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The pandemic crisis – A new factor to slow down the expansion of the Eurozone

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Abstract. *The pandemic crisis from 2020-2021 has produced negative effects on the economies of six European Union (EU) member states outside the Eurozone: Bulgaria, Croatia, Czechia, Poland, Hungary, and Romania.*
This paper presents the economic and social situation in the aforementioned states, before the pandemic started in Europe and after the Sars-Cov-2 infection rates began to drop, and many restrictions previously imposed on tourism, hospitality, culture, sports and free movement were lifted. The paper highlights whether the Maastricht Treaty nominal convergence criteria were met or not by Bulgaria, Croatia, Czechia, Poland, Hungary, and Romania, as they represent an important pillar of joining the Eurozone; the paper also analyzes the real convergence – especially the Gross Domestic Product (GDP) per capita, calculated to the Purchasing Power Parity (PPP).
The pandemic crisis, as well as some misunderstandings at EU level, have led Romania, Czechia, Poland, and Hungary to postpone adopting the Euro, as the latter 3 states did not even set a Eurozone joining deadline. Yet, some progress has been made by Bulgaria and Croatia, as they included their national currency in the Exchange Rate Mechanism II (ERM II) starting July 10, 2020.

Keywords: convergence criteria, GDP per capita, regional gross domestic product, Euro area.

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

1. Introduction. A brief history of the Euro

The Maastricht Treaty has entered into force on November 1, 1993, and it provisions not only the creation of the European Union (EU), but also that of a single European currency to be adopted by all EU member states, provided that they meet certain nominal convergence criteria, such as: price stability, exchange rate stability, solid public finances and long-term interest rates.

At the reunion of the European Council in Madrid, in December 1995, the name of the single European currency was set to be the "Euro.

The Eurozone was formed on January 1, 1999, when 11 EU member states adopted the single currency – Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, The Netherlands, Portugal and Spain, but cash payments continued to be made in national currencies, as the Euro was used only in virtual form and for accounting purposes from January 1, 1999 to December 31, 2001. Denmark is the only EU state that obtained and exemption clause from adopting the Euro. The rest of EU member states were under the obligation of adopting the single currency at a certain date, following the conditions imposed by the Maastricht Treaty. It should be mentioned here that the United Kingdom also appealed at the "opt-out clause" of the Euro, same as Denmark, but today this state is no longer part of the European Union.

From 2001-2015, the single European currency was adopted by the following eight member states: Greece, Slovenia, Malta, Cyprus, Slovakia, Estonia, Latvia, and Lithuania (the latter joined the Eurozone on January 1, 2015).

From 2015 to present day, the expansion of the Eurozone was stopped because of the economic crisis of 2008-2010, which determined tougher conditions imposed by the European institutions to the new states interested in adopting the Euro, but also because of the recent pandemic crisis and the high-level misunderstandings between certain member states on economic, cultural and social issues. Out of the seven EU member states outside the Eurozone, it was only Bulgaria and Croatia that moved on to the final step of adopting the Euro, which is joining the Exchange Rate Mechanism II (ERM II) and, automatically, to the Banking Union, i.e., the Single Supervisory Mechanism (SSM) and the Single Resolution Mechanism (SRM).

2. Bulgaria and Croatia take the final step before joining the Eurozone, by participating in the ERM II

On July 10, 2020, after having been positively evaluated by the European Commission and by the European Central Bank, Bulgaria and Croatia received the agreement of the parties comprising the ERM II (Eurozone Finance Ministers, the European Central Bank, the Danish Finance Minister, and the Danish Central bank Governor) to join the ERM II and the Banking Union. Bulgaria had previously expressed their intention to participate in the ERM II through the letter of intent from June 29, 2018, and Croatia had expressed their

intention on July 4, 2019. For their national currencies to be included in the ERM II, the two candidates had to implement a set of measures, known as previous engagements, in the following six policy areas: the banking supervision (to consolidate banking supervision through a close cooperation with the ECB), the macro-prudential framework, the supervision of the non-banking financial sector, the insolvency and anti-money laundering frameworks, and the governance of state-owned enterprises. The implementation of measures on banking supervision and on the macro-prudential framework was evaluated by the ECB, and the other 4 measures, by the European Commission.

It is a known fact that, once a member state adopts the Euro, their monetary policy is no longer handled by their national central bank, but it is coordinated by the European Central Bank. The Eurozone states can no longer devalue their national currency to encourage export. A state's participation in ERM II for at least 2 years means setting a central exchange rate of their national currency against the Euro and it entails the interdiction for that state to devalue their own currency against the Euro. These ERM II conditions are meant to imitate the ones the respective state will have to deal with after adopting the Euro, and they are meant to prepare joining the Eurozone by encouraging the use of adequate budgetary and structural policies.

For the transition within ERM II to be successful, European institutions deem joining the Banking Union at the same time as necessary and mandatory, as it contributes to the solidity of the banking sector in the respective state.

Bulgaria and Croatia participate in the Single Supervisory Mechanism and the Single Resolution Mechanism, which entail the regulation of the national central banks in close cooperation with the ECB as regards the supervision of credit institutions (setting up a close cooperation between the national central banks of the two states and the European Central Bank) and they also entail the transfer of contributions to the Single Resolution Fund.

The Bulgarian Central Bank and the Croatian Central Bank will each have a representative in the ECB Supervisory Council, with the same rights and obligations as the other members (European Central Bank, 2020a).

Through ECB's press release of September 11, 2020, based on an evaluation conducted by the ECB at the credit institutions from Bulgaria and Croatia, meant to establish which ones can be classified as significant institutions, the ECB has announced that they would begin the direct supervision of five banks from Bulgaria and eight banks from Croatia. "The ECB will also be responsible for the oversight of the less significant institutions and in charge of the common procedures for all supervised entities in the two countries" (European Central Bank, 2020c).

Bulgaria and Croatia were accepted in the ERM II based on the "firm commitment" by the respective authorities "to pursue sound economic policies with the aim of preserving economic and financial stability and achieving a high degree of sustainable economic convergence" (European Central Bank, 2020d).

On July 13, 2020, the Bulgarian lev got a central rate of 1.95583 lev/euro, and the Croatian kuna a rate of 7.53450 kuna/euro, both with a band of fluctuation of ± 15% around the central rate of each national currency (European Central Bank, 2020f).

Table 1. *Euro central rates and compulsory intervention rates for the Bulgarian lev and Croatian kuna entered into force on 13 July 2020*

Bulgarian lev (BGN)	Upper rate	2.24920
	Central rate	1.95583
	Lower rate	1.66246
Croatian kuna (HRK)	Upper rate	8.66468
	Central rate	7.53450
	Lower rate	6.40433

Source: European Central Bank, Press release: Euro central and compulsory intervention rates for Bulgarian lev and Croatian kuna in ERM II, 13 July 2020.

We should mention that Denmark has been participating in ERM II since January 1, 1999, but they have not adopted the Euro because they opted for the "opt-out clause" when they joined the EU.

3. Czechia, Hungary, Poland, and Romania say no to the Euro for the near future

If Bulgaria and Croatia have taken important steps towards joining the Eurozone, Czechia, Hungary, and Poland do not want it yet, as they did not set any deadline within their national convergence programs.

Moreover, the statements made during the last few years by state officials in the three countries, strongly point to that direction.

According to Reuters, the Governor of the National Bank of Poland, Adam Glapinski, has declared that for as long as he holds his current position, he would not allow his country to request the adoption of the Euro, