(ECS/GDP)	-3.8943	-0.0474 (-0.8085)	-0.0090	0.5873	-2.5242
5b	ln(ESEES/GDP)	-3.5656	0.0556 (4.0889)	0.2873	0.8763**	-3.2156*
5c	ln(ED/GDP)	-0.0736	-0.2098 (-10.968)	0.7536	0.1213	-1.4457
5d	ln(CE/GDP)	-1.8019	0.0004 (0.0313)	-0.0263	0.3145	-1.9291
5e	ln(DE/GDP)	0.2393	-0.2226 (-8.7703)	0.6693	0.4374	-1.9134
6	ln(GE/GDP)	-0.8026	-0.0731 (-6.1624)	0.4867	0.4397	-2.1062
6a	ln(ECS/GDP)	-4.0424	-0.0556 (-0.7785)	-0.0102	0.5863	-2.5218
6b	ln(ESEES/GDP)	-3.4124	0.0674 (4.0672)	0.2850	0.8736**	-3.2125*
6c	ln(ED/GDP)	-0.6235	-0.2570 (-11.2690)	0.7636	0.1243	-1.4407
6d	ln(CE/GDP)	-1.7909	0.0005 (-0.0305)	-0.0263	0.3145	-1.9353
6e	ln(DE/GDP)	-0.3754	-0.2695 (-8.6275)	0.6531	0.4277	-1.8927

Note: The ln represents logarithm. ***, **, * shows significance at 1%, 5%, and 10% level, respectively**.** CRDW stands for Cointegration Regression Durbin-Watson. The 1%, 5% and 10% critical value for the CDRW is 1.00, 0.78 and 0.69, respectively (Engle and Yoo, 1987). The 1%, 5% and 10% critical value for the ADF residual test is -3.9001, -3.3377 and -3.0462, respectively (MacKinnon, 1991). Standard errors are in parenthesis.

The next step after establishing the cointegration relationship between variables in model 1b, 3b, 4b, 5b, and 6b is to develop error correction model (ECM), which captures the speed of short run adjustments towards the long run equilibrium. Results of ECM of model 1b, 3b, 4b, 5b, and 6b are presented in Table 3. The estimated coefficient of ECT is negative and significant in all the models.

Table 3. *Results of ECM for Model I, Model III, Model IV, Model V, and Model VI*

Model	Dependent Variable	Constant	Coefficient of Explanatory Variable	ECT (-1)
1b	ln(ESEES)	0.1116	0.2583 (0.4216)	-0.4568*** (0.1324)
3b	ln(ESEES)	0.1024	0.4022 (0.4156)	-0.4186*** (0.1253)
4b	ln(ESEES/N)	0.0805	0.3697 (0.4200)	-0.4566*** (0.1337)
5b	ln(ESEES/GDP)	0.1116	-0.7417 (0.4216)	-0.4568*** (0.1324)
6b	ln(ESEES/GDP)	0.0805	-0.6303 (0.4200)	-0.4566*** (0.1337)

Note: *** shows significance at 1% level**.** Standard errors are in parenthesis.

The study analyzes the short run causality for validity of Wagner's or Keynesian hypothesis. Results of Granger causality test for Model I, Model II, and Model III are reported in Table 4a. Result shows that neither unidirectional nor bidirectional causality exists in model 1. Wagnerian hypothesis is applicable in model 1a, 1b, 1c and 1d indicating that an increase in GDP will increase expenditure on current subsidies, social economic and education services, defence, and current expenditure. However, causality flows from developmental expenditure to GDP in favor of Keynesian hypothesis in model 1e. An increase in developmental expenditure is a prerequisite to boost economic growth. Neither unidirectional nor bidirectional causality exists between government consumption expenditure and GDP in model 2. Model 3 shows that no causality exists between GDP per capita and total government expenditure. Unidirectional causality in favor of Wagner hypothesis flows from GDP per capita to expenditure on current subsidies, social, economic and education services, and current expenditure in model 3a, 3b, and 3d, respectively. Unidirectional causality in favor of Keynesian hypothesis flows from developmental expenditure to GDP per capita in model 3e.

Table 4a. *Results of Granger Causality Test for Model I, Model II, and Model III*

Model	Null Hypothesis	F-Statistics	Causality
1	∆ln(GDP) does not cause dln(GE)	1.8997	No
	∆ln(GE) does not cause ∆ln(GDP)	0.5151	No
1a	∆ln(GDP) does not cause ∆ln(ECS)	4.6510**	Yes (WH holds)
	∆ln(ECS) does not cause ∆ln(GDP)	1.6897	No
1b	∆ln(GDP) does not cause ∆ln(ESEES)	5.3076***	Yes (WH holds)
	∆ln(ESEES) does not cause ∆ln(GDP)	0.3417	No
1c	∆ln(GDP) does not cause ∆ln(ED)	2.6638*	Yes (WH holds)
	∆ln(ED) does not cause ∆ln(GDP)	0.0606	No
1d	∆ln(GDP) does not cause ∆ln(CE)	3.0045*	Yes (WH holds)
	∆ln(CE) does not cause ∆ln(GDP)	0.0490	No
1e	∆ln(GDP) does not cause ∆ln(DE)	2.1335	No
	∆ln(DE) does not cause ∆ln(GDP)	4.3446**	Yes (KH holds)
2	∆ln(GDP) does not cause ∆ln(GCE)	1.1845	No
	∆ln(GCE) does not cause ∆ln(GDP)	0.3642	No
3	∆ln(GDP/N) does not cause ∆ln(GE)	2.1426	No
	∆ln(GE) does not cause ∆ln(GDP/N)	0.6333	No
3a	∆ln(GDP/N) does not cause ∆ln(ECS)	4.8046**	Yes (WH holds)
	∆ln(ECS) does not cause ∆ln(GDP/N)	1.8617	No causality exists

Model	Null Hypothesis	F-Statistics	Causality
3b	∆ln(GDP/N) does not cause dln ESEES)	5.9135***	Yes (WH holds)
	∆ln(ESEES) does not cause ∆ln(GDP/N)	0.3612	No
3c	∆ln(GDP/N) does not cause ∆ln(ED)	2.4471	No
	∆ln(ED) does not cause ∆ln(GDP/N)	0.0219	No
3d	∆ln(GDP/N) does not cause ∆ln(CE)	2.9954*	Yes (WH holds)
	∆ln(CE) does not cause ∆ln(GDP/N)	0.0242	No
3e	∆ln(GDP/N) does not cause ∆ln(DE)	2.1894	No
	∆ln(DE) does not cause ∆ln(GDP/N)	4.7262**	Yes (KH holds)

Note: ***, **, * shows significance at 1%, 5%, and 10% level, respectively. WH, KH denotes Wagner's hypothesis and Keynesian hypothesis, respectively.

Table 4b reports the results of Granger causality test for Model IV, Model V, and Model VI. Unidirectional causality in favor of Wagner hypothesis flows from GDP per capita to total government expenditure per capita, expenditure on current subsidies per capita, social, economic and education services per capita, and current expenditure per capita in model 4, 4a, 4b and 4d, respectively. Unidirectional causality in favor of Keynesian hypothesis flows from developmental expenditure per capita to GDP per capita in model 4e. Neither unidirectional nor bidirectional causality exists in model 5, 5a, 5b, and 5d. Wagner hypothesis holds in model 5c, while Keynesian hypothesis holds in model 5e. Unidirectional causality in favor of Wagner hypothesis flows from GDP per capita to total government expenditure, expenditure on social, economic and education services, and defence expenditure as percentage of GDP in model 6, 6b, and 6c, respectively. However, unidirectional causality in favor of Keynesian hypothesis flows from developmental expenditure as percentage of GDP to GDP per capita in model 6e.

Table 4b. *Results of Granger Causality Test for Model I, Model II, and Model III*

Model	Null Hypothesis	F-Statistics	Causality
4	∆ln(GDP/N) does not cause ∆ln(GE/N)	2.6013*	Yes (WH holds)
	∆ln(GE/N) does not cause ∆ln(GDP/N)	0.4667	No
4a	∆ln(GDP/N) does not cause ∆ln(ECS/N)	4.5290**	Yes (WH holds)
	∆ln(ECS/N) does not cause ∆ln(GDP/N)	1.6890	No
4b	∆ln(GDP/N) does not cause ∆ln(ESEES/N)	6.0474***	Yes (WH holds)
	∆ln(ESEES/N) does not cause ∆ln(GDP/N)	0.3812	No
4c	∆ln(GDP/N) does not cause ∆ln(ED/N)	2.1376	No
	∆ln(ED/N) does not cause ∆ln(GDP/N)	0.0212	No
4d	∆ln(GDP/N) does not cause ∆ln(CE/N)	3.2304**	Yes (WH holds)
	∆ln(CE/N) does not cause ∆ln(GDP/N)	0.0050	No
4e	∆ln(GDP/N) does not cause ∆ln(DE/N)	2.3533	No
	∆ln(DE/N) does not cause ∆ln(GDP/N)	3.7982**	Yes (KH holds)
5	∆ln(GDP) does not cause ∆ln(GE/GDP)	1.7900	No
	∆ln(GE/GDP) does not cause ∆ln(GDP)	0.5152	No
5a	∆ln(GDP) does not cause ∆ln(ECS/GDP)	1.1281	No
	∆ln(ECS/GDP) does not cause ∆ln(GDP)	1.0305	No
5b	∆ln(GDP) does not cause ∆ln(ESEES/GDP)	1.0585	No
	∆ln(ESEES/GDP) does not cause ∆ln(GDP)	0.3417	No
5c	∆ln(GDP) does not cause ∆ln(ED/GDP)	3.2029**	Yes (WH holds)
	∆ln(ED/GDP) does not cause ∆ln(GDP)	0.0606	No
5d	∆ln(GDP) does not cause ∆ln(CE/GDP)	0.7485	No
	∆ln(CE/GDP) does not cause ∆ln(GDP)	0.0490	No

Model	Null Hypothesis	F-Statistics	Causality
5e	∆ln(GDP) does not cause ∆ln(DE/GDP)	0.8960	No
	∆ln(DE/GDP) does not cause ∆ln(GDP)	4.3445**	Yes (KH holds)
6	∆ln(GDP/N) does not cause ∆ln(GE/GDP)	2.5967*	Yes (WH holds)
	∆ln(GE/GDP) does not cause ∆ln(DGDP/N)	0.4667	No
6a	∆ln(GDP/N) does not cause ∆ln(ECS/GDP)	1.3944	No
	∆ln(ECS/GDP) does not cause ∆ln(GDP/N)	0.9612	No
6b	∆ln(GDP/N) does not cause ∆ln(ESEES/GDP)	2.2958*	Yes (WH holds)
	∆ln(ESEES/GDP) does not cause ∆ln(GDP/N)	0.4847	No
6c	∆ln(GDP/N) does not cause ∆ln(ED/GDP)	3.0955*	Yes (WH holds)
	∆ln(ED/GDP) does not cause ∆ln(GDP/N)	0.0212	No
6d	∆ln(GDP/N) does not cause ∆ln(CE/GDP)	1.0242	No
	∆ln(CE/GDP) does not cause ∆ln(GDP/N)	0.0050	No
6e	∆ln(GDP/N) does not cause ∆ln(DE/GDP)	0.8565	No
	∆ln(DE/GDP) does not cause ∆ln(GDP/N)	3.7982*	Yes (KH holds)

Note: ***, **, * shows significance at 1%, 5%, and 10% level, respectively. WH, KH denotes Wagner's hypothesis and Keynesian hypothesis, respectively.

In sum, there is no long run relationship between output and total government expenditures in all the models. Ansari et al. (1997), Biswal et al. (1999), Iyare and Lorde (2004), Afzal and Abbas (2010), Babatunde (2011), Rauf et al. (2012), and Muhammad et al. (2015) also found no cointegration between total government expenditure and economic growth. No long run relationship exists between defence expenditure and output in all the models. Chowdhury (1991), Cohen et al. (1996), Khilji and Akhtar (1997), Antonakis (1999), and Smyth and Narayan (2009) also found absence of cointegration between defense expenditure and output. Result also shows that no long run relationship exists among current expenditure and output in all the models. Bose et al. (2007) also found absence of long run association between current expenditure and output. However, in all the models expenditure on social, economic and education services have long run and positive relationship with GDP in Pakistan. Iqbal and Zahid (1998), Birdsall et al. (1995), Idrees and Siddiqi (2013), and Mercan and Sezer (2014) also found long run and positive relationship between social, economic and education services and output. In short run, unidirectional causality exists in favor of Wagener's hypothesis from output to expenditure on current subsidies, expenditure on social, economic and education services, defence expenditure, and current expenditure in majority of the models. However, unidirectional causality exists in favor of Keynesian hypothesis from developmental expenditure to output in all the models.

5. Conclusion

The government expenditure policy plays a critical role in the economy of both developed and underdeveloped countries. Previous literature provides mix result between public spending and economic growth as well as applicability of Wagner's or Keynesian hypothesis. Wagner (1883) argues that causality flows from GDP to public spending, while Keynes (1936) advocates that causality runs from government expenditure to GDP. The objective of this study is to examine the long run as well as short run relationship between government expenditure at aggregate as well as disaggregate level and economic growth in

Pakistan. There are different mathematical formulations of Wagner's law presented by different researchers. This study uses six functional forms of Wagner's law and further classify these forms to incorporate disaggregate expenditure. Study uses annual time series data of Pakistan from 1976 to 2015 and applies Engle and Granger (1987) cointegration test for long run relationship, while Granger (1969) causality test is employed for short run analysis.

Result shows that no long run relationship exists between GDP and total expenditure as well as its sub-components i.e. expenditure on current subsidies, defence expenditure, current expenditure, and developmental expenditure in all the models. However, long run relationship exists among GDP and expenditure on social, economic and education services in Pakistan. Therefore, an increase in economic growth will increase the expenditure on social, economic and education services because more educated and healthy people would take active participation in labor markets.

In short run, Granger causality shows mix results for the existence of Wagner's or Keynesian hypothesis in Pakistan. Unidirectional causality in favor of Wagener's hypothesis exists from GDP to expenditure on current subsidies, expenditure on social, economic and education services, defence expenditure, and current expenditure in majority of the models. None of these expenditures play any role in boosting economic growth, while an increase in GDP will increase the government expenditure in these subcomponents in the short run. However, unidirectional causality in favor of Keynesian hypothesis flows from developmental expenditure to GDP in all the models. Hence, an increase in developmental expenditure is a prerequisite to boost economic growth in Pakistan in the short run.

In the light of the above findings, the study suggests the following recommendations: Expenditure on social, economic and education services have long run positive relationship with economic growth, therefore, government should invest more on human resource development to achieve sustainable economic growth. Government has to reallocate more resources towards developmental projects to achieve higher economic growth in the short run.

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GARCH based VaR estimation: An empirical evidence from BRICS stock markets

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Abstract. *This paper examines the adequacy of GARCH based VaR models in risk estimation for BRICS emerging stock markets. This study uses the daily data of stock indices in these markets for the period 25th September 1997 to 30th March 2018. Here we employ SGARCH, EGARCH and GJR-GARCH models to test volatility persistence and leverage effect of these markets. It is observed that the volatility persistence and leverage effect is present in all these markets. In GARCH estimation the error distribution - students t is found to be suitable for Brazil, Russia, India, and South Africa whereas GED for China. From the backtesting results of Kupiec and Christoffersen test, it is found that these models are appropriate for Brazil, Russia, India, and South Africa in risk estimation at 99% one day VaR.*

Keywords: emerging markets, GARCH models, volatility and leverage, VaR estimation, backtesting.

JEL Classification: C22, C52, G15.

1. Introduction

Globalization and financial sector reforms in emerging market economies (EMEs) led to greater integration of emerging stock markets with the developed economies. As a result, these EMEs have started experiencing an increase in both domestic and foreign investments. When the foreign institutional or portfolio investments are directed towards a EMEs, the inflow of foreign currency into the EMEs adds volume to their stock markets and long-term investment for the infrastructure projects. As this capital flows increase, they bring profit opportunities along with high risk in these markets.

In the last three decades, the financial liberalization and integration of markets have resulted in unrestricted access to the cross-border capital flows which is an important source of external finance for emerging countries. Among these emerging countries, the BRICS countries gained a lot of importance as these BRICS countries are the most rapidly growing economies in terms of their GDP and the size of the stock markets. The market capitalization is a commonly measured indicator used to measure the size of the markets and the development levels of the markets across various countries markets. In the last two decades, the BRICS stock markets have increased its share in the world market and played a significant role in the growth of the world economy. The stock markets of BRICS grew from US$1.19 trillion to US$13 trillion during the period of 1997 to 2017 (WDI, 2019) which accounts for 17% of world market capitalization. Despite the robust growth experienced by these five markets in terms of size, the presence of excess volatility in the market returns would adversely affect the investment decisions and increases the risks in the investments. Also, the increased disorders during the crisis necessitate study on volatility behavior and accurate market risk prediction in the BRICS stock markets.

The outbreak of financial distress and uncertainty in the 1990's induced intensive research from financial institutions, regulators, and researchers to design sophisticated tools for measuring and forecasting risk. Though there exists several statistical risk measures such as standard deviation, variance, and Beta, Value-at-Risk (VaR) is the better measure to estimate the risk (Mehmet and Bulent (2012)). Value-at-Risk is described as the probable maximum loss to occur over a targeted period at a given level of confidence. The concept of VaR as a method of risk management was first introduced by J.P. Morgan in 1994 with its Risk Metrics system. Since then the researchers like Philippe (1996), Darrell and Jun (1997), and Kevin (1998) contributed for improving the accuracy of VaR estimates. In financial risk management, the application of VaR models gained a lot of importance and several studies have been conducted to compare the relative performance of various methods. However, researchers observed that there is no single measure to obtain accurate risk estimates, for example, Manganelli and Engle (2001), Christoffersen et al. (2001), Wong et al. (2002), Angelidis et al. (2004), Harmantzis et al. (2006), Raghavan et al. (2017).

The objective of this study is twofold. First, among the various types of VaR models, we employed the symmetric (SGARCH) and asymmetric (EGARCH, GJRGARCH) GARCH models under three error distributions of BRICS stock markets. The reason for using GARCH based VaR is that the GARCH model gives accurate time-varying volatility forecasts which are important in the calculation of VaR measures.(1) Second, to compare

the relative performance of GARCH models by evaluating the estimated VaR through backtesting measures under a risk management framework. The present study contributes to the existing literature on the following aspects. This study offers a comparison of various VaR models to the existing emerging market literature under GARCH framework. This study also encompasses the entire time period since the inception of VaR applications to the most recent period i.e. from 25th September 1997 to 30th March 2018.

The remainder of the paper is arranged as follows: In section 2 the relevant literature is reviewed. Section 3 describes the methodology. In section 4 we present data and empirical results of this study. Section 5 ends the paper with a summary and conclusions.

2. Literature review

The empirical studies available in the estimation of VaR for developing or emerging markets is limited compared to the developed markets (Julija, 2017). Da Silva et al. (2003) computed VaR estimates using extreme value theory (EVT) for Asian stock markets and found that extreme value method is conservative than traditional methods to determine capital requirements. Gencay and Selcuk (2004) estimated VaR for nine emerging markets using EVT, variance-covariance approach and historical simulation and showed that EVT-VaR results are more accurate at higher confidence interval. Timotheos et al. (2004) evaluated the performance of ARCH family models in estimating the daily VaR in five developed stock indices and showed that leptokurtic distributions are able to produce a better result than the normal distribution models. Bao, Lee, and Saltoglu (2006) compared the predictive power of VaR models for five Asian economies and found that exponentially weighted moving average (EWMA) of RiskMetrics model is appropriate for a calm period, while EVT performed better in the crisis period. Mike and Philip (2006) used RiskMetrics, GARCH models, and two long memory GARCH models on developed and emerging market indices and found that asymmetric GARCH with t-error distribution gives superior estimates than other methods. Zikovic and Aktan (2009) explored the relative performance of a wide array of VaR models for Turkish and Croatian stock indices and found that during crisis period except for EVT and historical hybrid simulation all the VaR models underpredict the true level of risk. Andjelic et al. (2010) investigated the relative performance of Historical simulation (HS) and Delta normal VaR methods for four emerging markets and opined that these models may not be suitable. Under the GARCH framework to estimate VaR for BELEX15 index based on normal and student t distribution, Nikolic and Dragan (2011) found that GARCH models perform better than IGARCH models in evaluating the VaR for the index. Stavros and Christos (2012) compared three methods such as exponentially weighted moving average (EWMA) of RiskMetrics, symmetric and asymmetric GARCH to evaluate VaR in developed markets and found that ARCH model provided satisfactory forecasts of VaR than the other methods. Bucevska (2013) estimated VaR for Macedonian stock indices and showed that the EGARCH model with student's t distribution and GJR-GARCH model are more robust and adequate for estimating and forecasting VaR. Mirjana and Sinisa (2013) evaluated the performance of symmetric and asymmetric GARCH models in Serbian stock markets and found that EGARCH model with normal distribution and GARCH with t distribution have made an

adequate estimation of VaR. Mirjana and Sinisa (2015) employed the GARCH type methods to estimate VaR for CEE emerging markets and showed that the GARCH model with t distribution gives better estimates than the normal distribution. Stavros and Artemis (2017) observed that the GARCH model is more suitable for evaluating VaR in developed markets. Julija et al. (2017) examined the adequacy of GARCH models in estimating the VaR of Montenegrin Stock market and found that these models with student-t and Johnson distribution produce relatively better VaR estimates.

With regard to BRICS stock markets, the literature has been very sparse. Mehmet and Bulent (2011) compared the GARCH models in estimating VaR for emerging (Brazil and Turkey) and developed (Germany and the USA) markets during the global financial crisis period and showed that GARCH(1,1) with student's t distribution performs better than the Normal. Leandro and Rosangela (2017) estimated VaR for S&P 500 and IBOVESPA index using the traditional GARCH and range based volatility GARCH models and showed that range based models provide more accurate VaR than the traditional GARCH models. Wilton et al. (2018) employed the GARCH models on Brazilian sectoral stock indices to estimate VaR and showed that the models with student-t distribution are more suitable. Jayanth R. Varma (1999) observed that the GARCH-GED performed well at all risk levels considered for Indian stock market. Indrajit Roy (2011) estimated VaR of Indian stock markets using historical simulation, GARCH models and found that the GARCH model produced better estimates of VaR. Sai Pranav et al. (2018) employed various GARCH models and observed that GJR-GARCH and EVT-t copula outperforms traditional VaR methods. Wai-Cheung Ip et al. (2006) compared the switching-regime ARCH model and the GARCH(1,1) in estimating the VaR for China stock markets and found that ARCH models preferred to GARCH(1,1). Guangquang Liu et al. (2018) showed that Heterogeneous autoregressive quarticity (HARQ) models estimate the VaR better than the HAR-type models in the Chinese stock market. McMillan and Thupayagale (2010) evaluated the performance of alternative volatility models in forecasting volatility and VaR in South Africa market and showed that asymmetric GARCH and long memory models outperform other models considered for the VaR estimation. Raghavan et al. (2017) estimated VaR for BRIC stock markets using historical, Monte Carlo and GARCH simulations and found that GJR-GARCH is more suitable for Brazil and China while the historical simulation is most appropriate for Russia and Indian stock markets. Lumengo and Lebogang (2018) compared the performance of three multivariate GARCH models, the DCC, ADCC and CCC GARCH models in estimating VaR for BRICS stock markets and found that the DCC performs the best among three GARCH models.

3. Methodology

GARCH-based VaR estimation

Mainly there are two fundamental approaches for VaR estimation viz. parametric and non-parametric. One of the most popular non-parametric methods among practitioners is the historical simulation (HS) because it works well for nonlinear components. However, the limitation of the HS is that it responds very late to the big movements. As far as the

parametric approach is concerned the GARCH based methods are chosen because they overcome the limitations of HS and ability to capture the volatility clustering in the series which is very common in stock returns. Considering that modeling time-varying risk is vital for the measurement of VaR, GARCH-based methodology provides valuable information about the forthcoming risk. If the GARCH model satisfies the volatility persistence or the sum of $ARCH\ and\ GARCH\ terms$ closer to unity it means that the model is able to describe the conditional volatility which is the basis for VaR estimation.

The GARCH (p, q) model

The time series econometric model with an autoregressive moving-average model (ARIMA) (m, d, n), for VaR estimation can be represented as:

$$r_t = \mu + \sum_{i=1}^{m} r_{t-i} + \sum_{j=1}^{n} \varepsilon_{t-j} \quad (1)$$

The conditional variance of returns r_t are estimated using the symmetric as well as asymmetric volatility models such as SGARCH, EGARCH and GJR GARCH.

To model the changes in the variance of time series Engle (1982) introduced the ARCH model, later Bollerslev (1986) extended this model and is given by

$$\sigma_t^2 = \Omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \quad (2)$$

This model includes p ARCH terms (ε_{t-i}^2) and q GARCH $\left(\sigma_{t-j}^2\right)$terms. The sum of ARCH and GARCH (α + β) terms indicates the level of persistence of volatility of the series. If the sum is close to one (unity) then the volatility is said to be persistence.

EGARCH (p, q) model

In order to accommodate the asymmetric response, a new class of models was introduced by Nelson (1991) and is known as exponential GARCH or EGARCH (p, q). The model is represented as

$$\log(\sigma_t^2) = \Omega + \sum_{i=1}^{q} \alpha(|Z_{t-i}| - E|Z_{t-i}|) + \gamma Z_{t-i} + \sum_{j=1}^{p} \beta \log(\sigma_{t-j}^2) \quad (3)$$

Where $Z_{t-i} = \frac{\varepsilon_{t-i}}{\sigma_{t-i}}$

For $\gamma < 0$ negative shocks will have a bigger impact on future volatility than positive shocks of the same magnitude. Furthermore, the sum of α and β governs the persistence of volatility shocks in the GARCH (1,1) model, whereas only parameter β governs the persistence volatility shocks in EGARCH(1,1) model.

GJR GARCH (p, q) model

Another variant of the asymmetric GARCH model to capture the leverage effect is the Glosten, Jagannathan, and Runkle (1993) model also known as the GJR GARCH (p, q) model. The Conditional variance of this model is specified as follows:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \gamma_i I_{t-i} \varepsilon_{t-i}^2 + \sum_{k=1}^{r} \beta_i \sigma_{t-i}^2 \quad (4)$$

In Eq (4), γ_i is the asymmetric or leverage effect and $I_{t-1}$is the dummy variable used to differentiate the good and bad news i.e., $I_{t-1} = 1$ if $\varepsilon_{t-1} < 0$ indicating bad news, and $I_{t-1} = 0$ if $\varepsilon_{t-1} \geq 0$ indicating good news. The GJR GARCH model specification assumes that unexpected changes in the market returns or $\varepsilon_t$will have a different effect on the volatility of stock return σ_t^2. Good news will lead to higher return; hence it is associated with higher variance through γ. A non-zero value of γ indicates the asymmetric nature of the returns. On the other hand, when γ is zero, the model reduces to symmetric GARCH model.

VaR estimation and Backtesting

In order to estimate VaR we have divided the entire data into the estimation window and a test window. The first 1000 observations have been used for estimation window and the remaining observations are used as an out-of-sample testing window for the 1-day VaR estimates at a 99% confidence level.

It is necessary to check the reliability and accuracy of the model once we estimate the VaR model. Using a statistical procedure for examining the appropriateness of the VaR model is called Backtesting. The backtesting enables us to ascertain the robustness of VaR estimates. There are two statistical tests namely Kupiec and Christoffersen tests for unconditional and conditional coverage respectively to know the number of exceedances. The unconditional coverage test checks whether in a given time interval the number of exceptions is equal to the number of theoretically estimated exceptions at a specified confidence level. Also, the unconditional coverage test assumes that the exceptions are evenly spread out across the period. However, in the real world the exceptions are very much bunched up and are not evenly spread out signaling they are conditioned or based on time variation[(2)]. The conditional coverage tests check whether the exceptions are time-varying and independent.

Kupiec (1995) test

The Kupiec test for unconditional coverage is based on the Binomial approach. It uses a likelihood ratio test to check whether the number of actual exceptions from the calculated VaR is equal to the theoretically expected exceptions number at a given confidence level. If the data suggests that the probability of exceptions is different than *p*, the VaR model is rejected. The Kupiec test statistic is computed from the following equation.

$$LR_{uc} = -2\log\left(\frac{(1-p)^{N-x}p^x}{\left(1-\frac{x}{N}\right)^{N-x}\left(\frac{x}{N}\right)^x}\right) \quad (5)$$

Where *x* is the number of failures, *N* the number of observations and *p = 1- VaR* level. This statistic is asymptotically distributed as a chi-square variable with 1 degree of freedom. The VaR model fails the test if this likelihood ratio exceeds a critical value. The critical value depends on the test confidence level.

Christoffersen's (1998) test

Christoffersen (1998) proposed a test for conditional coverage estimation. This test measures the dependency between consecutive days and the test statistic for independence is given by

$$LR_{cc} = -2\ln[\ln(1-\mathrm{p})^{\mathrm{N}-\mathrm{x}}\mathrm{p}^{\mathrm{x}}] + 2\ln\left[(1-\pi_{01})^{n_{00}}\pi_{01}^{n_{01}}(1-\pi_{11})^{n_{10}}\pi_{11}^{n_{11}}\right] \qquad (6)$$

n_{00} = Number of periods with no failures followed by a period with no failures.
n_{10} = Number of periods with failures followed by a period with no failures.
n_{01} = Number of periods with no failures followed by a period with failures.
n_{11} = Number of periods with failures followed by a period with failures.
and
π_{01} – Probability of having a failure on period t, given that no failure occurred on period $t-1 = n_{01} / (n_{00}+ n_{01})$
π_{11} – Probability of having a failure on period t, given that a failure occurred on period $t-1 = n_{11} / (n_{10}+ n_{11})$

This statistic is asymptotically distributed as a chi-square with 1 degree of freedom. You can combine this statistic with the frequency of unconditional coverage test to get a conditional coverage (CC) mixed test:

$LR_{CC} = LR_{uc} + LR_{ind}$

This test is asymptotically distributed as a chi-square variable with 2 degrees of freedom.

The null and alternative hypothesis of both the tests are given as follows

For Kupiec unconditional coverage test

H_0: Correct unconditional coverage.

H_1: Incorrect unconditional coverage.

Similarly, for Christoffersen conditional coverage.

H_0: Correct exceedances and independence of failures.

H_1: Incorrect exceedances and independence of failures.

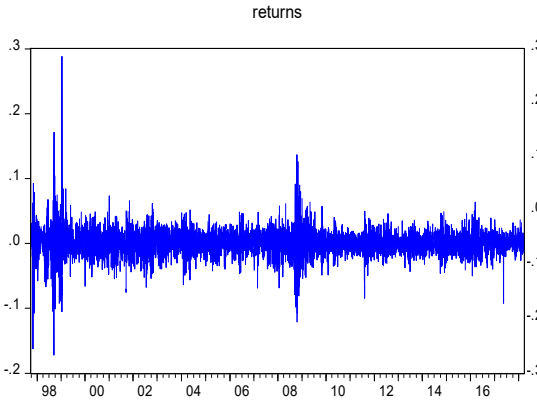
4. Data and results

This study uses the daily returns calculated from closing prices of BRICS stock markets for the period 25th September 1997 to 30th March 2018. The stock indices considered here are BOVESPA (Brazil), MICEX (Russia), SENSEX (India), SSE (China) and JSE (South Africa). The closing prices data for Brazil, Russia, India, and China are obtained from the Yahoo finance (www.yahoofinance.com) and South Africa prices are from the Wallstreet Journal (www.wsj.com). Here we consider all local currency denominated stocks for this analysis. The returns of these indices are calculated from the closing prices by using formula, $r_t = \log\left(\frac{p_t}{p_{t-1}}\right) \times 100$, where p_t and p_{t-1} are the closing prices at period (t) and

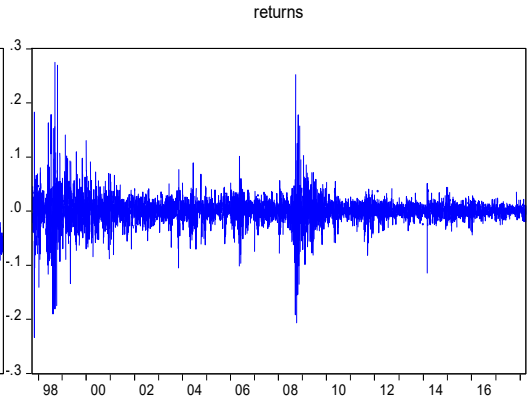
(t-1) respectively. It is observed from the log return series of BRICS stock markets that all the indices have volatility clustering[3] (Fig 1) which is also the prerequisite for GARCH analysis.

Figure 1: *Daily log return series of BRICS Stock Markets*

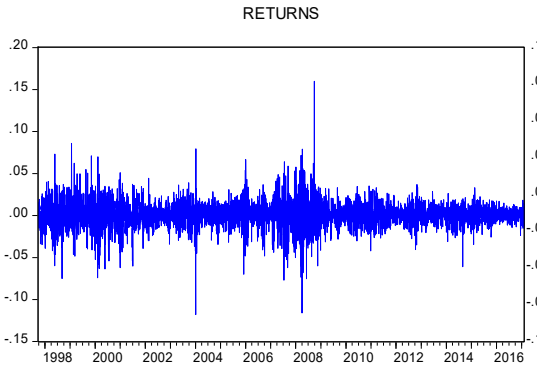
BOVESPA



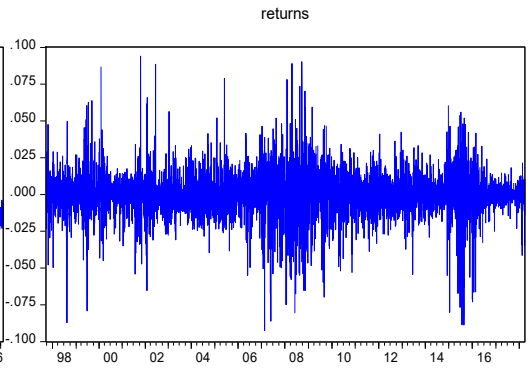
MICEX



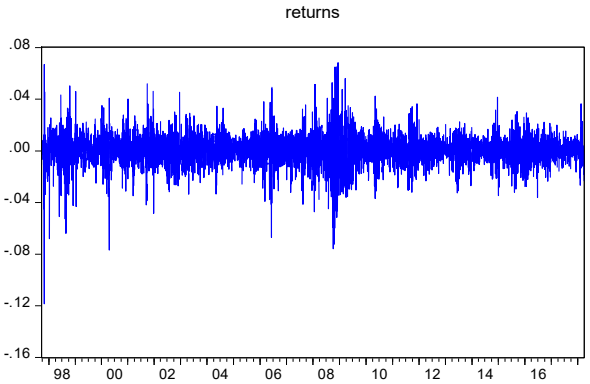
SENSEX



SSE



JSE



To know the important characteristics of BRICS stock market returns we calculated the summary statistics measures and provided in Table 1.

Table 1. *Descriptive Statistics of returns of BRICS Stock Markets*

Stock Indices	Mean	Std. Dev	Skewness	Kurtosis	JB Statistic	ARCH LM(Lag=5)
BOVESPA	0.039	2.032	0.320	16.91	40975.60(0.00)	447.68(0.00)
MICEX	0.061	2.574	0.123	19.63	58944.26(0.00)	782.12(0.00)
SENSEX	0.043	1.524	-0.108	9.58	9128.35(0.00)	464.67(0.00)
SSE	0.021	1.585	-0.318	7.85	4956.30(0.00)	379.94(0.00)
JSE	0.040	1.229	-0.427	8.29	6125.67(0.00)	719.00(0.00)

Note: p values are given in parenthesis.

From Table 1, it is observed that the mean returns of all the BRICS markets are positive indicating on an average all these markets have experienced profits during the study period. The larger value of standard deviation and mean of returns in case of Russian market indicating that higher the risk and higher the return. The skewness for all the return series is asymmetric with both positive and negative asymmetric values. The Kurtosis values indicate that the return series having fat tails which is a common phenomenon of stock returns. The JB statistic for all the markets is statistically significant, thereby indicating the return distributions are non-normal. The ARCH-LM test indicates that all the series have rejected the null hypothesis of no ARCH effect specifying that GARCH models can be employed.

In order to select the ARMA lag order and GARCH specification, we used the AIC criterion. The results of SGARCH, EGARCH and GJRGARCH models along with the error distributions: normal, students t and generalized error distribution are estimated based on AIC of BRICS returns series and are provided in following tables.

Table 2. *Estimation of SGARCH with Normal error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0007 (3.33)	0.001 (5.163)	0.0008 (5.310)	0.0002 (1.638)	0.0007 (5.395)
AR(1)	0.705 (1145.76)	-1.030 (-71.07)			
AR(2)	-0.997 (-1835.68)	-0.953 (-65.16)			
MA(1)	-0.707 (-1654.79)	1.046 (75.28)	0.083 (5.47)		0.064 (4.181)
MA(2)	0.998 (2627.21)	0.954 (66.88)	-0.012 (-0.89)		
Ω	0.000007 (7.560)	0.000004 (13.876)	0.000001 (7.14)	0.000001 (7.170)	0.000002 (7.771)
α	0.093 (16.51)	0.111 (19.75)	0.089 (18.98)	0.079 (19.87)	0.113 (17.675)
β	0.885 (118.47)	0.883 (172.16)	0.905 (211.07)	0.917 (248.87)	0.869 (133.79)
α+β	0.978	0.994	0.994	0.996	0.982
AIC	-5.2701	-5.1575	-5.8633	-5.7423	-6.2317

Table 3. *Estimation of SGARCH with Students t error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0007* (3.33)	0.001* (5.01)	0.0008* (5.05)	0.0002 (1.64)	0.0007* (5.36)
AR(1)	1.528* (46.89)	-0.99* (-20.09)			
AR(2)	-0.919* (-17.57)	-0.849* (-6.8)			
MA(1)	-1.518* (-42.74)	1.02* (18.55)	0.083* (5.55)		0.064* (4.36)
MA(2)	0.903* (15.85)	0.85* (7.5)	-0.012 (-0.86)		
Ω	0.000008 (3.62)	0.000005 (4.08)	0.000002 (1.36)	0.000002 (1.36)	0.000003 (2.31)
α	0.079* (22.69)	0.099* (12.29)	0.090* (5.84)	0.075* (6.3)	0.104* (8.36)
β	0.903* (149.02)	0.900* (94.32)	0.903* (59.43)	0.921* (75.19)	0.878* (62.33)
α+β	0.982	0.999	0.993	0.996	0.983
AIC	-5.2960	-5.2294	-5.9054	-5.8221	-6.2561

Table 4. *Estimation of SGARCH with GED error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0008 (4.109)	0.0009 (5.186)	0.0008 (5.502)	0.0005 (3.796)	0.0008 (5.942)
AR(1)	1.491 (10.524)	-1.031 (-68.95)			
AR(2)	-0.706 (-5.592)	-0.955 (-66.28)			
MA(1)	-1.491 (-10.267)	1.042 (67.29)	0.082 (5.710)		0.054 (5.708)
MA(2)	0.692 (5.241)	0.954 (64.53)	-0.015 (-1.133)		
Ω	0.000007 (5.382)	0.000003 (5.35)	0.000001 (4.537)	0.000001 (3.83)	0.000002 (5.708)
α	0.088 (11.451)	0.099 (12.037)	0.089 (11.728)	0.075 (10.19)	0.109 (12.447)
β	0.890 (90.958)	0.897 (119.50)	0.904 (124.37)	0.921 (132.06)	0.872 (93.94)
α+β	0.978	0.996	0.993	0.996	0.981
AIC	-5.2899	-5.2144	-5.8976	-5.8252	-6.2493

Table 5. *Estimation of EGARCH with Normal error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0002 (1.048)	0.0008 (4.459)	0.0004 (2.526)	0.0001 (1.017)	0.0003 (2.793)
AR(1)	0.165 (8.946)	0.257 (0.266)			
AR(2)	-0.941 (-48.733)	0.050 (0.087)			
MA(1)	-0.162 (-9.238)	-0.222 (-0.230)	0.094 (6.263)		0.067 (4.71)
MA(2)	0.950 (53.422)	-0.078 (-0.129)	-0.003 (-0.225)		
Ω	-0.315 (-11.437)	-0.306 (-19.581)	-0.339 (-15.75)	-0.239 (-14.681)	-0.426 (-15.956)
α	0.154 (15.083)	0.234 (27.530)	0.194 (21.24)	0.178 (21.98)	0.202 (23.803)
β	0.975 (344.81)	0.983 (661.21)	0.978 (470.95)	0.987 (604.27)	0.970 (343.31)
γ	-0.081 (-13.758)	-0.038 (-8.99)	-0.080 (-13.78)	-0.025 (-5.988)	-0.093 (-15.90)
AIC	-5.2885	-5.1557	-5.8803	-5.7562	-6.2529

Table 6. *Estimation of EGARCH with Students t error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0004* (2.5691)	0.0008 (5.13)	0.0005 (3.59)	0.0004 (3.18)	0.0005 (3.50)
AR(1)	1.559* (996.29)	0.299 (0.68)			
AR(2)	-0.995* (-712.77)	-0.021 (-0.21)			
MA(1)	-1.555* (-980.54)	-0.258 (-0.59)	0.095 (6.81)		0.058 (3.71)
MA(2)	0.988 (76029.59)	-0.016 (-0.17)	-0.010 (-0.78)		
Ω	-0.167 (-20.35)	-0.077 (-10.34)	-0.188 (-14.53)	-0.102 (-10.22)	-0.194 (-18.13)
α	0.143 (9.18)	0.199 (38.17)	0.194 (12.96)	0.171 (91.69)	0.161 (8.41)
β	0.979 (929.23)	0.990 (998.31)	0.978 (659.73)	0.988 (814.21)	0.978 (814.80)
γ	-0.078 (-9.84)	-0.033 (-4.01)	-0.188 (-14.53)	-0.025 (-3.342)	-0.087 (-10.73)
AIC	-5.3108	-5.2299	-5.9191	-5.830	-6.2730

Table 7. *Estimation of EGARCH with GED error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0004 (1.995)	0.0007 (4.341)	0.0005 (3.535)	0.0004 (3.453)	0.0005 (3.725)
AR(1)	0.273 (18.987)	-1.033 (-68.202)			
AR(2)	-0.948 (-57.731)	-0.954 (-65.54)			
MA(1)	-0.271 (-19.209)	1.045 (67.14)	0.090 (6.243)		0.058 (4.046)
MA(2)	0.954 (60.652)	0.954 (64.21)	-0.009 (-0.662)		
Ω	-0.292 (-8.595)	-0.243 (-10.70)	-0.336 (-10.206)	-0.229 (-7.891)	-0.394 (-11.009)
α	0.147 (10.867)	0.203 (14.50)	0.194 (13.40)	0.171 (11.816)	0.190 (16.134)
β	0.978 (281.66)	0.988 (470.77)	0.978 (307.33)	0.988 (349.16)	0.973 (265.83)
γ	-0.079 (-10.317)	-0.033 (-4.656)	-0.083 (-9.452)	-0.025 (-3.33)	-0.090 (-11.859)
AIC	-5.3041	-5.2139	-5.9104	-5.8325	-6.266

Table 8. *Estimation of GJR-GARCH with Normal error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0003 (1.373)	0.0007 (3.655)	0.0005 (3.401)	0.0001 (0.926)	0.0004 (2.989)
AR(1)	0.264 (13.731)	-1.034 (-74.64)	0.092 (5.901)		
AR(2)	-0.929 (-58.253)	-0.954 (-66.01)	-0.005 (-0.356)		
MA(1)	-0.259 (-14.203)	1.049 (79.10)			0.069 (4.551)
MA(2)	0.938 (66.38)	0.956 (67.23)			
Ω	0.00009 (9.091)	0.000005 (13.320)	0.000002 (8.855)	0.000001 (7.340)	0.000003 (9.549)
α	0.019 (3.254)	0.082 (13.253)	0.045 (8.835)	0.066 (13.203)	0.039 (7.243)
β	0.892 (114.61)	0.883 (174.12)	0.895 (169.89)	0.916 (243.26)	0.879 (147.61)
γ	0.122 (12.822)	0.055 (7.488)	0.100 (11.25)	0.028 (4.657)	0.120 (12.039)
AIC	-5.2915	-5.1627	-5.8765	-5.7443	-6.2506

Table 9. *Estimation of GJR-GARCH with Students t error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0003 (1.47)	0.0007* (3.40)	0.0005* (3.291)	0.0001 (0.890)	0.0004* (2.904)
AR(1)	1.561* (1552.24)	0.346 (0.524)			
AR(2)	-0.995* (-1075.24)	0.163 (0.499)			
MA(1)	-1.557* (-8909.31)	-0.294 (-0.446)	0.092* (6.090)		0.068* (4.678)
MA(2)	0.991* (27002.27)	-0.198 (-0.570)	-0.0048 (-0.337)		
Ω	0.000009 (26.31)	0.000005 (4.067)	0.000003 (2.403)	0.000002 (1.554)	0.000003 (4.636)
α	0.0208* (6.70)	0.082* (8.84)	0.045* (5.950)	0.065* (6.397)	0.035* (4.636)
β	0.892* (159.21)	0.879* (99.53)	0.895* (82.72)	0.916* (83.71)	0.889* (78.67)
γ	0.117* (10.34)	0.061* (5.044)	0.099* (6.461)	0.028* (3.151)	0.113* (7.995)
AIC	-5.3119	-5.2315	-5.9719	-5.8234	-6.2695

Table 10. *Estimation of GJR-GARCH with GED error distribution*

	BOVESPA	MICEX	SENSEX	SSE	JSE
μ	0.0004 (2.203)	0.0008 (4.482)	0.0006 (4.06)	0.0004 (3.523)	0.0005 (3.957)
AR(1)	0.283 (15.279)	-1.005 (-23.840)			
AR(2)	-0.941 (-50.831)	-0.884 (-29.74)			
MA(1)	-0.279 (-15.600)	1.025 (23.73)	0.088 (6.029)		0.059 (3.990)
MA(2)	0.947 (54.368)	0.883 (29.36)	-0.010 (-0.72)		
Ω	0.000008 (6.55)	0.000003 (5.48)	0.000002 (5.871)	0.000001 (3.941)	0.000002 (6.943)
α	0.018 (2.363)	0.075 (7.775)	0.042 (5.007)	0.062 (6.96)	0.037 (5.135)
β	0.898 (92.198)	0.896 (118.81)	0.891 (107.57)	0.918 (129.77)	0.882 (108.81)
γ	0.115 (9.574)	0.046 (3.938)	0.109 (7.983)	0.027 (2.529)	0.116 (9.141)
AIC	-5.3060	-5.2168	-5.9085	-5.8261	-6.2635

The ARIMA(m, d, n)-GARCH(p, q) specification for each market is selected based on the AIC criterion. From the above Tables 2-10 it is observed that the symmetric GARCH models of all the markets show that there is strong volatility persistence in all the markets

as the lagged squared residuals parameter(α) and the lagged conditional variance parameter(β) are significant and the sum of both is close to unity. Also, both the asymmetric GARCH models reveal that the asymmetric or leverage effect (γ) is statistically significant in all the markets for both the models.

For the VaR estimation, here we consider all the three models namely SGARCH, GJR-GARCH, and EGARCH models with the error distributions as normal, students t, and GED distributions. From the above results, we can see that the Brazil, Russia, India, and South Africa markets are fitting with students t distribution and GED distribution for China as these distributions having minimum AIC. The same is observed by Mehmet and Bulent (2011) for Brazil. However, each market following different orders of ARIMA-GARCH orders and we can observe for Brazil, ARIMA(2,0,2)-GARCH(1,1), Russia ARIMA(2,0,2)-GARCH(1,1), India ARIMA(0,0,2)-GARCH(1,1), China ARIMA(0,0,0)-GARCH(1,1), South Africa, ARIMA(0,0,1)-GARCH(1,1).

The accuracy of the model considered for the estimation of VaR is measured comparing the number of actual or realized exceedances with the frequency of expected exceedances for a level of significance. The best model is the one which has the realized return exceedances closer to the expected exceedances. If the actual exceedances are more than the expected exceedances it indicates the model has underestimated the risk. On the contrary, if the expected exceedances are more than the actual exceedances it denotes that the model has overestimated the risk. When actual and expected exceedances are closer we can say that the model is properly estimated the risk. However, since we are interested in the left tail of the distribution (losses), corresponding to a long-position portfolio, an actual failure rate lower than the expected is "good" enough.

We perform the backtesting using unconditional and conditional converge tests for all the models considered in the study. The unconditional coverage test checks whether the number of actual exceedances is closer to the expected exceedances while the conditional coverage test checks whether the exceptions are time-varying and serially independent. The Kupiec and Christoffersen tests are used for unconditional and conditional coverage tests at 1% level of significance and the results are given in Table 11.

Table 11. *Backtesting results of VAR models*

Stock Indices		SGARCH	EGARCH	GJR GARCH
BOVESPA	Expected Exceedance	40.7	40.7	40.7
	Actual Exceedance	30	32	27
	The Kupiec test 99%	3.116	2.019	5.272
	p-value	0.07	0.155	0.022
	The Christoffersen test 99%	3.562	2.526	6.633
	p-value	0.168	0.283	0.06
MICEX		SGARCH	EGARCH	GJR GARCH
	Expected Exceedance	41	41	41
	Actual Exceedance	37	39	38
	The Kupiec test 99%	0.427	0.11	0.242
	p-value	0.513	0.74	0.623
	The Christoffersen test 99%	1.1	0.858	0.952
	p-value	0.577	0.651	0.621

Stock Indices		SGARCH	EGARCH	GJR GARCH
		SGARCH	EGARCH	GJR GARCH
	Expected Exceedance	40.5	40.5	40.5
	Actual Exceedance	35	35	33
SENSEX	The Kupiec test 99%	0.799	0.799	1.509
	p-value	0.371	0.371	0.219
	The Christoffersen test 99%	1.825	1.825	2.707
	p-value	0.402	0.402	0.258
		SGARCH	EGARCH	GJR GARCH
	Expected Exceedance	39.6	39.6	39.6
	Actual Exceedance	58	57	54
SSE	The Kupiec test 99%	7.535	6.781	4.735
	p-value	0.006	0.009	0.03
	The Christoffersen test 99%	7.561	6.819	4.823
	p-value	0.023	0.033	0.09
		SGARCH	EGARCH	GJR GARCH
	Expected Exceedance	41.2	41.2	41.2
	Actual Exceedance	40	42	44
JSE	The Kupiec test 99%	0.078	0.016	0.188
	p-value	0.78	0.901	0.665
	The Christoffersen test 99%	0.986	0.584	1.138
	p-value	0.611	0.747	0.566

Note: The Kupiec and Christoffersen critical values at 99% are 6.634 and 9.210, respectively.

From Table 11, we can see that Brazil, Russia, India, and South Africa markets have passed both the tests for all the three models at a 99% confidence level. This indicates that these models give correct VaR estimates regarding unconditional coverage (expected and actual exceedances are closer) and conditional coverage. However, in the case of South Africa, though the models have failed to reject the null hypothesis, both the asymmetric GARCH models have underestimated the VaR value as the actual exceedance is more than the expected exceedance. The GARCH models for China have failed both the test at a 99% confidence level indicating that these models have rejected the null hypothesis of correct exceedance and independence of failures. We can conclude that the GARCH based VaR are suitable for Brazil, Russia, India, and South Africa markets but not for China stock markets.

Summary & Conclusions

Ever since the emerging economies initiated reforms in their financial sector the stock markets experienced a remarkable growth due to an increase in foreign capital inflows. However, the asymmetric information in emerging markets results in a high degree of volatility than the developed markets. The presence of volatility makes the investments more risky for both domestic and foreign investors. Thus, it is important to study the volatility behavior of emerging markets and also estimation which arises due to excessive volatility in these markets. In this context, this study aims at examining the volatility behavior and estimation of the risk in BRICS emerging markets by considering the daily stock indices from 25th September 1997 to 30th March 2018.

This study examined the adequacy of GARCH models in estimating the Value at Risk (VaR) by employing symmetric and asymmetric GARCH models to estimate the VaR for BRICS stock markets. The results of the study reveal that for Brazil, Russia, India, and South Africa markets both symmetric and asymmetric GARCH models with student t distribution have passed the Kupiec and Christoffersen with a 99% level of confidence. Whereas in the case of China, the models (with GED error distributions) have failed the unconditional and independence test with a 99% level of confidence.

Notes

(1) David McMillan and Pako Thupayagale (2010).
(2) Some point in time the exceptions are higher and sometimes lower.
(3) Mandelbrot (1963) noted: "...large changes tend to be followed by large changes of either sign, and small changes tend to be followed by small changes..."

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Does FDI substitute exports of home country? A case of US FDI in select Asian economies

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Abstract. *This paper analyzes the substitution effect of outward FDI on the exports of the home country. The US is selected as the home country for its position amongst the top FDI providing countries and select Asian economies as host countries viz. China, Japan, India, Republic of Korea and Thailand. Study period covered is from 1991 to 2017. It is found that in case of Japan, US FDI in Japan had positive effect on exports of US to Japan. In case of all other economies no relation between US FDI and exports was observed. Thus the substitution effect was not observed in case of US FDI on US exports for the economies of China, Japan, India, Republic of Korea and Thailand.*

Keywords: Foreign Direct Investment, exports, Outward FDI, home country, substitution, United States, Asian economies, China, Japan, India, Republic of Korea, Thailand.

JEL Classification: A1, C0, C1, C2, E0, F0, F1, F2, F4.

I. Introduction

Foreign Direct Investment (FDI) involves investment by an entity of one country into another country. It includes setting up of operations abroad, purchase of assets in a foreign country, acquiring controlling stake in a foreign company, merger & acquisition abroad, setting up of a subsidiary in the foreign country etc. However, it does not involve such equity investments which do not acquire controlling stake as such investments are passive in nature and fall in the domain of portfolio investments.

Though there are various theories which explain the motivation of FDI, the FDI activity does have its pros and cons for both the home country and the host country. One such issue on which this paper is based upon is the effect outward FDI has on the exports of the home country. The concern of this paper is finding the possibility of a negative effect of this outward FDI on home country in the form of export substitution. Export substitution and resultant contraction of employment opportunities in home country causes balance of payment imbalances and labour market disruptions in the home country.

In this paper we study the substitution effect of outward FDI on exports of the home country. We have selected US as the home country considering its position amongst the top FDI providing countries and select Asian economies as host countries viz. China, Japan, India, Republic of Korea (Korea) and Thailand. The criteria used for selecting these Asian economies were average of GDP for F.Y. 2013 to F.Y. 2017. Though Indonesia was also one of the countries in the initial list of selected countries, the same was removed due to unavailability of US FDI data for the country. The above selected Asian nations are major emerging economies in Asia and have resultant importance and impact of their international activities on world trade and investment. The study period covered is from 1991 to 2017. This paper comprises of seven sections. Section I gives a brief introduction about the purpose of this paper. Section I provides the theoretical background of this study. It explains the various prominent theories of FDI. Section III discusses the previous empirical work on the effects of outward FDI on exports of the home country. The process of data collection and the research methodology is explained in Section IV and V respectively. The various statistical methods and test such as Correlation Analysis, Augmented Dickey-Fuller Unit Root Test, Co-integration Test, Granger Causality Test and Vector Autoregression (VAR) are explained. The process of selection of Asian economies is also described in this section. Empirical Results are presented with discussion in Section VI. The paper ends with conclusions of the study in Section VII.

II. Theoretical background

International trade and FDI in various forms have been in existence for several years. During the modern era, with the growth of international trade and the theoretical work on the subject, the concept of FDI also started to gain prominence. Various theories have been developed by the researchers which try to explain motivation for FDI. The most relevant FDI theories among them are MacDougall-Kemp Hypothesis, Industrial Organisation Theory, Location Specific Theory, Product Cycle Theory, Internalisation Approach and Eclectic Paradigm.

The MacDougall-Kemp hypothesis developed by MacDougall (1958) and Kemp (1964) postulates free movement of capital from capital abundant country to capital scarce country there by equalizing the marginal productivity of capital between the two countries. Industrial organisation theory propounded by Hymer (1976) states that an oligopolistic multinational firm with some kind of superiority looks for control in an imperfect market for maximizing its profit. Such advantages are mostly technological that helps it to produce product superior than the existing product. Location specific theory by Hood and Young (1979) emphasizes on the location specific advantages which motivates a firm to operate in another country such as low cost labour, availability of raw material etc. Product cycle theory by Vernon (1966) is based on the product life cycle due to which the product moves to various countries at different stages of its life cycle. The stages can be named sequentially as innovation, maturing, standardizing and dematuring of the product. Internalisation approach by Buckley and Casson (1976) emphasizes that the transaction costs involved in intra-firm transfer of intermediate products is almost zero whereas it is exorbitant in case of unrelated firms. This provides motivation for a firm to go international and set up a firm instead of an arms-length transaction incurring high costs. Eclectic paradigm by (Dunning 1980, 1993) is the combination of industrial organization theory, internalisation theory and location theory. It postulates that at any particular time, the stock of foreign assets owned by a MNC is determined by a combination of ownership advantages (O), location specific endowments (L) and the extent of marketing of these advantages among various units of the firm (I).

III. Previous empirical work

Though there is a dearth of theories which study the effects of outward FDI on exports of the home country, there is some empirical literature available. We will now discuss this literature. The literature work on outward FDI is divided into two major parts. One part studies the effects on domestic exports caused by production abroad causing reduction in exports from the home country i.e. export substitution. Second part deals with contraction of employment in the home country as an aftereffect of export substitution. The understanding in this case is that employment contraction is the spillover effect caused by substitution of exports brought over by outward FDI. It considers that domestic employment is substituted by foreign employment which is caused by production in overseas facilities when firms operate abroad. As this paper is focused only on the effects of outward FDI on exports of the home country, the literature discussed also pertains to this aspect only. The employment effect is not the subject of study of this paper.

The substitution effect was first documented by Mundell (1957) is his paper where he established that there is substitution between trade and FDI. Though his analysis makes assumptions which are far from reality the same maintains the central theme of substitution intact. Svensson (1996) in his research on Swedish multinationals found that increased foreign production both replaces exports of finished goods and attracts intermediate goods from the parent. The net effect found to be negative, albeit significant only in the case of affiliate exports in the EC. Agarwal (1996) suggested that efficiency seeking FDI may cause more unemployment due to exports substitution and reimports than employment

through additional exports to host countries. Gopinath, Pick and Vasavada (1998) in their study of US Food Processing Industry found a small substitution between foreign affiliate sales and exports. Markusen and Maskus (2001) in their survey of literature observed emerging evidence that FDI production complements increased trade in intermediates but in general substitutes for trade in final goods.

However, there are various studies which also found positive or complementary relation between FDI and Exports. Lipsey and Weiss (1981) found that U.S. manufacturing investment abroad is positively related to US exports. Lecraw (1993) found that the performance of Indonesian firms that invested abroad improved dramatically after their investment in terms of management expertise, exports, quality, and costs relative to their past performance and relative to the other firms. Blomstrom and Kokko (1994) summarized some research in respect of FDI by Swedish multinationals and found the net effect of the relation between foreign investment and home country exports and employment to be complementary. Pfaffermayr (1994) in his study of Austrian economy observed possibility of a positive effect of exogenously increased foreign direct investment on exports and a negative effect of export shocks on foreign direct investment. However, significant long-run effects were not established. In another study, Pfaffermayr (1996) in respect of Austrian manufacturing found significant complementary relationship between FDI and exports in the eighties and early nineties. Long-run multipliers of exogenously increased FDI and exports were found to be positive but small in magnitude. Lin (1995) estimated the effect of Taiwan's outward FDI in four ASEAN countries viz. Indonesia, Malaysia, the Philippines and Thailand on exports to and imports from these host countries and the trade effect of inward FDI from these countries. It was observed that Taiwan's outward FDI has greatly increased trade with these host countries. Clausing (2000) using two panel data sets of operations of US multinational firms abroad and the operations of foreign multinational firms in the US found that multinational activity and trade are complimentary activities, more particularly multinational activity and intra firm trade. Head and Ries (2001) using a panel dataset containing 25 years of data on 932 Japanese manufacturing firms investigated the effect of direct investment abroad on exports. They found complementarity for the full sample of firms. Alguacil, Cuadros and Orts (2002) observed positive causal relationship from FDI to exports in Mexico during the period 1980 to 1999. Camarero and Tamarit (2004) estimated the demand for exports and imports of manufactured goods for the majority of the EU countries and the United States and Japan. The authors included both the traditional determinants of trade and also the stock of foreign direct investment (FDI) as explanatory factors. They mainly found a complementary relationship between trade and FDI. Kim and Mah (2006) analyzed the pattern of FDI flows of South Korea into China. They observed that China has become the largest destination for Korean FDI and it appeared to complement Seoul’s export to China. Martínez-Martín (2010) in the analysis of Spanish economy found positive causality relationship running from outward FDI to exports. In respect of goods it was stronger and for services it was weaker in the long run. The complementary relation was found consistent with vertical FDI strategies. In the short run, however, only exports of goods were found to be affected positively by FDIs. Chen, Hsu and Wang (2012) using data of Taiwanese manufacturing firms found that exports in Taiwan are positively associated with outward FDI by Taiwanese firms supporting the view that outward FDI complements home country exports.

Some authors could not find any relation between outward FDI and exports or had mixed results. They could not find any definitive relation. Buckley and Casson (1981) attempted to model for optimal timing of FDI. They analysed foreign market servicing decision of firms in terms of the costs of servicing the foreign market, demand conditions in that market and host market growth. It was concluded that decisions on market servicing are more complex than is sometimes assumed. Lipsey and Weiss (1984) observed that foreign production by a US firm did not substitute for exports by the firm from the US to the area in which the production takes place. Blomstrom, Lipsey and Kulchycky (1988) considering the theoretical models of direct foreign investment, which then typically treated the size of a market as exogenous and a company's share of a market as a function of its firm specific capital, opined that the decision of firms on how to serve foreign markets is a matter of choice among other methods such as to produce abroad, exporting from the home country and licensing others to produce the firm's product. Kim and Kang (1997) examined the relationship between outward FDI and exports in South Korea and Japan. In both the countries, outward FDI was not found to decrease exports nor were there any positive effects of outward FDI on exports. Blonigen (1999) found substantial evidence for both a substitution and a complementarity effect between affiliate production and exports with Japanese automobile parts for the US market. Head and Ries (2004) observed existence of substitutive relationship between FDI and exports in several papers. They also found that FDI sometimes complements exports by stimulating exports of intermediate goods for use by overseas affiliate. Africano and Magalhães (2005) found that the stock of outward FDI has no significant relation either with Portuguese exports or imports. Ellingsen, Likumahuwa and Nunnenkamp (2006) did not find that Singapore's FDI has replaced exports. Majeed and Ahmad (2007) in their study of developing countries found no evidence of a substitution relationship between FDI and exports. Goh, Wong and Tham (2012) in the study of Malaysian economy did not find any significant relation between outward foreign direct investment and trade. Bhasin and Paul (2016) analyzed the relationship of outward FDI with exports of the home country, for a group of developing/ emerging countries in Asia. They found no evidence of long-run causality from OFDI to exports and also no evidence of short-run causality between OFDI and exports in either direction.

IV. Data collection

The GDP data for selection of top Asian economies has been obtained from the World Bank Database for the years 2013 to 2017. Data on foreign direct investment of US in the shortlisted Asian economies has been obtained from the website of the United States, Bureau of Economic Analysis. Data on Exports from US to these economies has been collected from the website of United Nations, Comtrade Database. Both the FDI and exports data cover the period from financial year 1991 to 2017. Due to limited availability of data for services, the paper has only considered exports of goods and FDI in manufacturing sector. All data used is in USD millions. FDI and exports data has been transformed into natural logs for ease of analysis. The details of variables and data is presented in Table 1.

Table 1. *Variables used in analysis of relation between US FDI Position and US Exports in Select Partner Nations (Period F.Y. 1991 - 2017)*

Variable	Symbol	Data Source	Granularity	Transformation	Ln Symbol	Currency
US FDI in China	FDI_CHN	US - Bureau of Economic Analysis	Annual	Natural Logarithm	LFDI_CHN	USD in Millions
US FDI in Japan	FDI_JPN	US - Bureau of Economic Analysis	Annual	Natural Logarithm	LFDI_JPN	USD in Millions
US FDI in India	FDI_IND	US - Bureau of Economic Analysis	Annual	Natural Logarithm	LFDI_IND	USD in Millions
US FDI in Korea	FDI_KOR	US - Bureau of Economic Analysis	Annual	Natural Logarithm	LFDI_KOR	USD in Millions
US FDI in Thailand	FDI_THA	US - Bureau of Economic Analysis	Annual	Natural Logarithm	LFDI_THA	USD in Millions
US Exports to China	EXP_CHN	UN - Comtrade Database	Annual	Natural Logarithm	LEXP_CHN	USD in Millions
US Exports to Japan	EXP_JPN	UN - Comtrade Database	Annual	Natural Logarithm	LEXP_JPN	USD in Millions
US Exports to India	EXP_IND	UN - Comtrade Database	Annual	Natural Logarithm	LEXP_IND	USD in Millions
US Exports to Korea	EXP_KOR	UN - Comtrade Database	Annual	Natural Logarithm	LEXP_KOR	USD in Millions
US Exports to Thailand	EXP_THA	UN - Comtrade Database	Annual	Natural Logarithm	LEXP_THA	USD in Millions

Note: Due to unavailability of data on export of services and FDI in services for the entire period of F.Y. 1999 - 2017, only Manufacturing Sector is covered in the study.

V. Research methodology

1. Selection of Asian economies

We selected the Asian economies for this study on the basis of their 5 year average GDP for the period covering F.Y. 2013 to 2017. The economies with highest average GDP were to be shortlisted. Initially we found China, Japan, India, Republic of Korea (Korea) and Indonesia as the top countries. However, due to unavailability of US FDI data for Indonesia the country was replaced by Thailand the next country with highest average GDP. Thus the economies selected for study were China, Japan, India, Republic of Korea (Korea) and Thailand. The details are presented in Table 2.

Table 2. *Selection of Top 5 Asian Economies based on average of GDP for F.Y. 2013 – 2017*

(Current USD in Millions)

Economy	Rank	GDP						Selected for Study
		2013	2014	2015	2016	2017	5 Year Average	
China	1	9607224,48	10482372,11	11064666,28	11190992,55	12237700,48	10916591,18	Y
Japan	2	5155717,06	4850413,54	4394977,75	4949273,34	4872136,95	4844503,73	Y
India	3	1856722,12	2039127,45	2102390,81	2274229,71	2597491,16	2173992,25	Y
Korea	4	1305604,98	1411333,93	1382764,03	1414804,16	1530750,92	1409051,60	Y
Indonesia	5	912524,14	890814,76	860854,24	932256,50	1015539,02	922397,73	N*
Thailand	6	420333,33	407339,36	401399,42	411755,16	455220,92	419209,64	Y
Malaysia	7	323277,16	338061,96	296434,00	296535,93	314500,28	313761,87	N
Singapore	8	304454,33	311539,50	304097,76	309763,88	323907,23	310752,54	N
Hong Kong	9	275696,88	291459,36	309383,63	320881,18	341449,34	307774,08	N
Philippines	10	271836,12	284584,52	292774,10	304889,08	313595,21	293535,81	N

*** Note:** Indonesia was not selected as the FDI data of US for the country was not available.
Source: World Bank Database.

2. Analysis of time series

In order to initiate the study, we first need to understand the relationship between US FDI and exports to host countries. Only if there is any relationship among these variables we will be in a position to proceed further. For this we use few statistical methods which form part of time series analysis:

2.1. Correlation analysis

To understand the behavior of the time series of the FDI and exports among themselves, we use correlation analysis as a preliminary method. The method is used to understand the prima facie direction and strength of relationship among the variables under study.

2.2. Augmented Dickey-Fuller unit root tests

In regression analysis involving time series data, a critical assumption is that the times series under consideration is stationary. A series is said to be weakly or covariance stationary if the mean and autocovariances of the series do not depend on time. Any series that is not stationary is said to be non-stationary. It is important to check whether a series is stationary or not before using it in a regression. The formal method to test the stationarity of a time series is the unit root test. In our study we use the Augmented Dickey - Fuller Unit Root Tests to test for presence of unit root.

2.3. Co-integration test

There is always a possibility that time series of macroeconomic variables may contain a unit root. If we regress a non-stationary time series on another non-stationary time series we may get a spurious relationship. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. However, when more than three variables are involved we have to use Johansen Co-integration Test which is more advanced than Engle-Granger Co-integration Test.

2.4. Granger causality test

If it is found that two time series under study are cointegrated it indicates a long term equilibrium relationship between them. When such a relationship is found it becomes apt to study the causality between such time series which can help for forecasting purpose. The concept of causality rests on the understanding that future events cannot cause past events but past event can affect the future outcomes. One time series can cause an effect on another time series and vice versa. It is this forecasting possibility of one time series based on the other time series which is of interest to this study. In this paper we propose to use the Granger Causality Test developed by Granger (1969). In a bivariate scenario the Granger Causality Test involves estimating a pair of equations. As this paper is concerned with the causality of FDI on exports we use the following equation:

$$lEXP_t = \sum_{i=1}^{m} \alpha_i lEXP_{t-i} + \sum_{j=1}^{m} \beta_2 lFDI_{t-j} + \lambda_1 t + u_t \qquad \text{Eq. No. 1}$$

Where t is the trend variable. $lEXP$ is natural log of EXP i.e. exports and $lFDI$ is natural log of FDI i.e. foreign direct investment. u_t is the white noise error term.

A critical assumption under this test is that the variables under study are stationary. However, in case of non-stationary variables it is still possible that the variables are cointegrated. In such case the use of error correction mechanism (ECM) is required.

Granger Causality Test with ECM can be performed with the following equation:

$$\Delta lEXP_t = \alpha_1 + \alpha_2 \Delta lEXP_{t-1} + \cdots + \alpha_p \Delta lEXP_{t-p} + \beta_1 \Delta lFDI_{t-1} + \cdots +$$
$$+ \beta_q \Delta lFDI_{t-q} + \lambda e_{t-1} + v_t \qquad \text{Eq. No. 2}$$

Where Δ is the first difference operator and e_{t-1} is the lagged residual term from the cointegrating regression also termed as error correction (EC) term.

2.5. Vector Auto Regression (VAR)

The concept of Vector Auto Regression was introduced by Sims (1980). It was introduced to address the problem of identification in the equations. It was observed that often arbitrary restrictions were imposed by excluding some variables from an equation which may be present in other equations in the system. Sims argued that if there are m endogenous variables, they should all be treated on an equal footing and there should not be any distinction between endogenous and exogenous variables. Therefore, the VAR system was introduced.

A bivariate VAR can be specified with the following equations:

$$lEXP_t = A_1 + \sum_{j=1}^{j=p} B_j lEXP_{t-j} + \sum_{j=1}^{j=p} C_j lFDI_{t-j} + u_{1t} \qquad \text{Eq. No. 3}$$

$$lFDI_t = A_2 + \sum_{j=1}^{j=p} D_j lEXP_{t-j} + \sum_{j=1}^{j=p} E_j lFDI_{t-j} + u_{1t} \qquad \text{Eq. No. 4}$$

Where *us* are white noise error terms.

A critical requirement of VAR is that the time series under consideration are stationary. If both series are individually I(0) i.e. stationary, each equation can be estimated by OLS. If both series are I(1) then we can take first difference of the two series and use OLS thereafter. However, if both the I(1) series are cointegrated then error correction mechanism (ECM) has to be used. This method is called Vector Error Correction Model (VECM). In VECM, we first estimate the cointegrating relation between the two time series. Then the residuals of the regression are tested for stationarity. This residual is the error correction (EC) term. Then the short run dynamics are tied to long run relations via the EC terms as given in the following equations:

$$\Delta lEXP_t = \alpha_1 + \alpha_2 e_{t-1} + v_{1t} \quad \text{Eq. No. 5}$$

$$\Delta lFDI_t = \alpha_3 + \alpha_4 e_{t-1} + v_{2t} \quad \text{Eq. No. 6}$$

We propose to use VAR / VECM only if causality is observed so that the direction of the coefficients could be determined.

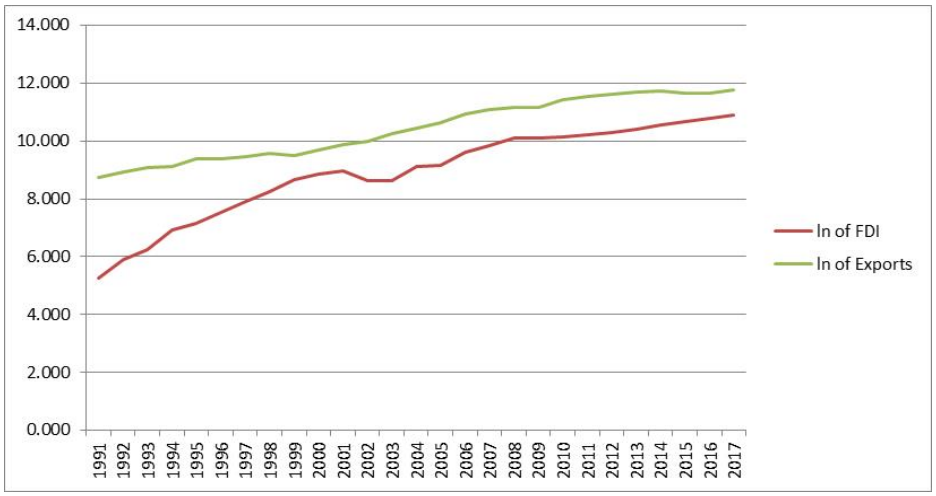
VI. Empirical results

1. Trend analysis

We now perform the graphical trend analysis of the US FDI position and US exports in the selected Asian economies. The FDI and exports data for each economy is annexed to this paper for detailed reference.

a. China

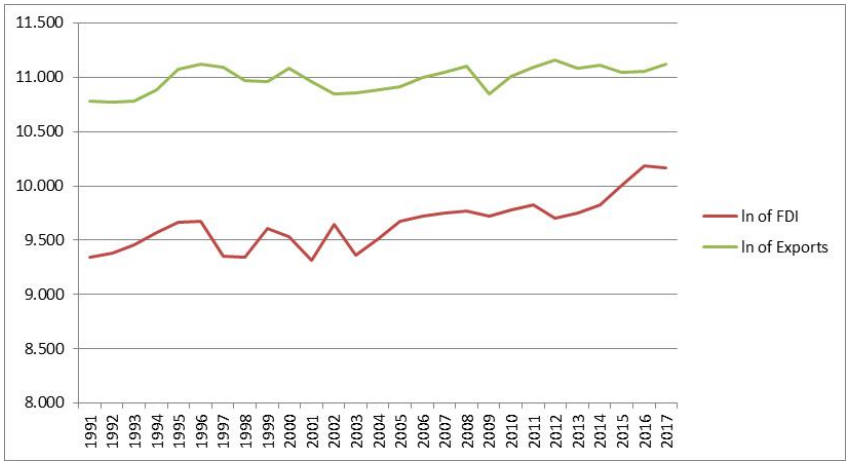
Graph 1. *Trend of US FDI Position and Exports to China from 1991 to 2017*



It can be observed from Graph No. 1 that in case of China both FDI and exports are increasing consistently with the exception that FDI has failed to maintain pace with exports briefly from 2000 to 2004. In 1991 there was a wide gap in the FDI and exports which started narrowing down and getting much closer during 1999 to 2001. Thereafter the variables moved little apart and maintained consistent distance. Visually there appears to be high correlation among both the time series.

b. Japan

Graph 2. *Trend of US FDI Position and Exports to Japan from 1991 to 2017*

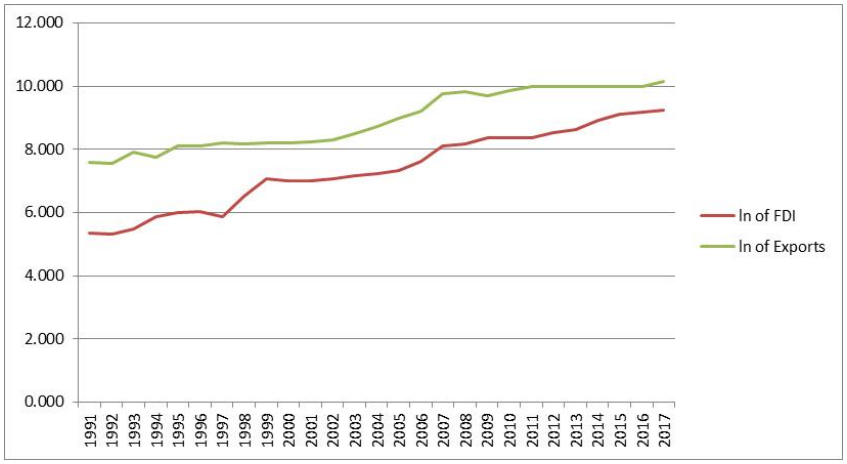


In case of Japan, it is evident from Graph 2 that both FDI and exports are maintaining a significant distance from each other. The gap has started to narrow down from 2015. The correlation among them appears to be on the lower side. Both the series are moving almost at the same pace.

c. India

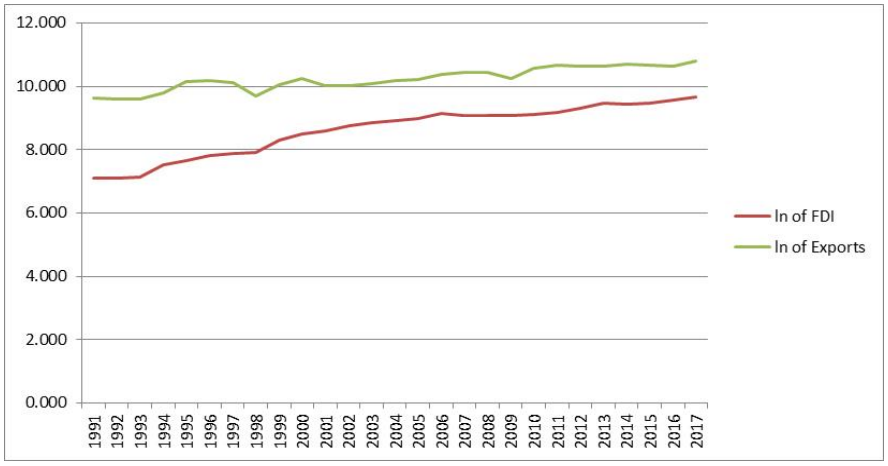
In Graph 3 pertaining to India both FDI and exports are increasing almost consistently but not aggressively maintaining equidistant relationship. Major divergence could only be observed during the period 1996-1999 where there is sudden spurt in FDI with flat movement in exports. The gap between the two series is maximum in 1991-1992 and thereafter reduced in 2016-2017 to almost to one third of that in 1991-1992. Correlation among both the time series appear to be high.

Graph 3. *Trend of US FDI Position and Exports to India from 1991 to 2017*



d. Korea

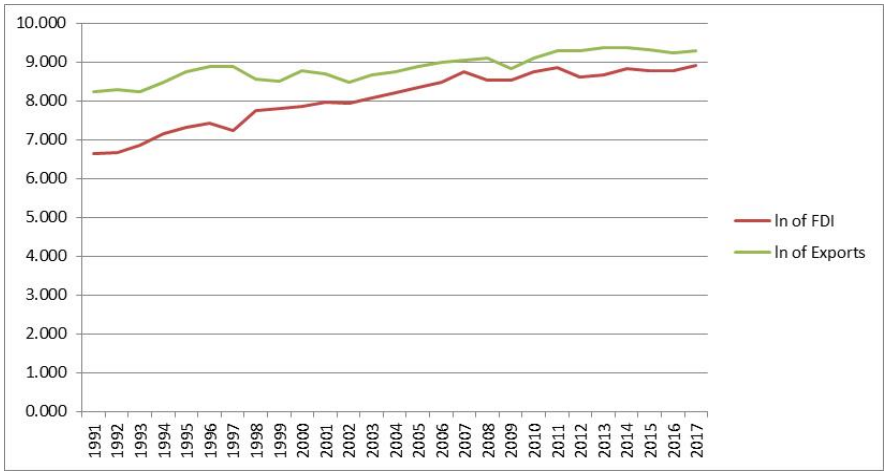
Graph 4. *Trend of US FDI Position and Exports to Korea from 1991 to 2017*



As can be observed from Graph 4 both FDI and exports for Korea show flatter growth for most of the period. The increase in both variables is very limited but they trend along together. Though movement of FDI is smooth for the entire period the movement is erratic for exports for brief periods of 1995-1998 and 2008-2010. In 1991 there was a wide gap in the FDI and exports which started narrowing down and got much lesser from 2013 and continued till 2017 at the same level. Visually there appears to be high correlation among both the time series.

e. Thailand

Graph 5. *Trend of US FDI Position and Exports to Thailand from 1991 to 2017*



In Graph 5 for Thailand both FDI and exports are moving along quite close to each other from 2002 onwards and very close in 2009 and then maintaining some distance thereafter. The series are almost hugging each other from 1999 onwards. The increase in both

variables is very limited but they trend along together. In 1991 there was maximum gap in the FDI and exports which started narrowing down throughout. Visually the correlation among the series appear to be at medium level.

2. Correlation analysis

Table 3. *Correlation Analysis of US FDI Position and US Exports in Select Asian Economies*

China	Japan	India	Korea	Thailand
0,945512	0,543210	0,957818	0,900321	0,865688

Source: Compiled from the database of US - Bureau of Economic Analysis and UN - Comtrade.

It is observed from Table 3 that the correlation for India is highest at 0.957818 followed by China at 0.945512. Japan has lowest correlation coefficient amongst all at 0.543210. Korea has a correlation coefficient of 0.900321 followed by Thailand at 0.865688. Here we find that except for Japan the correlation for other economies is quite high. However, simple correlation is only a cursory indication of relationship among series which needs to be probed further. A first step forward is the testing of stationarity of the time series to rule out the possibility of spurious regression. We use the Augmented Dickey-Fuller Unit Root Test for this assessment.

3. Augmented Dickey-Fuller Unit Root Tests

Based on the graphical analysis of the trend of FDI and Exports for each economy we find that there appears to be a pattern of trend followed by the time series variables in each case. We therefore while using the Augmented Dicky-Fuller Unit Root Test assume presence of trend with intercept for each time series. The results are presented in Table 4. It is found that at level analysis only the series for US Export to Korea is stationary where as other variables are not stationary. On testing for unit root at first difference, we find all the variables to be stationary. However, as the Exports and FDI in case of Korea are not integrated of the same order, we exclude Korea from our study. We find that Export to China (LEXP_CHN) and FDI in China (LFDI_CHN) are stationary at 5% significance where as in case of other economies the significance is observed at 1% level for all variables except Export to Korea (LEXP_KOR) which is an I(0) integrated series and hence not considered further.

Table 4. *Unit Root Tests of US FDI Position and US Exports in Select Asian Economies*

Augmented Dickey - Fuller Test : Level

Variable	Constant & Trend	
	Test Statistic	P- value
LEXP_CHN	-0,696653	0,9627
LEXP_JPN	-2.821660	0,2026
LEXP_IND	-1.362607	0,8470
LEXP_KOR	-4.447360	0.0085**
LEXP_THA	-2.789046	0,2132
LFDI_CHN	-2.445685	0,3495
LFDI_JPN	-2.898333	0,1790
LFDI_IND	-2.916922	0,1772
LFDI_KOR	-1.196567	0,8902
LFDI_THA	-1.954124	0,5980

Augmented Dickey - Fuller Test : First Difference

Variable	Constant & Trend	
	Test Statistic	P- value
LEXP_CHN	-4.218350	0.014*
LEXP_JPN	-4.951331	0.0028**
LEXP_IND	-5.265198	0.0014**
LEXP_KOR	-5.498751	0.0009**
LEXP_THA	-4.749587	0.0046**
LFDI_CHN	-4.310293	0.0115*
LFDI_JPN	-5.163634	0.0019**
LFDI_IND	-5.375220	0.0018**
LFDI_KOR	-5.295680	0.0013**
LFDI_THA	-6.245618	0.0002**

* indicates ADF test value is significant at 5% level of significance.

** indicates ADF test value is significant at 1% level of significance.

Source: Compiled from the database of US - Bureau of Economic Analysis and UN - Comtrade.

4. Engle-Granger Co-integration Test

We know that when the variables are non-stationary they can give spurious regression results. However, the only exception to it is when the variables are cointegrated indicating a long term equilibrium. As we have only two time series variables per economy we choose the Engle-Granger Co-integration Test. We do not find any co-integration among any of the variables. The P-values are observed to be high in all the cases. The results are presented in Table 5.

Table 5. *Engle - Granger Cointegration Test of US FDI Position and US Exports for China, Japan, India and Thailand*

China:

Variable	tau-statistic	Prob.*	z-statistic	Prob.*	Max Lags based on SIC	Number of Lags used
LEXP_CHN	-1,800540	0,635	-6,158262	0,597	5	1
LFDI_CHN	-2,277022	0,404	-7,955097	0,436	5	1

*MacKinnon (1996) p-values.

Japan:

Variable	tau-statistic	Prob.*	z-statistic	Prob.*	Max Lags based on SIC	Number of Lags used
LEXP_JPN	-3,177778	0,106	-14,198510	0,100	5	0
LFDI_JPN	-2,191645	0,444	-10,013460	0,287	5	0

*MacKinnon (1996) p-values.

India:

Variable	tau-statistic	Prob.*	z-statistic	Prob.*	Max Lags based on SIC	Number of Lags used
LEXP_IND	-2,071453	0,502	-7,629570	0,466	5	0
LFDI_IND	-1,998372	0,539	-8,874942	0,363	5	1

*MacKinnon (1996) p-values.

Thailand:

Variable	tau-statistic	Prob.*	z-statistic	Prob.*	Max Lags based on SIC	Number of Lags used
LEXP_THA	-2,663232	0,244	-11,546490	0,201	5	0
LFDI_THA	-2,490347	0,310	-10,000670	0,288	5	0

*MacKinnon (1996) p-values.
Null hypothesis: Series are not cointegrated
Automatic lags specification based on Schwarz criterion (maxlag=5)
Source: Compiled from the database of US - Bureau of Economic Analysis and UN - Comtrade.

5. Granger Causality Test

As we observed that the variables in case of none of the economies are cointegrated and also they are non-stationary at level, we test causality using their first differences. As per the objective of our study we test whether changes in FDI causes changes in Exports. From Table 6, we can see that only in case of Japan causality is present. The P-value is 0.035 which is significant at 5% level. In all other cases except Thailand the P-values are very high ruling out the possibility of any causality. In case of Thailand the P-value is 0.090 which is significant at 10% level. However, we do not consider the same.

Table 6. *Granger Causality Test of US FDI Position on US Exports for China, Japan, India and Thailand*

China:

Dependent Variable (A)	Independent Variable (B)	Null Hypothesis	Obser-vations	F - Stat	P - value	Causa-lity	Lags Used	Mini-mum Lag	Optimum Lag based on VAR	Lag Criteria
D(LEXP_CHN)	D(LFDI_CHN)	B does not cause A	25	0,215	0,647	No	1	1	0	AIC & SC

Japan:

Dependent Variable (A)	Independent Variable (B)	Null Hypothesis	Obser-va-tions	F - Stat	P - value	Cau sa-lity	Lags Used	Minimum Lag	Optimum Lag based on VAR	Lag Crite-ria
D(LEXP_JPN)	D(LFDI_JPN)	B does not cause A	25	5,059	0.035*	Yes	1	1	1	AIC

India:

Dependent Variable (A)	Independent Variable (B)	Null Hypothesis	Obser-va-tions	F - Stat	P - value	Cau sa-lity	Lags Used	Minimum Lag	Optimum Lag based on VAR	Lag Crite-ria
D(LEXP_IND)	D(LFDI_IND)	B does not cause A	25	0,023	0,880	No	1	1	0	AIC & SC

Thailand:

Dependent Variable (A)	Independent Variable (B)	Null Hypothesis	Obser-va-tions	F - Stat	P - value	Cau sa-lity	Lags Used	Minimum Lag	Optimum Lag based on VAR	Lag Crite-ria
D(LEXP_THA)	D(LFDI_THA)	B does not cause A	25	3,153	0,090	No	1	1	0	AIC & SC

Significance: ** 1%, * 5%
AIC: Akaike information criterion
SC: Schwarz information criterion
Source: Compiled from the database of US - Bureau of Economic Analysis and UN - Comtrade.

6. Vector Autoregression (VAR)

As causality is observed only in case of Japan we run the Vector Auto Regression (VAR) for this economy. Based on Akaike Information Criteria (AIC) we use 1 lag which is the optimum lag length. Here, we have used first difference of the variables as their level series are not co-integrated and also non-stationary. It is observed from Table 7 that the coefficient of the intercept is almost zero at 0.005473 which is not significant. D(LEXP_JPN(-1)) i.e. First lag of the first difference of the log of US exports to Japan is negative at -0.089671 which is also not significant. However, when we observe the coefficient of US FDI position in Japan in the form D(LFDI_JPN(-1)) it is 0.280702 which is significant as per the t-statistic of 2.24926. This indicates that in case of Japan US FDI has positive effect on exports.

Table 7. *Vector Autoregression Test (VAR) of US FDI Position and US Exports for Japan*
Japan:

Dependent Variable	Independent Variables		
D(LEXP_JPN)	D(LEXP_JPN(-1))	D(LFDI_JPN(-1))	C
Coefficient	-0,089671	0,280702	0,005473
Standard Error	(-0.19363)	(-0.1248)	(-0.01934)
t - statistic	[-0.46312]	[2.24926]	[0.28299]

Additional Information:

Granger Causality	Yes	Log likelihood	39,29752
Included Observations	25	Akaike information criterion	-2,663801
Lags Used	1	Schwarz criterion	-2,371271
Minimum Lag	1		
Optimum Lag based on VAR	1		
Lag Criteria	AIC		

AIC: Akaike information criterion
SC: Schwarz information criterion
Source: Compiled from the database of US - Bureau of Economic Analysis and UN - Comtrade.

VII. Conclusions

The objective of this paper was to analyze the substitution effect of outward FDI on the exports of the home country. We selected US as the home country considering its position amongst the top FDI providing countries and select Asian economies as host countries viz. China, Japan, India, Republic of Korea (Korea) and Thailand based on their average of GDP for F.Y. 2013 to F.Y. 2017 and also availability of data for analysis. These are major emerging economies in Asia and their international activities have influence on world trade and investment. The study period covered was from 1991 to 2017. After setting the background of the study we discussed the various prominent theories of FDI such as MacDougall-Kemp Hypothesis, Industrial Organisation Theory, Location Specific Theory, Product Cycle Theory, Internalisation Approach and Eclectic Paradigm. Previous work on substitution effect was also discussed. We found that the previous empirical work has given mixed results as different authors have found different outcomes in their studies. GDP data for selection of top Asian economies was obtained from the World Bank Database. Data on foreign direct investment of US in the shortlisted Asian economies was obtained from the website of the United States, Bureau of Economic Analysis. Data on Exports from US to these economies was collected from the website of United Nations, Comtrade Database. Due to limited availability of data for services, the paper only considered exports of goods and FDI in manufacturing sector. We performed graphical trend analysis of the US FDI position and US exports in the selected Asian economies and found various patterns. In correlation analysis the correlation between FDI and exports for India was highest at 0.957818 followed by China at 0.945512. Japan had lowest correlation coefficient amongst all at 0.543210. Korea had a correlation coefficient of 0.900321 followed by Thailand at 0.865688. Except for Japan the correlation for other economies was quite high. To rule out the possibility of spurious regression, we used the Augmented Dickey-Fuller Unit Root Test. Presence of trend with intercept for each time series was assumed based on visual observation. It was found that at level analysis only the series for US Export to Korea is stationary where as other variables were not stationary. On testing for unit root at first difference, we found all the variables to be stationary. As the Exports and FDI in case of Korea were not integrated of the same order we excluded Korea from the study. To test for co-integration we used the Engle-Granger Co-integration Test and did not find co-integration among any of the variables. Since the variables for none of the Asian economies were cointegrated and also were non-stationary at level, we tested causality using their first differences using Granger Causality Test. It was tested whether changes in FDI causes changes in exports. We found that only in case of Japan causality is present. Since causality was observed only in case of Japan we used the Vector Auto Regression (VAR) for this economy. Here, we used first difference of the variables as their level series were not co-integrated and also non-stationary. It was observed that the coefficient of the intercept was almost zero at 0.005473 which was not significant. D(LEXP_JPN(-1)) i.e. First lag of the first difference of the log of US exports to Japan was negative at -0.089671 which was also not significant. However, when we observed the coefficient of US FDI position in Japan in the form D(LFDI_JPN(-1)) it was 0.280702 which was significant as per the t-statistic of 2.24926. This makes us to conclude that in case of Japan, US FDI in Japan had positive effect on exports of US to Japan. In case of all other economies no relation between US

FDI and exports was observed. Thus substitution effect was not observed from US FDI on US exports in respect of the selected Asian economies viz. China, Japan, India, Republic of Korea and Thailand.

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ANNEXURES

Annexure I

Data of US FDI Position and Exports to China from 1991 to 2017

(USD in Millions)

Year	Variables			
	FDI	ln of FDI	Exports	ln of Exports
1991	196,00	5,278	6278,34	8,745
1992	363,00	5,894	7469,57	8,919
1993	523,00	6,260	8767,10	9,079
1994	1000,00	6,908	9286,69	9,136
1995	1263,00	7,141	11748,11	9,371
1996	1837,00	7,516	11977,75	9,391
1997	2737,00	7,915	12804,86	9,458
1998	3862,00	8,259	14257,94	9,565
1999	5787,00	8,663	13117,67	9,482
2000	7076,00	8,864	16184,68	9,692
2001	7727,00	8,952	19181,94	9,862
2002	5554,00	8,622	22127,51	10,005
2003	5499,00	8,612	28367,72	10,253
2004	9008,00	9,106	34427,69	10,447
2005	9346,00	9,143	41190,67	10,626
2006	14759,00	9,600	55224,10	10,919
2007	18461,00	9,823	65237,88	11,086
2008	24004,00	10,086	71456,41	11,177
2009	23972,00	10,085	69575,61	11,150
2010	25422,00	10,143	91910,98	11,429
2011	27501,00	10,222	104121,00	11,553
2012	29389,00	10,288	110517,00	11,613
2013	33165,00	10,409	121721,00	11,709
2014	38315,00	10,554	123676,00	11,725
2015	43245,00	10,675	116072,00	11,662
2016	47847,00	10,776	115602,00	11,658
2017	54158,00	10,900	129894,00	11,774

Source: US - Bureau of Economic Analysis, UN - Comtrade Database.

Annexure II

Data of US FDI Position and Exports to Japan from 1991 to 2017

(USD in Millions)

Year	Variables			
	FDI	ln of FDI	Exports	ln of Exports
1991	11463,00	9,347	48107,62	10,781
1992	11873,00	9,382	47748,66	10,774
1993	12778,00	9,455	47932,75	10,778
1994	14292,00	9,567	53453,45	10,887
1995	15760,00	9,665	64259,69	11,071
1996	15867,00	9,672	67514,64	11,120
1997	11505,00	9,351	65657,90	11,092
1998	11428,00	9,344	57884,42	10,966
1999	14947,00	9,612	57480,84	10,959
2000	13838,00	9,535	64921,65	11,081
2001	11142,00	9,318	57449,65	10,959
2002	15507,00	9,649	51447,93	10,848
2003	11609,00	9,360	52003,77	10,859
2004	13534,00	9,513	53568,57	10,889
2005	15908,00	9,675	54679,31	10,909
2006	16745,00	9,726	59647,55	10,996
2007	17078,00	9,746	62663,67	11,046
2008	17440,00	9,767	66573,42	11,106
2009	16628,00	9,719	51178,32	10,843
2010	17699,00	9,781	60469,05	11,010
2011	18517,00	9,826	65791,78	11,094
2012	16396,00	9,705	69971,99	11,156
2013	17112,00	9,748	65213,79	11,085
2014	18480,00	9,824	66825,97	11,110
2015	22080,00	10,002	62441,25	11,042
2016	26514,00	10,185	63234,27	11,055
2017	26067,00	10,168	67602,40	11,121

Source: *US - Bureau of Economic Analysis, UN - Comtrade Database.*

Annexure III
Data of US FDI Position and Exports to India from 1991 to 2017

(USD in Millions)

Year	Variables			
	FDI	ln of FDI	Exports	ln of Exports
1991	210,00	5,347	1999,31	7,601
1992	202,00	5,308	1914,40	7,557
1993	239,00	5,476	2761,09	7,923
1994	357,00	5,878	2296,32	7,739
1995	399,00	5,989	3295,74	8,100
1996	417,00	6,033	3318,09	8,107
1997	359,00	5,883	3615,60	8,193
1998	674,00	6,513	3544,68	8,173
1999	1163,00	7,059	3707,36	8,218
2000	1098,00	7,001	3667,13	8,207
2001	1120,00	7,021	3757,04	8,231
2002	1166,00	7,061	4101,05	8,319
2003	1284,00	7,158	4979,69	8,513
2004	1402,00	7,246	6109,36	8,718
2005	1549,00	7,345	7918,60	8,977
2006	2060,00	7,630	10091,10	9,219
2007	3328,00	8,110	17592,45	9,775
2008	3595,00	8,187	18666,53	9,834
2009	4344,00	8,377	16462,44	9,709
2010	4243,00	8,353	19248,89	9,865
2011	4260,00	8,357	21542,18	9,978
2012	5009,00	8,519	22105,72	10,004
2013	5532,00	8,618	21811,34	9,990
2014	7519,00	8,925	21607,50	9,981
2015	8951,00	9,100	21451,88	9,974
2016	9702,00	9,180	21652,27	9,983
2017	10483,00	9,258	25688,82	10,154

Source: US - Bureau of Economic Analysis, UN - Comtrade Database.

Annexure IV

Data of US FDI Position and Exports to Korea from 1991 to 2017

(USD in Millions)

Year	Variables			
	FDI	ln of FDI	Exports	ln of Exports
1991	1226,00	7,112	15504,11	9,649
1992	1199,00	7,089	14629,69	9,591
1993	1255,00	7,135	14775,54	9,601
1994	1870,00	7,534	18028,33	9,800
1995	2083,00	7,642	25413,12	10,143
1996	2501,00	7,824	26582,87	10,188
1997	2661,00	7,886	25066,62	10,129
1998	2712,00	7,905	16538,27	9,713
1999	4059,00	8,309	22949,36	10,041
2000	4845,00	8,486	27829,96	10,234
2001	5422,00	8,598	22180,58	10,007
2002	6385,00	8,762	22575,71	10,025
2003	6922,00	8,842	24072,54	10,089
2004	7385,00	8,907	26186,73	10,173
2005	7909,00	8,976	27571,60	10,225
2006	9345,00	9,143	32455,28	10,388
2007	8920,00	9,096	34702,62	10,455
2008	8829,00	9,086	34806,59	10,458
2009	8660,00	9,066	28639,75	10,263
2010	9217,00	9,129	38820,63	10,567
2011	9807,00	9,191	43461,39	10,680
2012	11107,00	9,315	42282,53	10,652
2013	12905,00	9,465	41686,04	10,638
2014	12440,00	9,429	44470,81	10,703
2015	13014,00	9,474	43444,79	10,679
2016	14504,00	9,582	42308,10	10,653
2017	15909,00	9,675	48326,09	10,786

Source: US - Bureau of Economic Analysis, UN - Comtrade Database.

Annexure V
Data of US FDI Position and Exports to Thailand from 1991 to 2017

(USD in Millions)

Year	Variables			
	FDI	ln of FDI	Exports	ln of Exports
1991	780,00	6,659	3752,66	8,230
1992	798,00	6,682	3982,31	8,290
1993	960,00	6,867	3768,47	8,234
1994	1306,00	7,175	4861,00	8,489
1995	1525,00	7,330	6401,91	8,764
1996	1671,00	7,421	7211,29	8,883
1997	1400,00	7,244	7357,19	8,903
1998	2313,00	7,746	5233,36	8,563
1999	2457,00	7,807	4983,52	8,514
2000	2627,00	7,874	6617,49	8,797
2001	2931,00	7,983	5989,36	8,698
2002	2837,00	7,951	4860,19	8,489
2003	3223,00	8,078	5835,28	8,672
2004	3745,00	8,228	6368,29	8,759
2005	4221,00	8,348	7256,62	8,890
2006	4905,00	8,498	8152,47	9,006
2007	6295,00	8,748	8444,88	9,041
2008	5144,00	8,546	9066,83	9,112
2009	5176,00	8,552	6920,20	8,842
2010	6325,00	8,752	8976,30	9,102
2011	7074,00	8,864	10929,77	9,299
2012	5610,00	8,632	10887,76	9,295
2013	5784,00	8,663	11797,15	9,376
2014	6892,00	8,838	11809,68	9,377
2015	6557,00	8,788	11230,09	9,326
2016	6566,00	8,790	10444,61	9,254
2017	7518,00	8,925	10991,20	9,305

Source: US - Bureau of Economic Analysis, UN - Comtrade Database.

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Exploring the role of institutions in cross country Malmquist productivity analysis: A two-stage double bootstrap DEA approach

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Abstract. *This paper explore the role of institutions to enhance the productivity growth across countries using a two stage Double Bootstrap Data Envelopment Analysis (DEA). The productivity growth is calculated on the basis of Malmquist productivity index. It also explores the sources of productivity growth and the influence of different types of institutions (Siddiqui and Ahmed, 2013a) on them. In the first stage, productivity growth and its decompositions a) technological change and b) efficiency change are estimated for a period of 1990-2000 for 78 countries. In the second stage, the impact of institutions on these estimates is analyzed through a bootstrapped regression. Findings suggest that institutions played a strong and positive role in enhancing cross country productivity mainly through promoting technological change but the evidences of institutions influencing efficiency change are not found. This study also shows that institutions that curb corruption, bureaucratic inefficiencies, lax regulations and unfriendly business policies, tend to have a larger effect on productivity growth than other two indices that curb political rents and that reduces transactional risks. However when they are aggregated, their impact is more pronounced than their combined individual impacts.*

Keywords: institutions; Malmquist; DEA; productivity.

JEL Classification: C23, D24, Q22, O43, Z13.

1. Introduction

This study attempts to measure aggregate productivity growth across countries and how this productivity growth is affected by the quality of institutions. This study decomposes productivity into efficiency and technological change and the impact of institutions on both of these is analyzed using regression analysis. Siddiqui and Ahmed (2013b) showed that those countries that have better quality institutions, utilize their resources more efficiently.(1) The present study attempts to show that institutions not only improve productivity but also identify the channels through which productivity is increased using a two-stage procedure.(2) In the first stage, Malmquist productivity indices i.e. productivity growth and its components technological and efficiency change of 78 countries were calculated. These indices were calculated based on a non-parametric method developed by Fare et al. (1992) using DEA(3) for the period of 1990-00 and were corrected for the biasness and to construct confidence interval for providing statistical inferences using the methodology of Simar and Wilson (2000). In the second stage, these indices as dependent variables were regressed with other determinants of efficiencies including institutions using Bootstrap Linear regression.

Castellacci and Zheng (2008) and Dismuke and Sena (1999) employed two-stage regression analysis based on Malmquist productivity index and found that the productivity variation across nations was the most important determinant for sustainable growth. Baier et al. (2006), Hall and Jones (1999) and Klenow and Rodriguez-Clare (1997) found workers' productivity as important determinant of income per worker. Baier et al. (2006) estimated that about one fourth of output per worker is contributed by TFP growth in western countries; however, Productivity explains as much as 84% variance in output per worker across countries. (World Bank, 1993; Sarel, 1997; Nelson and Pack, 1999) provide the evidence of productivity growth as a major driver of economic performance in East Asian region. Similar results were obtained by (Abramovitz, 1956; Solow, 1957; Kendrick, 1961; Denison, 1985; Jorgenson et al., 1987; Maddison, 1995; Klenow and Rodriguez-Clare 1997a; Jones, 1997; Ark et al., 2008) for United States, and Sun (2004) for Taiwan.

Traditional studies on measurement of productivity are based on standard growth accounting that relies on restrictive specification and often takes the form of Cobb-Douglas production function.(4) They also employ inappropriate assumptions that lead to overestimation of the role of total factor productivity (TFP) (Caselli, 2005; Jerzmanowski, 2007; Brock and Durlauf, 2001). These include 1) All countries are fully efficient. 2) Factor markets are perfectly competitive, 3) constant and same elasticity across countries and 4) constant returns to scale.(5)

Applied literature offers different approaches to measure productivity that includes both parametric and non-parametric frontier models. A widely used parametric frontier approach to measure efficiencies is the stochastic frontier analysis (SFA) developed by Sealey and Lindley (1977).(6) In this approach, some of the above-mentioned assumptions are relaxed; however, it still has functional form restriction. Studies such as (Fare et al., 1994; Koop et al., 2000; Limam and Miller 2004; Osiewalski et al., 2000) applied this approach to aggregate production functions whereas (Sharma et al., 2007; Wu, 2000; Li and Tung, 2010; Gumbau-Albert, 1998, 2000) used this approach to estimate regional productivity

within a country. Most of these studies found improved efficiencies as a main driver of productivity growth.

The non-parametric approach eliminates most of the abovementioned problems. DEA is considered a standard non-parametric methodology in performance investigation of firms and industries.(7) However, it also applies to aggregate production functions.(8) Productivity indices using DEA approach are normally calculated through Malmquist productivity index technique. Efficiency frontier is formed in this approach through mapping most efficient countries on the frontier, and relative efficiency is calculated from their distance from it. In this way, productivity is decomposed into technological change (shift in frontier through technological progress and innovation) and efficiency improvement (catching up to the frontier). Distance functions of Malmquist indices are measured using DEA. The benefit of this approach is that there are no subjective weights to combine different factors, and no specification of any particular functional form. It is also free from distribution assumptions made in SFA. However, there are some drawback of this analysis are mentioned below. First, that it attribute all the variations from the frontier to the inefficiency. Secondly, the estimator defines efficiency relative to the best practice observations in the sample, not the "true" frontier. An associated complication with inference is that since the true efficiency scores are not observed directly but are empirically estimated, they are serially correlated. Simar and Wilson (1998, 2000). Moreover, the asymptotic sampling distribution of the DEA estimator is generally very hard to derive (Kneip et al., 2005). Furthermore, if these estimates are used in the 2 stage procedure like in our case, the second stage variables might be correlated with inputs and outputs of productivity estimates thus implying that the error term must be correlated with the second-stage explanatory variables.

In order to overcome these deficiencies, SIMAR and WILSON (1998, 2000 and 2007) introduced a bootstrapping method that provides the means of incorporating a stochastic element into DEA, and obtain unbiased beta coefficients and valid confidence intervals. It is based on the idea that the unknown distribution of the difference between the true and estimated productivity score is approximated by the difference between the estimated and the bootstrapped productivity score. In the double bootstrap procedure, Malmquist productivity indices are bootstrapped in the first stage and in the second stage, they are regressed them on potential covariates with the use of a bootstrapped regression. A similar approach is also followed in Jeon and Sickles (2004).

There could be many determinants of productivity growth. However, large number studies attributed this role to institutions. For example (Hall and Jones, 1999; Olson et al., 1998, Bjørnskov and Foss, 2010; Chanda and Dalgaard, 2008) explained their influence in TFP growth through growth accounting approach. Lambsdorff (2003) used the SFA technique to measure institutional impact on productivity and its relationship was also being tested using DEA based nonparametric Malmquist productivity index approach (Baris Yoruk, 2007; Krüger, 2003; M del Mar and Javier, 2007). Nearly all of the above mentioned studies found a strong and positive influence of institutions including those that inhibit corruption. Theoretical models like Olson (1982), Baumol (1990) and North (1990) and recent models like Restuccia (2004), and Landon-Lane and Robertson (2005), also attribute lower productivity to barriers to technological adoption, as well as inefficient use of existing

technology all due to weak institutions. There could be other determinants of productivity growth. Using Traditional growth accounting approach, Easterly and Levine (2003), Alcála and Ciccone (2004) focused on the impact of other determinants like trade openness and geography. However, productivity estimates that all of these studies produced could be biased due to limitation in their approaches as discussed above. Furthermore, the institutional proxies used in these studies might not fully represent the concept. They also fail to identify the channels through which these institutions could influence productivity.

In this study, productivity indices were calculated using the values of output, physical and human capital per worker were taken from the data set developed by Baier et al. (2006) which is more comprehensive than any other previously available data used in growth analysis. Data set representing institutional quality was taken from Siddiqui and Ahmed (2013b) in which three orthogonal factors were extracted covering the period from 1990 to 2000 and measuring different theoretical dimensions.(9) Their Index of Institutional Social Technologies (IIST) and its three orthogonal factors were identified through Principal Components Analysis (PCA) utilizing twenty-nine indicators covering 84 countries. This First factor of the IIST named Risk-reducing Technologies (SiiF1) refers to institutions that reduce the cost of protecting property rights and strengthen contract enforcement. These services include provision of public goods such as rule of law and justice. The Second factor named Factor of Institutional and Policy Rents (RiiF2), focuses on technologies that help to eliminate or minimize two kinds of rent – institutional and policy rents. Third factor named Factor of Political Rent (RpiF3) measures the extent of power granted by institutions to political authorities. Theoretical and economic intuitions of the indices and their principal components can be found in Siddiqui and Ahmed (2013a).

Various other databases also measure institutional quality and many of them widely are used in empirical literature. These include various commercial (PRS and BERI), or non-commercial (WEF; Global Integrity; Bertelsmann; POLITY; World Bank (Doing Business); Kaufmann at al 2008; Gwartney and Lawson 2008; Miller and Holmes 2009) sources. All these databases have several shortcomings that have been addressed in this dataset.(10)

2. Malmquist productivity indices methodology

Concept of Efficiency analysis and measurement was first developed by Farrell (1957), inspired by the earlier work of Debreu (1951) and Koopmans (1951). He defined efficiency as the ratio of observed values to optimal values of output and input relative to a given technology. Efficiency frontier is made up of these optimal values and acts as a benchmark. Country's relative efficiency (E^{it})is calculated as a ratio of radial distance between their inputs-outputs (y^{it}, x^{it}) and potential optimum inputs-outputs that lies on the frontier (y^{*t}, x^{*t}). Each country's efficiency can be calculated as $\left(E^{ot} = \frac{(y^{*t}, x^{*t})}{(y^{it}, x^{it})}\right)$.

Productivity change is calculated using Quantity indices that were first introduced by Malmquist (1953) as ratios of radial distance functions D (•) to measure efficiency change across time. These ratios of distance functions were first applied in productivity analysis to

measure productivity change by Caves et al. (1982) and so were named Malmquist productivity indices. Färe et al. (1992,1994a and 1994) combined Farrell (1957) efficiency concepts with Caves et al. (1982) formalization of productivity change into Malmquist productivity indices that used DEA based methodology to measure distance function.(11)

Färe et al. (1992) modified Caves et al. (1982) radial distance functions incorporating inefficiency in technology and made the frontier of technology function piecewise linear. Radial Distance functions can be classified into output and input distance functions where Input (Output) oriented efficiency ($E_{i(o)}$) is calculated as the reciprocal of input (Output) distance function *($D_{i(o)}$)* Färe (1994a, p. 228).

In this study, output oriented Malmquist productivity change index is used. An input oriented index can also be used; however, since results from both indices would be the same (Thanassoulis, 2001, p. 182), this specification is more of a theoretical issue than a practical one. As shown in equation 1, Färe et al. (1994b) model, M_o^{t+1} is output oriented radial Malmquist productivity index representing the change year t+1 level of production (X^{t+1}, Y^{t+1}) as compared to previous year t level of production (X^t, Y^t) can be written in terms of output distance functions *(D_o)*as

$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \sqrt{\frac{D_o^t(y^{t+1}, x^{t+1}|CRS)}{D_o^t(y^t, x^t|CRS)} \times \frac{D_o^{t+1}(y^{t+1}, x^{t+1}|CRS)}{D_o^{t+1}(y^t, x^t|CRS)}} \qquad \text{(Eq. 1)}$$

Where subscript *i* is input orientation, *t* is time period, *D* are distance functions under constant return to scale (CRS) technology (Charnes et al., 1978 model) and *y*, *x* are the output and input vectors.

This index is the geometric mean of two productivity indices. In the ratio form, the value greater than one means current year productivity is more than the previous year, hence it indicates positive productivity growth from year *t* to *t+1*. The underlying assumptions include piecewise linear shape of technology frontier and trans log form of distance functions with identical second-order terms. These distance functions are graphically illustrated in Figure 1, as horizontal distance between points is equal to projection of those points on x-axis. For example, the distance of point e from y-axis can be interpreted as 0e. In this way, Malmquist index can be written as

$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \sqrt{\left[\frac{0h/0j}{0c/0e} \times \frac{0f/0j}{0a/0e}\right]}$$

Productivity could be due to adoption of new technology or managing resources efficiently under existent technology. In the similar fashion, M_o^{t+1} productivity index can be further decomposed into Efficiency change (E) and technological change (T) as under

$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) =$$

$$= \underbrace{\frac{D_o^{t+1}(y^{t+1}, x^{t+1}|CRS)}{D_o^t(y^t, x^t|CRS)}}_{\Delta E} \times \underbrace{\sqrt{\frac{D_o^t(y^{t+1}, x^{t+1}|CRS)}{D_o^{t+1}(y^{t+1}, x^{t+1}|CRS)} \times \frac{D_o^t(y^t, x^t|CRS)}{D_{io}^{t+1}(y^t, x^t|CRS)}}}_{\Delta T}$$

This decomposition can be illustrated in Figure 1 as

$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \underbrace{\frac{0a/0e}{0h/0j}}_{\Delta E} \times \underbrace{\sqrt{\frac{0c/0e}{0a/0e} \times \frac{0h/0j}{0f/0j}}}_{\Delta T}$$

The first ratio on left hand side (outside the brackets) represents efficiency change (ΔE) which is the ratio of current level of efficiency divided by the previous one. With efficiency change greater than one, it shows that the country is utilizing existing technology more adeptly as compared to previous year, and is catching up to the frontier.

The group of ratios under root represents technological change (ΔT) over the period *t* and *t+1,* which are the changes in technology frontier as compared to its previous period. It is the geometric mean of two ratios. First ratio measures current level of efficiency with respect to the previous period production technology, relative to the current level. The second ratio tells the previous level of efficiency with respect to the current technology frontier. A larger than one technological change means progressive shift in technology frontier and is attributed to one of the reasons for change in country's productivity. Factors influencing it are increased knowledge, innovations in technologies of management (improved production processes), finance (financial liberalization and development) and market technologies (deregulation and competition).

If constant return to scale (CRS) assumption is relaxed to incorporate variable return to scale (VRS) (Banker et al., 1984 DEA model), the efficiency change (ΔE) measure can be decomposed into change in pure efficiency (ΔP) and change in scale efficiency (ΔS) (Fare et al., 1994a). Mathematically we can express it as follows:

$$\text{Pure efficiency } (\Delta\text{P}) = \frac{D_o^{t+1}(y^{t+1}, x^{t+1}|VRS)}{D_o^t(y^t, x^t|VRS)}$$

$$Scaleefficiency\ (\Delta S) =$$

$$\left[\frac{D_o^{t+1}(0by^{t+1}, 0e\ x^{t+1}|VRS)}{D_o^{t+1}(0ay^{t+1}, 0ex^{t+1}|CRS)} \Big/ \frac{D_o^{t+1}(0gy^t, 0jx^t|VRS)}{D_o^{t+1}(0fy^t, 0jx^t|CRS)}\right] \times \left[\frac{D_o^t(0dy^{t+1}, 0ex^{t+1}|VRS)}{D_o^t(0cy^{t+1}, 0ex^{t+1}|CRS)} \Big/ \frac{D_o^t(0iy^t, 0jx^t|VRS)}{D_o^t(0hy^t, 0jx^t|CRS)}\right]$$

In this way productivity change is made up of pure efficiency, scale efficiency and technological change ($M_o^{t+1} = (\Delta P \times \Delta S) \times \Delta T$).

Change under CRS technology is ΔE which carries both efficiency and scale effects, whereas similar change under VRS technology is in pure efficiency ΔP, and scale efficiency ΔS shows the magnitude to change between CRS and VRS technologies in each period. It is the ratio of CRS efficiency scores to VRS ones and refers to exploiting economies of scale by operating closer to CRS frontier. Scale efficiency change score of one means that economy is operating at capacity where economies of scale are fully

captured and production frontier depicts CRS. For graphical illustration in Figure 1, Malmquist productivity index is given as

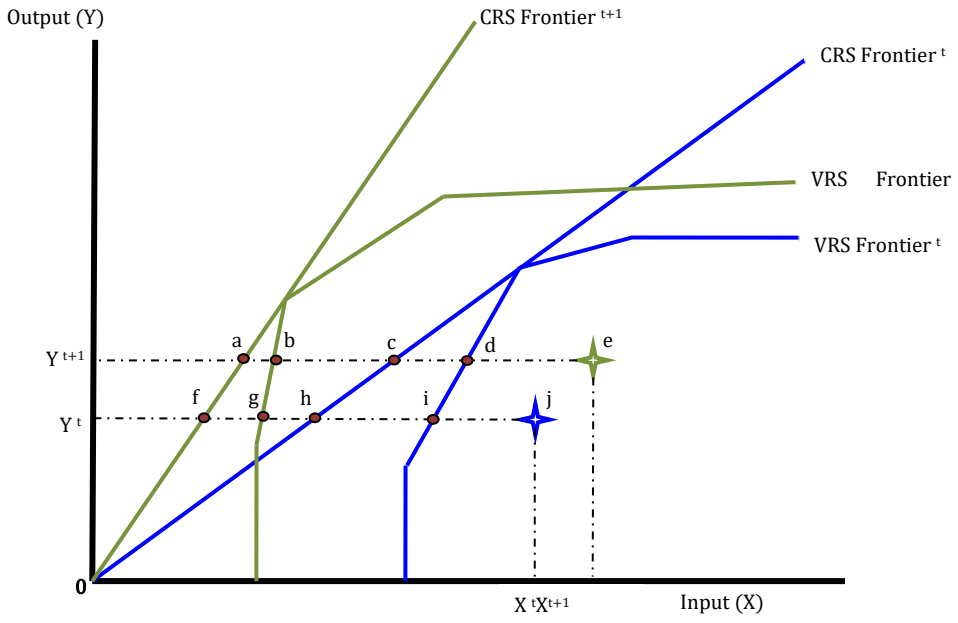
$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) =$$

$$= \underbrace{\underbrace{\frac{0b/0e}{0h/0j}}_{\Delta P} \times \underbrace{\left[\frac{0b/0e}{0a/0e} \Big/ \frac{0g/0j}{0f/0j}\right] \times \left[\frac{0d/0e}{0c/0e} \Big/ \frac{0i/0j}{0h/0j}\right]}_{\Delta S}}_{\Delta E} \times \underbrace{\sqrt{\frac{0c/0e}{0a/0e} \times \frac{0h/0j}{0f/0j}}}_{\Delta T}$$

Radial distance functions used in productivity index are calculated through DEA linear programming (LP) methodology using Wilson's FEAR 2 software (2008).This frontier construction method used input and output quantities data points of countries in our sample to solve a series of LP problems, one for each country. To estimate distance functions, we used output oriented both CRS and VRS models.

Since DEA based approach calculating the Malmquist index has serious shortcomings as discussed before, we apply bootstrap procedure of Simar and Wilson (2000) to correct for the biasness and construct confidence interval to provide statistical inferences(12). Hence the statistical significance of productivity, efficiency and technological changes was also tested. The bootstrap approach in the DEA context was first introduced by Simar and Wilson (1998) and was further developed by them in Simar and Wilson 2000).

Figure 1. *Malmquist Productivity Change using VRS and CRS technology with one input and output*



The bootstrap is a computer-based method that re samples the original data in order to assign statistical properties. It is based on the idea that the unknown distribution of the difference between the true and estimated score is approximated by the distribution of the

difference between the estimated and the bootstrapped score. To illustrate, we follow the following steps:

(1) The Malmquist indices are first computed using output-oriented DEA model (as discussed previously).
(2) A pseudo data set is then generated using the bivariate kernel density estimator to construct the reference bootstrap technology.
(3) The bootstrap estimates of the Malmquist indices are then computed by applying the original estimators to the pseudo sample obtained in step (2). The bivariate smoothed bootstrap procedure of Simar and Wilson (2000) is used to correct for the temporal correlations between these scores in two time periods.
(4) Steps (2)–(3) are repeated 10,000 times to create a set of vector estimates.
(5) Bootstrap confidence intervals are then constructed using the percentile method for the Malmquist indices.

Bias-corrected estimates of the Malmquist indices are also obtained to improve the confidence interval as suggested by Simar and Wilson (2000). For Malmquist productivity index (Mo), the bias-corrected estimate is expressed as

$$\text{(Bias Corrected) Mo} = 2 \times \text{Mo} - \frac{\sum_{n=1}^{10,000} \text{Bootstrap estimate of Mo}}{N}$$

Where

$$\text{Bias} = \frac{\sum_{n=1}^{10,000} \text{Bootstrap estimate of Mo}}{N} - \text{Mo}$$

The same procedure is also applied for all other Malmquist indices. A second bootstrap is also used in regression analysis to further improve the results.

In the second stage, we use the bias corrected Malmquist indices as the dependent variable (y_i) regressing them on potential exogenous (environmental) variables including institutions (x_i):

$$y_i = a + x_i\beta + ©_i$$

where $©_i$ is a statistical noise.

At first, Bias corrected Malmquist indices are regressed on their potential covariant. To overcome the problem of correlation of second stage environmental variables with inputs and outputs of productivity estimates, we performed a second (double) bootstrap on linear regression to re-estimate the marginal effects of the environmental variables. We obtain 10,000 replications for each parameter estimate. Bias corrected regression coefficients and Standard errors are thus created for the parameters following the same procedure as discussed above.

3. Input/output specification and data description in productivity analysis

In productivity analysis, output per worker is used as output, whereas Physical capital per worker and human capital per worker are taken as inputs. As confirmed by Maudos et al. (1999) on OECD sample, human capital is the biggest source of variation in productivity growth after technical progress. However, it is not included in many studies as a productive factor, hence TFP estimated in these cases might be biased. We took the values of physical and human capital per worker as inputs and output per worker as output from the data set developed by Baier et al. (2006).

This data set is more comprehensive than any other previously available data used in growth analysis. They used a perpetual inventory method of calculation of the stock of physical and human capital made up of enrolment rates, years of schooling and experience. This data set covers 145 countries and spans for about hundred years for few countries and is divided into 10 years intervals so that single observation covers the effects of 10 years. The time span is long enough to neutralize the impact of business cycle fluctuations from the data. Table 1 reports the summary statistics of input and output variables used in this analysis.

We included 78 countries from this data set in our analysis and used the last two observations for each country covering the period of 1990 and 2000. These countries are from all parts of the world and are evenly distributed. Region wise distribution is as follows. Region wise distribution is as follows. Africa 9, East Asia and Australia 11, Eastern Europe 12, Latin America 18, Middle East and North Africa 8, North America 2, South Asia 4, Western Europe 14.

Total number of observations included in our dataset would be 468. In Growth accounting literature Summers and Heston (1988) database is widely used to estimate the production function; however, the information on human capital is not included in that data set which is considered a major drawback. This information then would have to be taken separately from other databases like Barro and Lee (1993).

Table 1. *Summary Statistics of Input and Output variables*

	Input Variables				Output variable	
	Human Capital per Worker		Physical Capital per Worker		Income per Worker	
	2000	1990	2000	1990	2000	1990
Mean	5.505933	4.959734	29955.59	26161.26	15931.57	13531.3
Median	5.624855	5.227323	21327.7	17807.79	10637.72	9507.424
Maximum	7.620805	7.299808	83329.67	77606	47047.83	38854.14
Minimum	2.411952	2.219233	656.1504	128.0718	743.4831	1001.961
Std. Dev.	1.332949	1.254658	25019.51	22726.33	13278.2	10648.75
Skewness	-0.433125	-0.288717	0.737446	0.786006	0.772058	0.808043
Kurtosis	2.377278	2.129405	2.21345	2.226252	2.212441	2.31949

4. Productivity results and discussion

Table 2 reports the productivity score of 78 countries included in our sample. Scores of Malmquist productivity change index, its two components namely technological and efficiency change along with further decomposition of efficiency change into change in

scale and pure efficiency are displayed. Productivity change and its components have shown a slight decline of 0.3% from 1990 to 2000; however, there was no change in productivity in bias corrected scores. The Value of Malmquist productivity index or its sub components if more than unity shows improvement and less than unity shows decline in performance.

Un-weighted average scores showed that countries experiencing most productivity growth were Romania, South Africa and Argentina of about 75%, 75% and 61% respectively whereas major decline in productivity was experienced in Bangladesh, Nigeria and Ukraine of about 60%, 51% and 47% respectively. Region with highest productivity growth was Western Europe with about 12% growth, followed by North America, East Asian and Australian, and Eastern Europe by 6%, 1.3% and 1% respectively. Largest decline in productivity was experienced by south Asia of about 26% growth followed by Middle East and North Africa (MENA) and Latin America with decline in productivity of about 7%, 8%, and 1.3% respectively.

However, un-weighted average of world sample showed improvement of efficiency by about 0.8%, while decline in technology adoption by about 1%. An improvement in efficiency depicts that on average, world is utilizing its existent resources and technology more adeptly as in previous periods. Largest increase in efficiency over time under constant return of scale is of Romania of 100%, followed by South Africa and China of about 76%, and 75% respectively. Eastern Europe and Latin America experience highest improvement in efficiency of about 7% and 5% respectively whereas South Asia followed by North America and MENA region witnessed the biggest efficiency decline of about 13%, 11% and 7% respectively. We can also witness signs of catch-up or convergence as majority of countries that experience high growth have efficiency scores lower than average.[13]

Technology index also shows a slight decline of about 1%, which does not mean a reduction in knowledge stocks. This index depicts the change in a country's production frontier over time relative to that country inputs, not the actual shift of technology frontier. A negative growth of technology change index of a country could be due to comparatively less investment in development or absorption of new technology in terms of new procedures, techniques and skills as well as in adoption of existing technologies by that country. Numeric values suggested that countries like Ireland, Germany, Spain and Netherland witnessed the highest growth in innovations and technological adoption of about 24%, 23%, 22% and 22% respectively as compared to previous period whereas Morocco, Zimbabwe and Kenya registered significant decline in technological investments of about 21% each. Region witnessing the highest growth in technology is North America followed by Western Europe of 18% and 14% respectively. Largest decline appeared in the South Asian region followed by Africa of about 14% and 12% respectively.

When applying VRS assumption, efficiency change is further decomposed into1) changes in scale operations, and 2) pure efficiency change.

While decomposing the change, we witnessed a large variation in its two sub components. Pure efficiency increased and scale efficiency declined by about 1.5%. Largest increase in pure efficiency was witnessed in China followed by El Salvador and South Africa of about

66%, 65%, and 63% respectively, whereas largest decline was noted in Ukraine and Russia of about 51% and 42% respectively. Africa and Latin American regions showed largest growth of about 16% and 7% respectively whereas largest decline was seen in MENA and Eastern European region of about 7% and 5% respectively. In case of scale efficiency, countries like Philippines, Sri Lanka, and Slovakia also experienced huge growth in scale operations of about 25%, 24%, and 23%. Eastern Europe showed the largest improvement in Scale operations of about 11%, whereas South Asia and Africa showed the largest decline of about 25%, and 20% respectively. When comparing bias and bias-corrected scores, the ranking of regions for all productivity indices remains stable even after the bias-correction.

5. Regression methodology

Calculation of Productivity indices in the above section was the first stage in two stage procedure. In the second stage the factors that influence these indices will be explored. These factors may be exogenous to the production model and therefore have not been included in inputs directly but have a huge indirect impact on the outcome. Institutions may be one of such factors. Hence, in the second stage, these factors are analyzed using regression analysis and the channels through which these factors impact productivity are identified.

In empirical literature, there is no specific approach to specify second stage regression equations. We thus used Malmquist productivity change index (MPC) and its components along with its efficiency change (EC) and technology change (TC) sub-indices as dependent variables. We used bias corrected values of these three indices. The Index of Institutional Social Technologies (IIST) and its three sub-indices Risk-reducing Technologies (SiiF1), Factor of Institutional and Policy Rents (RiiF2) and Factor of Political Rent (RpiF2) were used as explanatory variables for institutional characteristics. They variables have values ranges between 0 and 1 and higher values indicate better institutional quality. Other variables like Inflation and Trade Balance are also used as explanatory ones to control the different macroeconomic conditions. Higher inflation could possibly retard the productivity growth due to higher level of uncertainty and hence could have a negative expected sign. Trade balance as percentage of GDP is used to measure the country dependence on international resources. A high level of trade increases output and may have positive impact on productivity. Inflation is measured as the ratio of GDP in current local currency to GDP in constant local currency. The base year varies by country whereas Trade is measured as percentage of GDP. These variables are taken from World Development Indicators WDI (2008) and are expressed in terms of averages from the year 1990 to 2000 depending on the availability of data. Table 3 provided their descriptive statistics. These explanatory variables are used in all equations to access their influences on productivity and their components.

Table 2. *Bootstrap Malmquist Productivity Index and its Decomposition*

Countries	Productivity Change (MPC)				Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
					Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
	MPC	MPC_bc (Baised Corr.)	95% confidence Interval		EC	EC_bc (Baised Corr.)	95% confidence Interval		TC	TC_bc (Baised Corr.)	95% confidence Interval		PEC	PEC_bc (Baised Corr.)	95% confidence Interval		SEC	SEC_bc (Baised Corr.)	95% confidence Interval	
			Low	High			Low	High			Low	High			Low	High			Low	High
Algeria	0.9285	0.9343	0.9244	0.9482	0.8879	0.9111	0.8412	0.9782	1.0457	1.0227	0.9350	1.1054	0.8376	0.8472	0.7815	0.9087	1.0601	1.0750	0.9917	1.1490
Argentina	1.6116	1.6142	1.6032	1.6281	1.5841	1.6133	1.5003	1.7254	1.0173	0.9985	0.9211	1.0695	1.5780	1.6081	1.4732	1.7369	1.0039	1.0027	0.9597	1.0401
Australia	0.9534	0.9627	0.9243	0.9811	0.8375	0.8461	0.7246	0.9585	1.1384	1.1328	0.9753	1.2741	0.8443	0.8535	0.7284	0.9680	0.9920	0.9909	0.9409	1.0478
Austria	1.2317	1.2230	1.2022	1.2655	1.0765	1.0653	0.9153	1.1955	1.1442	1.1435	0.9859	1.2856	1.0829	1.0701	0.9145	1.2046	0.9941	0.9949	0.9459	1.0750
Bangladesh	0.3929	0.4060	0.3575	0.4256	0.4795	0.4114	0.0906	0.6241	0.8194	0.9042	0.5219	1.1846	0.8999	1.1054	0.7227	1.5065	0.5329	0.2217	-0.5784	0.5693
Belgium	1.1400	1.1359	1.1077	1.1802	0.9856	0.9699	0.8326	1.0873	1.1566	1.1664	1.0120	1.3068	1.0000	0.9876	0.8444	1.1159	0.9856	0.9814	0.9365	1.0607
Bolivia	0.7919	0.7748	0.7502	0.7904	0.9691	0.9286	0.7469	1.0827	0.8172	0.8275	0.6907	0.9505	0.9922	0.9639	0.7986	1.1053	0.9767	0.9644	0.9135	1.0305
Botswana	1.3537	1.3552	1.3516	1.3598	1.4607	1.4678	1.3506	1.5837	0.9268	0.9217	0.8435	0.9931	1.4702	1.5267	1.4019	1.6538	0.9935	0.9575	0.8632	1.0490
Brazil	0.9735	0.9735	0.9717	0.9752	0.9905	1.0038	0.9381	1.0705	0.9828	0.9683	0.8965	1.0323	0.9989	1.0122	0.9427	1.0830	0.9916	0.9912	0.9351	1.0453
Bulgaria	0.6963	0.7032	0.6846	0.7256	0.6817	0.7004	0.6496	0.7501	1.0214	1.0016	0.9250	1.0719	0.6859	0.7122	0.6461	0.7731	0.9939	0.9818	0.9332	1.0260
Canada	1.0199	1.0261	1.0103	1.0494	0.8624	0.8450	0.7325	0.9452	1.1826	1.2089	1.0628	1.3462	0.8951	0.8951	0.7596	1.0161	0.9635	0.9423	0.8613	1.0273
Chile	0.9032	0.9032	0.8863	0.9197	0.9155	0.9280	0.8659	0.9905	0.9866	0.9717	0.8999	1.0355	0.8741	0.8696	0.8066	0.9314	1.0473	1.0668	1.0191	1.1072
China	1.2961	1.4608	1.3211	1.6262	1.5841	1.7501	1.4778	2.0305	0.8182	0.8333	0.6887	0.9639	1.5479	1.6567	1.4514	1.9295	1.0234	1.0616	0.9694	1.1393
Colombia	0.9357	0.9410	0.9318	0.9531	1.0242	1.0314	0.9442	1.1190	0.9136	0.9107	0.8275	0.9857	1.0670	1.0973	1.0111	1.1917	0.9599	0.9385	0.8929	0.9845
Costa Rica	1.2778	1.2774	1.2710	1.2831	1.2852	1.3036	1.2166	1.3901	0.9942	0.9783	0.9055	1.0442	1.3196	1.3433	1.2451	1.4358	0.9739	0.9699	0.9302	1.0174
Czech Republic	1.3083	1.3212	1.2702	1.3764	1.3663	1.3913	1.2885	1.5021	0.9576	0.9481	0.8764	1.0129	1.2088	1.1936	1.1029	1.2763	1.1302	1.1644	1.0997	1.2416
Denmark	1.1929	1.1942	1.1708	1.2074	1.0602	1.0731	0.9405	1.1847	1.1252	1.1089	0.9800	1.2331	1.0715	1.0942	0.9412	1.2215	0.9894	0.9794	0.9220	1.0423
Dominican Rep.	1.1268	1.1210	1.1034	1.1348	1.2074	1.2072	1.1095	1.2997	0.9333	0.9271	0.8509	0.9963	1.2313	1.2428	1.1537	1.3285	0.9806	0.9711	0.9321	1.0143
Ecuador	0.6338	0.6265	0.6107	0.6386	0.6915	0.6853	0.6215	0.7435	0.9165	0.9125	0.8312	0.9857	0.6765	0.6675	0.6095	0.7172	1.0223	1.0265	0.9809	1.0728
Egypt	1.0783	1.0628	1.0447	1.0847	1.2471	0.9687	0.1821	1.5457	0.8647	0.9719	0.5866	1.2510	1.1964	0.8829	0.0256	1.4692	1.0424	1.0708	0.9530	1.1669
El Salvador	1.2305	1.2485	1.2312	1.2736	1.4472	1.4547	1.2629	1.6354	0.8502	0.8548	0.7411	0.9593	1.5911	1.6548	1.4835	1.8349	0.9096	0.8760	0.7973	0.9533
Estonia	0.9170	0.9177	0.8950	0.9402	0.9345	0.9471	0.8834	1.0127	0.9813	0.9675	0.8962	1.0306	0.8560	0.8518	0.7860	0.9147	1.0917	1.1111	1.0472	1.1770
Finland	1.0217	1.0199	0.9912	1.0483	0.8645	0.8384	0.7187	0.9485	1.1818	1.2101	1.0610	1.3476	0.9008	0.8945	0.7530	1.0207	0.9597	0.9359	0.8569	1.0346
France	0.9040	0.9188	0.8762	0.9386	0.8020	0.8228	0.7056	0.9303	1.1272	1.1110	0.9530	1.2528	0.8277	0.8675	0.7439	0.9782	0.9689	0.9457	0.8808	1.0339
Germany	1.0540	1.0502	1.0326	1.0675	0.8829	0.8469	0.7199	0.9625	1.1937	1.2317	1.0766	1.3736	0.9047	0.8787	0.7461	0.9977	0.9760	0.9639	0.9127	1.0379
Greece	1.2494	1.2405	1.2210	1.2534	1.1793	1.1975	1.0903	1.2932	1.0594	1.0331	0.9397	1.1221	1.1771	1.2083	1.0858	1.3179	1.0018	0.9899	0.9448	1.0279
Guatemala	0.9183	0.9171	0.9145	0.9191	1.0007	1.0014	0.9156	1.0839	0.9177	0.9142	0.8330	0.9883	1.0000	1.0939	0.9163	1.2337	1.0007	0.8895	0.6723	1.0918
Honduras	0.6822	0.6944	0.6758	0.7177	0.7477	0.7628	0.7020	0.8295	0.9123	0.9086	0.8263	0.9827	0.8021	0.8123	0.7379	0.8944	0.9323	0.9382	0.8630	1.0047
Hungary	1.0524	1.0565	1.0075	1.1062	1.0799	1.0953	1.0080	1.1837	0.9744	0.9631	0.8924	1.0276	0.9460	0.9273	0.8543	0.9956	1.1416	1.1794	1.1151	1.2551
India	0.9650	1.0109	0.9693	1.0728	1.2105	1.2355	1.0008	1.4513	0.7972	0.8120	0.6545	0.9521	1.3055	1.3737	1.1639	1.5865	0.9272	0.8960	0.8156	0.9831

					Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
Countries	Productivity Change (MPC)				Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
	MPC	MPC_bc (Baised Corr.)	95% confidence Interval		EC	EC_bc (Baised Corr.)	95% confidence Interval		TC	TC_bc (Baised Corr.)	95% confidence Interval		PEC	PEC_bc (Baised Corr.)	95% confidence Interval		SEC	SEC_bc (Baised Corr.)	95% confidence Interval	
			Low	High			Low	High			Low	High			Low	High			Low	High
Indonesia	0.6549	0.6658	0.6524	0.6843	0.7398	0.7502	0.6771	0.8252	0.8852	0.8852	0.7896	0.9707	0.7862	0.8174	0.7453	0.8961	0.9411	0.9153	0.8529	0.9758
Ireland	1.4966	1.4930	1.4851	1.4995	1.2454	1.1909	1.0126	1.3508	1.2017	1.2445	1.0890	1.3876	1.2033	1.1017	0.9242	1.2830	1.0350	1.0728	1.0084	1.1464
Israel	1.1616	1.1573	1.1226	1.1767	1.0419	1.0538	0.9269	1.1598	1.1150	1.0945	0.9730	1.2133	1.0005	0.9655	0.8378	1.0814	1.0413	1.0876	1.0389	1.1412
Italy	0.9813	0.9840	0.9650	0.9935	0.8471	0.8375	0.7170	0.9476	1.1584	1.1697	1.0134	1.3113	0.8540	0.8452	0.7251	0.9562	0.9920	0.9905	0.9419	1.0551
Jamaica	0.6356	0.6418	0.6341	0.6526	0.7171	0.7225	0.6510	0.7940	0.8863	0.8861	0.7904	0.9713	0.6342	0.6144	0.5532	0.6667	1.1308	1.1730	1.1122	1.2528
Japan	1.0725	1.0587	1.0225	1.1180	0.9415	0.9312	0.8018	1.0422	1.1391	1.1329	0.9791	1.2722	0.9586	0.9699	0.8244	1.1027	0.9822	0.9582	0.8850	1.0411
Jordan	0.6195	0.6176	0.6078	0.6255	0.6104	0.6186	0.5743	0.6611	1.0149	0.9965	0.9206	1.0663	0.6156	0.6009	0.5361	0.6581	0.9916	1.0262	0.9369	1.1075
Kenya	0.7009	0.6609	0.6004	0.7099	0.9246	0.7891	0.3186	1.1334	0.7580	0.7922	0.5179	1.0158	1.1739	1.1458	0.7506	1.4486	0.7877	0.6962	0.5308	0.8487
Korea, South	0.9155	0.8943	0.8491	0.9285	0.8775	0.8765	0.7892	0.9479	1.0433	1.0187	0.9342	1.0973	0.8404	0.8316	0.7428	0.9088	1.0441	1.0533	0.9975	1.1004
Latvia	0.8705	0.8680	0.8510	0.8836	0.9005	0.9075	0.8421	0.9703	0.9667	0.9550	0.8842	1.0180	0.8495	0.8392	0.7659	0.9104	1.0601	1.0803	1.0201	1.1353
Lithuania	0.8931	0.8963	0.8852	0.9092	0.9387	0.9500	0.8846	1.0183	0.9514	0.9420	0.8698	1.0070	0.8473	0.8361	0.7705	0.8985	1.1079	1.1348	1.0689	1.2057
Malawi	0.6576	0.6374	0.6044	0.6727	0.7833	0.6143	0.1039	0.9736	0.8395	0.9283	0.5671	1.1983	0.9581	1.0340	0.7419	1.2633	0.8176	0.5390	-0.0932	0.9951
Malaysia	0.8052	0.8032	0.7987	0.8060	0.7469	0.7647	0.6906	0.8293	1.0782	1.0465	0.9419	1.1494	0.6736	0.6494	0.5517	0.7462	1.1088	1.1685	1.0109	1.3039
Mexico	0.8051	0.8208	0.8008	0.8495	0.7511	0.7831	0.7148	0.8465	1.0719	1.0439	0.9454	1.1404	0.6778	0.6840	0.6262	0.7415	1.1080	1.1447	1.0400	1.2264
Morocco	0.6466	0.7425	0.6627	0.8315	0.8353	0.9367	0.7199	1.1101	0.7740	0.7876	0.5925	0.9617	1.0000	1.1711	0.9202	1.3686	0.8353	0.7822	0.6505	0.8878
Namibia	1.1557	1.1660	1.1191	1.2159	1.1526	1.1804	1.0888	1.2682	1.0027	0.9858	0.9140	1.0513	0.8772	1.1092	0.8565	1.3130	1.3140	0.8154	0.0577	1.3883
Netherlands	1.1325	1.1301	1.1045	1.1500	0.9531	0.9203	0.7862	1.0388	1.1882	1.2208	1.0710	1.3603	1.0032	0.9893	0.8294	1.1282	0.9501	0.9288	0.8381	1.0443
New Zealand	0.9914	0.9963	0.9500	1.0592	0.8747	0.8794	0.7821	0.9784	1.1335	1.1302	1.0072	1.2465	0.8948	0.9116	0.7981	1.0240	0.9776	0.9633	0.9085	1.0203
Nicaragua	0.8964	0.7907	0.6507	0.8857	1.0710	0.9216	0.6474	1.1303	0.8370	0.8477	0.7223	0.9640	1.1850	1.0894	0.8702	1.2460	0.9038	0.8555	0.7739	0.9591
Nigeria	0.4947	0.4922	0.4887	0.4944	0.6363	0.6084	0.4414	0.7459	0.7774	0.7959	0.6112	0.9552	0.7337	0.7815	0.6524	0.8981	0.8673	0.7595	0.4727	0.9964
Norway	1.1796	1.1729	1.1689	1.1859	1.0686	1.0900	0.9375	1.2247	1.1039	1.0696	0.9052	1.2195	1.0766	1.0967	0.9298	1.2404	0.9926	0.9931	0.9396	1.0722
Pakistan	0.6591	0.6640	0.6580	0.6725	0.7526	0.7554	0.6737	0.8360	0.8757	0.8764	0.7743	0.9671	0.7888	0.9562	0.6689	1.2032	0.9541	0.6296	-0.1153	1.1006
Panama	0.9711	0.9718	0.9679	0.9761	1.0092	1.0204	0.9526	1.0903	0.9622	0.9509	0.8795	1.0145	0.9659	0.9635	0.8973	1.0291	1.0448	1.0588	1.0092	1.1037
Paraguay	1.3409	1.3539	1.3262	1.3875	1.4428	1.4630	1.3524	1.5813	0.9294	0.9239	0.8470	0.9935	1.5321	1.5536	1.4246	1.6942	0.9417	0.9410	0.8788	0.9992
Peru	1.3302	1.3289	1.3253	1.3317	1.4408	1.4437	1.3240	1.5584	0.9233	0.9189	0.8397	0.9917	1.3515	1.3297	1.2210	1.4259	1.0661	1.0850	1.0333	1.1387
Philippines	1.3519	1.3618	1.3523	1.3759	1.5823	1.5817	1.3746	1.7739	0.8544	0.8575	0.7446	0.9593	1.3402	1.2534	1.0772	1.4029	1.1806	1.2515	1.1791	1.3443
Poland	1.2117	1.2100	1.1992	1.2199	1.2573	1.2689	1.1817	1.3554	0.9637	0.9522	0.8811	1.0157	1.1839	1.1762	1.0789	1.2718	1.0620	1.0779	1.0147	1.1403
Portugal	1.0663	1.0514	1.0199	1.0726	1.0040	1.0136	0.9158	1.0980	1.0620	1.0348	0.9401	1.1253	0.9957	0.9987	0.8990	1.0872	1.0083	1.0147	0.9864	1.0443

					Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
Countries	Productivity Change (MPC)				Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
	MPC	MPC_bc (Baised Corr.)	95% confidence Interval		EC	EC_bc (Baised Corr.)	95% confidence Interval		TC	TC_bc (Baised Corr.)	95% confidence Interval		PEC	PEC_bc (Baised Corr.)	95% confidence Interval		SEC	SEC_bc (Baised Corr.)	95% confidence Interval	
			Low	High			Low	High			Low	High			Low	High			Low	High
Romania	1.7628	1.7542	1.7389	1.7646	2.0206	2.0019	1.7645	2.2262	0.8724	0.8733	0.7693	0.9656	1.7417	1.6239	1.4106	1.8091	1.1602	1.2230	1.1528	1.3097
Russia	0.6033	0.6010	0.5945	0.6057	0.5812	0.5899	0.5432	0.6333	1.0380	1.0166	0.9312	1.0961	0.5691	0.5821	0.5263	0.6334	1.0212	1.0122	0.9541	1.0710
Singapore	1.3719	1.3562	1.3399	1.4003	1.2368	1.2512	1.0794	1.4024	1.1092	1.0784	0.9171	1.2257	1.2092	1.1279	0.9093	1.3335	1.0228	1.0953	0.9570	1.1956
Slovakia	1.3721	1.4046	1.3488	1.4705	1.4817	1.5239	1.4071	1.6560	0.9261	0.9200	0.8425	0.9898	1.2595	1.2353	1.1422	1.3243	1.1764	1.2311	1.1636	1.3182
South Africa	1.7391	1.7517	1.7051	1.8054	1.7157	1.7566	1.6296	1.8812	1.0136	0.9951	0.9201	1.0630	1.5839	1.6352	1.5161	1.7565	1.0832	1.0725	0.9713	1.1616
Spain	1.0036	0.9981	0.9763	1.0134	0.8439	0.8122	0.6932	0.9185	1.1891	1.2215	1.0730	1.3596	0.8052	0.7366	0.6186	0.8565	1.0482	1.0930	1.0235	1.1695
Sri Lanka	0.8790	0.9010	0.8811	0.9295	1.0489	1.0621	0.9157	1.2005	0.8380	0.8446	0.7244	0.9533	0.8918	0.8546	0.7371	0.9528	1.1761	1.2375	1.1652	1.3322
Sweden	1.0006	1.0026	0.9952	1.0146	0.8565	0.8447	0.7353	0.9418	1.1682	1.1824	1.0408	1.3162	0.8464	0.8239	0.7134	0.9250	1.0120	1.0243	0.9877	1.0610
Switzerland	1.2089	1.2095	1.2089	1.2152	1.1153	1.1631	1.0000	1.3040	1.0840	1.0302	0.8640	1.1857	1.0466	1.0354	0.8644	1.1872	1.0657	1.1206	1.0379	1.2078
Taiwan	0.8916	0.8738	0.8379	0.8995	0.8430	0.8455	0.7609	0.9168	1.0576	1.0315	0.9402	1.1181	0.8481	0.8473	0.7552	0.9290	0.9939	0.9974	0.9590	1.0432
Tanzania	0.7209	0.7164	0.7093	0.7395	0.8772	0.7035	0.1169	1.1136	0.8219	0.9086	0.5027	1.2059	1.0000	0.9327	0.1352	1.4196	0.8772	0.6830	-0.3326	1.2882
Thailand	0.7394	0.7449	0.7224	0.7695	0.7726	0.7850	0.7300	0.8447	0.9571	0.9474	0.8762	1.0115	0.7962	0.8081	0.7423	0.8776	0.9703	0.9708	0.9160	1.0242
Tunisia	1.0138	1.0095	0.9951	1.0215	1.0771	1.0796	0.9963	1.1594	0.9413	0.9337	0.8602	1.0010	1.0947	1.1079	1.0290	1.1922	0.9839	0.9739	0.9204	1.0216
Turkey	0.8606	0.8658	0.8475	0.8868	0.9045	0.9174	0.8542	0.9856	0.9515	0.9423	0.8707	1.0069	0.9297	0.9463	0.8741	1.0241	0.9729	0.9687	0.9136	1.0203
Ukraine	0.5278	0.5304	0.5238	0.5386	0.5644	0.5703	0.5276	0.6142	0.9351	0.9286	0.8530	0.9975	0.4940	0.4859	0.4460	0.5230	1.1424	1.1720	1.0968	1.2515
United Kingdom	1.0330	1.0328	1.0312	1.0357	0.9238	0.9376	0.8302	1.0317	1.1182	1.0976	0.9703	1.2216	0.9138	0.9183	0.8040	1.0206	1.0110	1.0207	0.9817	1.0611
United States	1.0945	1.0885	1.0330	1.1245	0.9533	0.9418	0.8072	1.0559	1.1481	1.1516	1.0190	1.2766	1.0000	1.0306	0.8653	1.1613	0.9533	0.9091	0.8171	1.0250
Venezuela	0.7395	0.7604	0.7221	0.8091	0.6591	0.6713	0.6139	0.7376	1.1219	1.1312	1.0262	1.2295	0.5959	0.6284	0.5548	0.6967	1.1061	1.0604	0.9093	1.2029
Zambia	0.6349	0.5663	0.4745	0.6266	0.8001	0.6827	0.4351	0.8791	0.7935	0.8115	0.6469	0.9563	1.0857	1.1227	0.9566	1.2626	0.7370	0.5973	0.3874	0.7780
Zimbabwe	1.0229	1.0451	1.0251	1.0746	1.3346	1.3038	0.9310	1.6072	0.7665	0.7879	0.5891	0.9595	1.2782	1.2086	0.8977	1.4757	1.0442	1.0764	0.9808	1.1632
Average	0.9969	0.9992			1.0141	1.0080			0.9885	0.9896			1.0100	1.0154			1.0048	0.9848		

Bias Corrected Values and Confidence Interval are obtained from 10,000 bootstrap replications.

Table 3. *Descriptive Statistics*

	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Obs.
MPC_bc	0.9992	1.7542	0.4060	0.2834	0.3830	3.0294	78
EC_bc	1.0080	2.0019	0.4114	0.3042	0.9352	3.8114	78
TC_bc	0.9896	1.2445	0.7876	0.1208	0.3722	2.2955	78
IIST	0.5850	0.8120	0.3560	0.1290	0.2060	1.8930	84
SiiF1	0.5890	1	0	0.2160	-0.5740	2.9260	84
RpiF2	0.4670	1	0	0.2090	0.0780	2.7300	84
RiiF3	0.7120	1	0	0.2480	-1.2990	3.4070	84
TRADEBAL	-0.0269	0.139	-0.244	0.069	-0.527	4.017	83
INFLATION	461.9332	25107.73	9.270849	2751.879	8.814013	79.41708	83

Table 4. *Correlation coefficient matrix*

	MPC_bc	EC_bc	TC_bc	INFLATION	TRADEBAL	RpiF3	RiiF2	SiiF1	IIST
MPC_bc	1								
EC_bc	0.9149	1							
TC_bc	0.2289	-0.1677	1						
INFLATION	-0.0704	-0.0439	-0.0632	1					
TRADEBAL	0.2147	0.0294	0.4704	0.0023	1				
RpiF3	0.2004	0.0581	0.4156	0.0347	0.0775	1			
RiiF2	0.3145	0.1275	0.4694	0.1306	0.4207	0	1		
SiiF1	0.1929	-0.0035	0.4542	-0.2854	0.1087	0	0	1	
IIST	0.4086	0.1028	0.7783	-0.0795	0.3448	0.5687	0.556	0.5933	1

6. Results

Table 4 provides information about their correlations coefficient. Efficiency change is more closely related to productivity change whereas negatively correlated with the technological change. Table 4 also shows that Institutional indices are orthogonal (zero correlation among them), and have positive correlation with productivity indices particularly with technological change index which indicates that quality of institutions does produce a considerable positive influence on workers' productivities. Inflation is negatively correlated with other variables as expected. However, it is slightly positively correlated with some institutions and trade balance. The correlation coefficients of trade balance are positive for all variables as expected.

Results are given in Tables 5.1, 5.2 and 5.3. Columns 2 and 4 of Table 5.1 give biased corrected results from OLS method. Column 2 has combined index for institutions and column 4 gives the results when three separate indices of institutions are used. Columns 3 and 5 of Table 5.1 give biased corrected results using Bootstrap regression. Colum 3 used combined index of institution and Column 5 used three indices for three types of institutions. All equations have inflation and trade balances as other independent variables to capture the impact of macroeconomic effects on productivity, efficiency and technology.

Regression analysis in Columns 2 and 3 of Table 5.1 both show the impact of aggregate index of institutions on productivity change. This Table 5.1 shows either we use OLS and Bootstrap regression, the results are robust and show a very significant positive impact of institutions on productivity. The other variables that supposed to capture the impact of macro-economic conditions on productivity have expected sign but insignificant. Inflation retards productivity and volume of trade enhances productivity as theory suggests. Column 4 and 5 give the impact of three sets of institutions namely, Risk-reducing Technologies

(SiiF1) refers to institutions that reduce the cost of protecting property rights and strengthen contract enforcement. These services include provision of public goods such as rule of law and justice. The Second factor named Factor of Institutional and Policy Rents (RiiF2), focuses on technologies that help to eliminate or minimize two kinds of rent – institutional and policy rents. Third factor named Factor of Political Rent (RpiF3) measure the extent of power granted by institutions to political authorities. Among the three types of institutions, Factor of institutional and policy rents (RiiF2) seems to have a more significant impact on Productivity change indices as compared to other two as shown by their coefficient and significance values. This shows that institutions that curb corruption, bureaucratic inefficiencies, lax regulations and unfriendly business policies have more pronounced effect on productivity, as compared to those indices that curb political rents. Surprisingly institutions like law and order that reduce transactional risks seem to have no significant impact on productivity growth.

After discussing the impact of aggregate and individual indices of institutions on productivity growth, now we discuss the impact of these institutions on the components of productivity growth i.e. efficiency growth and technology growth. First we discuss effects on efficiency growth. Table 5.2 gives the effects of institutions and macroeconomic conditions on efficiency change. The results show all variables in each equation of this Table 5.2 whether estimated through OLS or Bootstrap give same results and all variables despite having correct signs are insignificant. Similarly, the macroeconomic variables are also insignificant.

Table 5.3 discusses the impact of these variables on technology change and unlike efficiency change all variables except inflation are significant and have correct sign. This indicates that institutions influence productivity mainly by increasing the pace of technological change. When institutions are strong, entrepreneurial resources, efforts and innovations are diverted from predatory activities towards production. Moreover, if Institutions that curb institutional and policy rents in the economies (RiiF2) are strong, it will lead to more efficient utilization of existent resources and technology. Overall, these findings prove positive relationship between institutions and productivity growth. Their estimates are large showing that marginal improvement in institutional qualities would produce huge impact on workers' productivity.

7. Conclusion

This paper analyze the role of different kinds of institutions in enhancing workers' productivity and efficiencies across countries in a two stage analysis. In the first stage, productivity growth and its components (technological and efficiency change) are calculated for 78 countries covering the period of 1990-2000 using a non-parametric method developed by Fare et al. (1985, 1994) and based on data envelopment analysis (DEA) as well as Malmquist index methodology. Apart from physical capital, this study also included human capital per worker as additional input. These estimates were improved adding stochastic elements and using bootstrap procedure as proposed by Simar and Wilson (2000).

Other factors such as institutions that are not included in Productivity Model are analyzed separately in the second stage by Regression Analysis where biased corrected productivity estimates on institutions and other macroeconomic variables are used. To further improve the result, the second (double) bootstrap is performed on the above regression, thus producing bias correct regression coefficients and standard errors.

For measuring quality of institutions, we had taken Institutions variables from Siddiqui and Ahmed (2013b). They are classified into three distinct dimensions namely institutional and policy rents, political rents and risk reducing technologies. The results suggest that across countries, workers 'productivity remained constant during the period of study; however, technology adoption shows a slight decline during the period.

Findings from second stage of regression analysis suggest a strong and positive role of institutions in enhancing productivity growth of workers and show that institutions that curb corruption, bureaucratic inefficiencies and unfriendly business policies have more pronounced effect on productivity, as compared to those that pertain to law and order, justice and property rights enforcement and that curb political rents. Moreover, institutions influence productivity mainly through increasing the pace of technological change. When institutions are strong, entrepreneurial resources, efforts and innovations are diverted from predatory activities towards production. Furthermore, strong Institutions that curb institutional and policy rents in the economies (RiiF2) will also lead to more efficient utilization of existent resources and technology. However, the impact of institutions on productivity growth through the channel of increased workers' efficiency is still not conclusive. Overall, these results suggest that institutional reforms might play a pivotal role in productivity growth and technological changes.

Table 5. *The Determinants of Productivity Growth (Second Stage Bootstrapped regression), 1990-00*

5.1. *Dependent Variables: Bias-corrected Malmquist Productivity Change (MPC_bc)*

	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.8315	0.8315		
	0.0010	*0.0010*		
SiiF1			0.2211	0.2211
			0.063	*0.075*
RiiF2			0.4054	0.4054
			0.013	*0.011*
RpiF3			0.2372	0.2372
			0.114	*0.087*
INFLATION	-4.1E-06	-4.1E-06	-6.8E-06	-6.8E-06
	0.927	*0.968*	*0.871*	*0.949*
TRADEBAL	0.3629	0.3629	0.2299	0.2299
	0.458	*0.451*	*0.66*	*0.644*
Constant	0.5187	0.5187	0.5150	0.5150
	0.0020	*0.0020*	*0.003*	*0.003*
F (Prob.)	*0.0003*		*0.0017*	
R Square	0.1748	0.1748	0.1848	0.1848
chi-Sq (Prob.)		*0.0001*		*0.0005*

5.2. *Dependent Variables: Bias-corrected Efficiency Change (EC_bc)*

	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.2417	0.2417		
	0.4	*0.412*		
SiiF1			-0.0265	-0.0265
			0.849	*0.858*
RiiF2			0.2214	0.2214
			0.239	*0.247*
RpiF3			0.0796	0.0796
			0.668	*0.647*
INFLATION	-3.8E-06	-3.8E-06	-7.7E-06	-7.7E-06
	0.957	*0.977*	*0.91*	*0.955*
TRADEBAL	-0.0259	-0.0259	-0.1724	-0.1724
	0.966	*0.966*	*0.793*	*0.784*
Constant	0.8684	0.8684	0.8633	0.8633
	0.0000	*0.0000*	*0.0000*	*0.0000*
F (Prob.)	*0.8003*		*0.8615*	
R Square	0.0119	0.0119	0.0253	0.0253
chi-Sq (Prob.)		*0.8021*		*0.8764*

5.3. *Dependent Variables: Technological Change (TC)*

	TC_bc (Bias-corrected)		TC_bc (Bias-corrected)	
	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.6590	0.6590		
	0.0000	*0.0000*		
SiiF1			0.2405	0.2405
			0.0000	*0.0000*
RiiF2			0.2129	0.2129
			0.0000	*0.0000*
RpiF3			0.2030	0.2030
			0.0000	*0.0000*
INFLATION	-3.50E-07	-3.50E-07	-8.53E-08	-8.53E-08
	0.983	*0.991*	*0.996*	*0.998*
TRADEBAL	0.4169	0.4169	0.4277	0.4277
	0.024	*0.015*	*0.046*	*0.025*
Constant	0.6083	0.6083	0.6086	0.6086
	0.0000	*0.0000*	*0.0000*	*0.0000*
F (Prob.)	*0.0000*	*0.0000*	*0.0000*	
R Square	0.6522	0.6522	0.6526	*0.6526*
chi-Sq (Prob.)		*0.0000*		*0.0000*

Bias-adjusted coefficients and their Confidence intervals obtained from 10,000 bootstraping interactions.
Values in italics are P-values of t-statistics.
Values in parentheses are 95% Confidence Interval.
Standard errors are robust to Heteroscedasticity.
*Breusch-Pagan (1979) and Cook-Weisberg (1983) test for heteroskedasticity with null hypothesis of constant variance.

Notes

(1) They applied two stage Double Bootstrap DEA based nonparametric frontier analysis as proposed by Simar and Wilson (2007).
(2) There is a dearth of literature both theoretical and empirical, on the two stage procedure See Simar and Wilson (2007) for survey of two-stage procedure for analysis on determinants of DEA scores.
(3) First developed by Charnes, C. and Rhodes (CCR)(1978) with constant returns to scale assumptions. However it was later refined by Banker, Charnes, and Cooper (BCC) (1984) accommodating variable returns to scale in their analysis. See Berger and Humphrey (1997) for a detailed survey.
(4) See Hall and Jones (1999) for example.
(5) See Siddiqui and Ahmed (1013b) for details.
(6) See Aigner et al. (1977) for efficiency measurement using this technique.
(7) See Berger and Humphrey (1997) for a detailed survey.
(8) See (Fare et al., 1994; Chang and Luh, 1999; Kumar and Russell, 2002; Henderson and Russell, 2005; Arestis et al., 2006; Growiec, 2008; Maudos et al., 2000; Taskin and Zaim, 1997; Mathur, 2007; Milner and Weyman-Jones, 2003; Jerzmanowski, 2007; Dimelis and Dimopoulou, 2002; Deliktas and Balcilar, 2002), for example.
(9) They follow the same approach as used in Siddiqui and Ahmed (2013a) who also explained how institutions influence economic growth in a theoretical framework proposed by North (1981),
(10) See Siddiqui and Ahmed (2013a) for a detailed discussion.
(11) See (Färe et al., 1997; Førsund, 1997; Balk, 1997; Coelli et al., 1999) for theoretical groundwork for analysis of productivity indices.
(12) For a detailed description of the bootstrap procedure, see Simar and Wilson (2000).
(13) See Siddiqui and Ahmed (2013b) for details.

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Does the Mundell-Fleming Model apply to Poland?

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Abstract. *Applying an extended IS-LM model to Poland, this paper finds that fiscal expansion does not raise output but causes real appreciation and that monetary expansion increases output and leads to real depreciation. Besides, a lower real interest rate, a higher real stock price or a lower expected inflation rate helps raise output; and a higher real interest rate, a higher real stock price or a lower expected inflation rate results in real appreciation. Hence, the predictions of the Mundell-Fleming model are applicable to Poland.*

Keywords: fiscal expansion, monetary expansion, exchange rates, Mundell-Fleming model.

JEL Classification: E52, E62, F41.

1. Introduction

Poland's authorities have engaged in fiscal policy, monetary policy and other macroeconomic measures to stimulate or stabilize its economy. During the global financial crisis, the Polish government used expansionary fiscal policy by raising the government deficit from 3.8% of GDP in 2008 to 5.3% of GDP in 2009 and 5.6% of GDP in 2010. As the economy continued to improve, the deficit-to-GDP ratio declined to a low of 0.6%in 2018. Central government debt as a percent of GDP also rose from 44.5% in 2008 to a high of 53.1% in 2013, and then declined to a low of 47.6% in 2018. These statistics suggest that after the passage of the stabilizing expenditure rule in 2014, the Polish authorities have maintained fiscal discipline and met the EU standards of the government deficit-to-GDP ratio and debt-to-GDP ratio of 3% and 60%, respectively (Korniluk, 2016).

During the global financial crisis, the National Bank of Poland lowered the interbank rate from 6.35% in 2008 to 4.34% in 2009 and 1.71% in 2018. M1 and M3 money supply rose 10.97% and 8.11%, respectively, during 2008-2009 to provide more liquidity to the banking and financial systems.

The Central Bank of Poland has pursued a floating exchange rate system since April 2000 and does not set any predetermined exchange rate target. However, the National Bank of Poland may intervene in the exchange rate market in order to meet the goal of the inflation target and maintain the criterion of exchange rate stability before joining the euro zone.

To the author's knowledge, few of previous studies have examined the effects of monetary policy and fiscal policy on output and the real effective exchange rate in Poland within the framework of an extended Mundell-Fleming model. This paper attempts to test if the predictions of the Mundell-Fleming model may apply to Poland. According to the Mundell-Fleming Model (Mundell, 1963, 2001; Fleming, 1962; Romer, 1996; Obstfeld, 2001; Mankiw, 2019), under a floating exchange rate system, fiscal expansion is ineffective in raising output and causes real appreciation whereas monetary expansion is effective in raising output and causes real depreciation. This paper differs from previous studies partly because the real effective exchange rate is included in the money demand function. Hence, the LM^* curve may not be vertical, and fiscal expansion may affect output.

2. Literature survey

Several recent studies have examined the effects of monetary policy, fiscal policy, and exchange rate movements on output and other related variables for Poland, the EU, and other countries.

Lopez-Villavicencio and Mignon (2016) studied exchange rate pass-through (ERPT) using a sample of 15 emerging economies including Poland during 1994-2015 period. They showed that more anti-inflationary and stable policy led to declining ERPT, that most countries adopting inflation targeting resulted in declining ERPT significantly, and that transparent monetary policy or adopting exchange rate targeting reduced ERPT.

Heryán and Tzeremes (2017) analyzed the bank lending channel for EU countries during 1999-2012. There are two major findings. Before the global financial crisis, the short-term interest rate had more pronounced effect on the bank lending channel in the old EMU countries. During the global financial crisis, M2 money was more important in the old EMU countries. In new EU countries, banks responded to monetary shocks differently.

Forte and Magazzino (2016) estimated impacts of different fiscal measures on growth for 18 EMU countries during 1980-2015. Cutting government spending instead of raising taxes increased economic growth. Reducing investment spending caused growth to decline. Public investment and tax cuts were more likely to increase growth than current government spending.

Ślusarczyk (2018) assessed fiscal policy on foreign direct investment (FDI) in Poland. Poland provided government assistance in Special Economic Zones and exemption of property taxes by the local government. Empirical results showed that fiscal policy had a positive significant impact on the increase in the value of FDI.

Brady and Magazzino (2018) evaluated the issue of fiscal sustainability in the 28 EU countries during 1980-2015. They found a long-term relationship between government spending and revenue and between government debt and the primary deficit and that government revenue does not cause government spending, and vice versa. The absence of fiscal sustainability was found in the PIIGS countries.

Brady and Magazzino (2018) examined fiscal sustainability for 19 EMU countries during 1970-2016. They found that average government debt level in recent years was much higher than that in the 1970s. These countries have satisfied the solvency condition mainly because austerity programs taken by these countries were effective.

Bökemeier and Stoian (2018) evaluated debt sustainability for 10 East and Central European economies during 1998-2015. They found that public debt was greater than the stabilized debt ratio in these 10 countries. But, public debt was relatively stable, less than the turning point, and far less from fiscal fatigue.

Afonso, Huart, Jalles, and Stanek (2018) studied the subject of the twin deficit using a sample of 193 countries including Poland during 1980-2016. The twin deficit relationship was confirmed if the fiscal rules were absent. The estimated coefficient for the effect of the budget balance on the current account balance was between 0.68 and 0.79. If fiscal rules were adopted, the coefficient would be 0.1.

Da Silva and Vieira (2017) examined monetary and fiscal policy for 113 advanced and developing countries including Poland during 2001-2008 and 2009-2012. Monetary policy appeared to be countercyclical in advanced countries before the global financial crisis. Fiscal policy seemed to be procyclical before the crisis. Smoothing of interest rates appeared to be an important instrument in monetary policy. Central banks in advanced countries ceased to react to the output gap after the global financial crisis. No significant relation between government spending and the output gap was found.

Afonso, Alves, and Balhote (2019) investigated the interaction between fiscal and monetary policies based on a sample of 28 EU countries during 1970-2015. There were

several major findings. Monetary policy was significantly impacted by inflation. The government increased primary balance when government debt rose. Central banks took a more active role when the government debt level was relatively high, suggesting that there was substitution between monetary policy and fiscal policy.

3. The model

Suppose that aggregate expenditures are a function of real income, government tax revenues, government spending, the real interest rate, the real stock price, and the real effective exchange rate and that real money demand is determined by the nominal interest rate, real GDP, the real stock price, and the real effective exchange rate. Extending Romer (1996) and Mankiw (2019), we can express the IS* and LM* functions as:

$$Y = W(Y, T, G, R, S, \varepsilon) \quad (1)$$

$$M/P = X(R + \pi^e, Y, S, \varepsilon) \quad (2)$$

Where:
Y – real GDP in Poland;
T – government tax revenue;
G – government spending;
R – the real interest rate;
S – the real stock price;
ε – the real effective exchange rate (An increase means real appreciation);
M – the money supply;
P – the price level, and
π^e – the expected inflation rate.

Solving for the two endogenous variables, Y and ε, we can find equilibrium real GDP and real effective exchange rate as:

$$\bar{Y} = \bar{Y}(G - T, M/P, R, S, \pi^e) \quad (3)$$

$$\varepsilon = \bar{\varepsilon}(G - T, M/P\,, R, S, \pi^e) \quad (4)$$

Assume that $X_\varepsilon < 0$ and that $W_G > W_T$. The Jacobian for the two endogenous variables is given by:

$$|J| = [-X_\varepsilon(1 - W_Y) - W_\varepsilon X_Y] > 0. \quad (5)$$

The impacts of fiscal expansion on equilibrium Y and ε can be shown as:

$$\partial\bar{Y}/\partial G - \partial\bar{Y}/\partial T = -(W_G - W_T)X_\varepsilon/|J| > 0, \text{ and} \quad (6)$$

$$\partial\bar{\varepsilon}/\partial G - \partial\bar{\varepsilon}/\partial T = (W_G - W_T)X_Y/|J| > 0. \quad (7)$$

Equations (6) and (7) suggest that more government deficit tends to raise output and lead to real appreciation. The prediction in equation (6) is different from the Mundell-Fleming model because of the inclusion of the real effective exchange rate in the money demand function. In the conventional Mundell-Fleming model, because the real effective exchange

rate is not included, $X_\varepsilon = 0$, and the partial derivative of equilibrium real GDP with respect to the government deficit is zero, suggesting that fiscal expansion does not affect real GDP.

The partial derivatives of equilibrium Y and ε with respect to the money supply can be expressed as:

$$\partial \bar{Y}/\partial M = -P^{-1}W_\varepsilon/|J| > 0. \quad (8)$$

$$\partial \bar{\varepsilon}/\partial M = -P^{-1}(1 - W_Y)/|J| < 0. \quad (9)$$

Equations (8) and (9) indicate that more money supply tends to raise output and cause real depreciation. When the money supply increases, the LM* curve shifts to the right, equilibrium real GDP rises, and equilibrium real effective exchange rate declines.

4. Empirical results

The data were collected from the *International Financial Statistics* and the *Eurostat*. Real GDP is measured in million zloty. Government borrowing as a percent of GDP is chosen to represent fiscal policy. The real effective exchange rate is a trade-weighted index. An increase means real appreciation. Real money supply is represented by M3 money adjusted for the consumer price index. M1 money is relatively narrow as it does not include saving accounts, small time deposits, money market accounts, and money market deposit accounts. The interbank rate minus the expected inflation rate is selected to represent the real interest rate. Other types of interest rates do not have adequate data. The financial stock index is divided by the consumer price index to derive the real financial stock index. The expected inflation rate is estimated as the average of lagged inflation rates in the past three years. Real GDP, real M3, and the real stock index are transformed to a log scale. The government borrowing-to-GDP ratio, the real interbank rate and the expected inflation rate are not transformed to a log scale due to negative values before or after the transformation. The sample consisting of annual data ranging from 1995 to 2018.

Figure 1. *Scatter Diagram between Real GDP (RGDP) and the Government Borrowing-to-GDP Ratio (BY)*

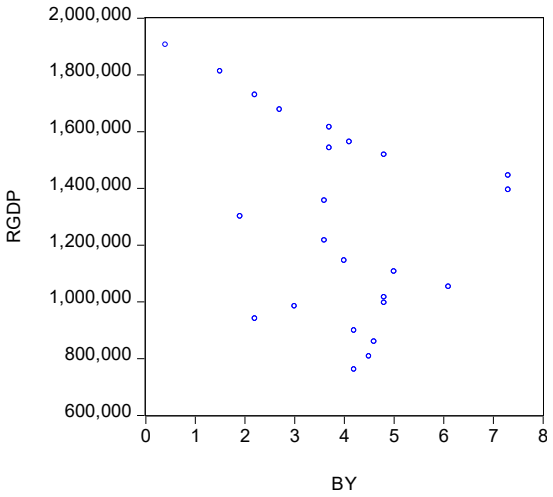
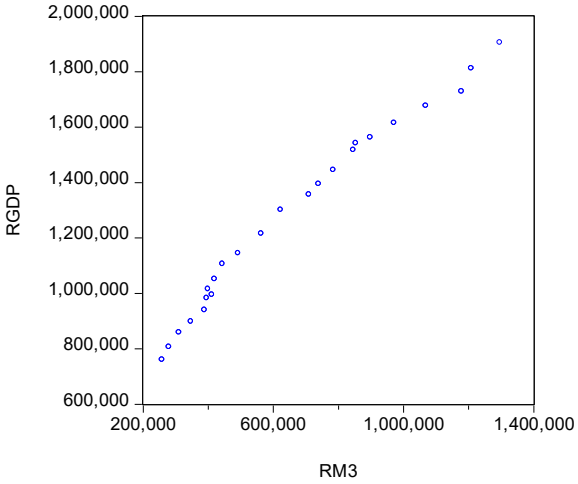


Figure 1 shows that real GDP and the government borrowing-to-GDP ratio seemed not to exhibit a consistent pattern during 1995-2010 and that their relationship seemed to be negative during 2011-2018. Figure 2 indicates that real GDP and real M3 had a strong positive relationship during the sample period of 1995-2018.

Figure 2. *Scatter Diagram between Real GDP (RGDP) and Real M3 (RM3)*



The EGARCH process is employed in empirical work to correct for autoregressive conditional heteroscedasticity. The estimated coefficients in the conditional variance equation are significant at the 1% level, suggesting that the EGARCH process is appropriate.

In the estimated regression for real GDP in Table 1, the exogenous variables with significant coefficients can explain approximately 99.72% of the variation in real GDP. Except for the coefficient of the borrowing-to-GDP ratio, other the estimated coefficients are significant at the 1% level. Real GDP has a positive relationship real M3 money and the real stock price and a negative relationship with the real interest rate and the expected inflation rate. A possible reason for the insignificant effect of fiscal expansion on real GDP is that the positive effect of fiscal expansion on aggregate demand is cancelled out by the negative crowding-out effect on private spending.

The positive significant coefficient of the real stock price indicates that the substitution effect dominates the wealth effect (Friedman, 1988). The substitution effect shows that a higher real stock price would reduce real money demand whereas the wealth effect indicates that a higher real stock price would increase real money demand. If the substitution effect dominates the wealth effect, the LM^* curve will shift to the right.

Specifically, a 1% increase in real M3 money would raise real GDP by 0.4895%. If the real stock price rises 1%, real GDP would increase by 0.0230%. A higher real stock price raises real GDP mainly due to increases in consumption and investment expenditures through the wealth effect, the balance sheet channel and Tobin's q theory (Mishkin, 1995).

Table 1. *Estimated regressions for real GDP and the real effective exchange rate*

	Log(real GDP)	Log(REER)
Constant	7.4437 (610.7170)	4.4623 (150.7197)
Government borrowing as a percent of GDP	0.0016 (1.3724)	0.0205 (4.4615)
Log(real M3)	0.4895 (521.3166)	-0.0265 (-4.3571)
Real interest rate	-0.0021 (-11.3284)	0.0095 (7.4274)
Log(real stock price)	0.0230 (23.6321)	0.0867 (5.2870)
Expected inflation rate	-0.0033 (-28.3855)	-0.0039 (-6.1238)
R-squared	0.9972	0.6823
Adjusted R-squared	0.9964	0.5940
Akaike information criterion	-5.4289	-3.2090
Schwarz criterion	-5.0361	-2.8163
Sample period	1995-2018	1995-2018
Number of observations	24	24

Notes:
REER: the real effective exchange rate.
Figures in the parentheses are z-statistics.

In the estimated regression for the real effective exchange rate, approximately 68.23% of the change in the dependent variable can be explained by the five right-hand side variables. All the coefficients are significant at the 1% level. The real effective exchange rate is positively affected by the government borrowing-to-GDP ratio, the real interest rate and the real stock index and negatively influenced by real M3 money and the expected inflation rate. These results indicate that fiscal expansion results in real appreciation whereas monetary expansion leads to real depreciation. A higher real interest rate tends to attract international capital inflows, increase the demand for the zloty, and cause real appreciation. A higher real stock value tends to attract foreign investors to purchase Poland's stocks, increase the demand for the zloty, and cause real appreciation.

5. Summary and conclusions

This paper has examined whether the Mundell-Fleming model may apply to Poland's economy. For Poland, fiscal expansion does not raise output but causes real appreciation whereas monetary expansion raises output and leads to real depreciation. The findings are consistent with the predictions of the Mundell-Fleming model. In addition, a lower real interest rate or a higher real stock price would raise output; and a higher real interest rate or a higher real stock price would result in real appreciation.

There are several policy implications. Fiscal discipline may need to be exercised as deficit-financed spending has little effect on output. Monetary expansion would be a better strategy than fiscal expansion as the former leads to more output and real depreciation whereas the latter results in real appreciation and little impact on output. Real appreciation hurts exports. A higher real interest rate hurts output and causes real appreciation. Hence, if the macroeconomic goal is to stimulate exports and output, a lower real interest rate would be

a better strategy because it tends to lead to real depreciation. A healthy stock market is important as a higher real stock value would lead to more output and real appreciation. Real appreciation tends to increase international capital inflows but hurt exports.

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The validity of Okun's Law: Evidences from Indian economy

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Abstract. *Unemployment is one of the most prominent issues being faced by developing countries especially India. Unemployment means productive resources not being utilized at all, which results low growth rate in real GDP. In macroeconomic terminology this relationship is called as Okun's Law. The main aim of this paper is to examine whether there exists an Okun type relationship in Indian economy or not. Empirical result shows negative and significant effect of growth upon unemployment rate. Our model suggests that 1% increase in GDP will decrease unemployment rate by 0.4 percentage point.*

Keywords: unemployment, GDP, Okun, Co-integration, casual relationship.

JEL Classification: E24, F43.

Introduction

Indian economy is the 6th largest economy in world with nominal GDP of USD 2.9 trillion and will overtake UK by 2020 to become 5th largest economy. India is fastest growing large economy after China, with numerous resources and favorable demographic dividend. It remains a challenge for Indian economy to take the advantage of this dividend. If we have a look on employment figures, we can see that unemployment rate is decreasing from 6.2% in 2014 to 2.3% in 2016 in India. The relationship between these two variables was first studied and estimated by Okun in 1962, which was commonly known as Okun's Law. Okun law states that there is negative relationship between GDP growth rate and unemployment rate, which is an important concept in macroeconomics both theoretically and empirically. Theoretically, Okun's law is the link between the aggregate supply curve and labour employment. Empirically, Okun's coefficient is a useful "rule of thumb" in forecasting and policymaking Harris and Silverstone (2001). Because Okun law drew the conclusion that unemployment rate was reduced about 0.3% points for every percentage point of GDP growth rate. This law intends to tell us how much of output we can lose if the unemployment rate is above its natural rate (potential level of output). This relationship was studied and examined by number of researchers. Some of them support Okun's law and some opposed this law. First we will examine those, who supported this law are Dornbusch et al. (2001). Who supported the existence of Okun's law and argued that foregone output is the major cost of unemployment. Zonzilos (2000) has also examined the Okun's law in Greece from time series data over the period 1965-1999 and found that unemployment decrease by 0.28 percent, if aggregate output increases by 1 percent. Noor et al. (2007) also examined whether there exist an Okun law in Malaysian economy or not. The empirical results showed the existence of inverse relationship between output and unemployment in Malaysia.

Bankole and Fatai (2013) studies the validity of Okun's law in Nigeria and estimated Okun's coefficient by using the annual data from 1980-2008. By using Engle Granger co-integration test, the empirical evidences showed Okun's coefficient is positive and is not applicable in case of Nigeria.

Data and methodology

The present study is based on the annual time series data over the period from 1983 to 2013 and has been collected from Reserve bank of India (RBI), NSSO data, statistical bulletin and Ministry of labour and Employment. The econometric methods were used to analyze the Indian unemployment and Gross domestic Product and to analyses the casual relationship between these variables.

Econometric methodology

The objective of this section is to test and estimate casual relationship between GDP and unemployment in the case of Indian Economy over the period of 1983-2013 and to verify the validity of Okun's Law, our model will be:

$$UNMt = \alpha + \beta GDP + \varepsilon \quad (1)$$

Where GDP is Gross Domestic Product in India and UNM is unemployment rate in India while α and β are the coefficient to be estimated and the ε is error term.

To ensure the linearity of variables, we have used the converted form of equation (1) which is given below, where "ln" standing for the natural logarithm.

$$\text{InUNM} = \alpha + \beta \text{lnGDP} + \varepsilon \quad (2)$$

For validity and verification of the model shown in eq. 2 has to pass through different steps as follows:

Step 1

To check whether the time series data of GDP and unemployment data are stationary or not. For this we have the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test of unit root. The null hypothesis in ADF test is that the time series data series is not stationary, or there exists a unit root, while the alterative hypothesis is that the series are stationary.

There are two cases used to show the existence of unit-root test:

1. with intercept

$$\Delta X_t = \alpha + \delta X_{t-1} + u_t \quad (3)$$

2. with intercept and trend

$$\Delta X_t = \alpha + \beta t + \delta X_{t-1} + u_t \quad (4)$$

Step 2

Next step is to test for co-integration and to verify whether the two series are co-integrated or not. For this purpose Johansen-Juselius technique was employed to test the existence of co-integration relationship between GDP and unemployment rate. The procedure depends on the Trace test and Maximum Eigenvalues test. In order to determine the number of co-integration equations between these variables. Accordingly the null hypothesis is (R = 0) there is no co-integration equations and alternatives one (R≤1) that there is existence of at least on co-integration equation.

Step 3

The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Co integration tests is sensitive for the number of lags used in the model. The optimal lag length for the model selected on the basis of Schwarz Information Criterion (SIC) criteria.

Step 4

After following the above steps, finally Vector Error Correction was employed to determine the casual relationship between inflation and unemployment. The methodology is adopted in line with Noor et al.(2007) and Khaliq et al. (2014).

Result and discussion

In order to obtain the desired results, we need to make sure that our model should be free from "spurious regression" (Gujarati 1995). First we test the order of integration for each variable using Augmented Dickey-Fuller Test (ADF) and Phillips-Perron (PP). The results of both the tests are reported in Table 1. With critical values both in intercept and intercept with trend. The empirical results suggest to reject the null hypothesis of no unit root. Accordingly, we accept that GDP is stationary on both at level as well as on first difference, while as unemployment has unit root problem at I(0) and is stationary on first difference.

Table 1. *Unit root tests result Augmented Dickey-fuller (ADF)*

Series	Intercept		Intercept with trend	
	ADF	PP	ADF	PP
LGDP	-4.093200 (-2.967767)*	-4.044684 (-2.967767)*	-4.421923 (-3.574244)*	-4.547020 (-3.574244)*
LUNM	-2.168123 (-2.967767)	-2.207717 (-2.967767)	-3.292831 (-3.574244)	-3.374622 (-3.574244)
DLGDP	-8.040722 (-2.971853)*	-15.86980 (-2.971853)*	-7.964546 (-3.580623)*	-18.93573 (-3.580623)*
DLUNM	-5.760033 (-2.971853)*	-9.382447 (-2.971853)*	-5.638339 (-3.580623)*	-9.272290 (-3.580623)*

From Table 2, the result of co-integration is shown. Accordingly we reject the null hypothesis of no co integration between the variables at 1% level of significance, because estimated values are more than the critical values. The long run co-integration is occurring in between GDP and UNM and is confirmed based on the results suggested by Durbin Watson statistics and F-statistics, and are significant at 5% level.

Table 2. *Result of the F-test for Co-integration*

Hypothesis	Trace Statistic	Max-Eigen Statistic
None (R=0)	991.2854 (15.49471) [0.0001]	989.8142 (14.26460) [0.0001]
At most 1	1.471223 (3.841466) [0.2252]	1.471223 (3.841466) [0.2252]

R^2 = 0.49, Adjusted R^2 = 0.45, Durbin Watson Stat 1.926622, F-Statistic = 9.364973, Prob F-stat 0.004837.

Table 3 reports the Okun's elasticity coefficient and also shows the impact of change in GDP which is negative and have significant at 1% level, which means that 1% increase in GDP leads to decrease in unemployment rate by 0.47%. This is much below the than the coefficient found in Okun's original work. The result is consistent with Noor et al. (2007), Khaliq et al. (2014), Haris and Silverstone (2001).

Table 3. *Result of long run elasticities of Okun's Law in India*

	Constant	GDP
UNM	1.05 (0.0048)	-0.47* (0.0000)

Table 4 examines the short run and long run Granger causality with the Error-Correction Mechanism (ECM). Thus long run relationship was not confirmed between unemployment rate and GDP in India, because the error coefficient term is (ECT_{t-1}) Positive and have significant at 5% level of significance. For long run causality relationship error correction mechanism should be negative. This confirms that there is no long run Ganger Causality between unemployment and GDP rate in India. However short run causality relationship was found and has been confirmed by Walt test. The F-Statistics critical values at 1 percent level of significance, which give us clear indication of short run causal effect. Therefore the finding of this paper reconfirms the existence of Okun's law in Indian economy.

Table 4. *Result of Granger causality*

Dependent Variable: ΔUNM				
$\Delta(UNM)t = b_1 + \sum_{i=1}^{n} b_{2i}\,\Delta(UNMt-i) + \sum_{i=1}^{n} b_{3i}\,\Delta(GDPt-i) + b_4 ECT_{t-1} + \varepsilon$				
	Coefficient	Std. Error	t-Statistic	Prob.
ECT_{t-1}	0.782356	0.165995	4.713126	0.0000
Wald Test:				
Test Statistic	Value	Probability		
Chi-square	8.313231	0.0039		
F-Statistic	9.364973	0.0048		

Conclusion

Now we are in a position to answer the question "Validity of Okun's law". Yes it is valid and is applicable for Indian Economy. Planners have to keep this thing in mind while framing employment policies in the country. Any attempt of the government to increase the GDP rate will definitely reduce the unemployment in India and vice versa. However, increase in GDP will not be the alone solution for unemployment. In addition of GDP, there are many other factors as well which are to be taken into consideration for reducing unemployment, like creating new jobs, job seekers talent and skill, incentives, labour intensive techniques, high tech production capabilities etc.

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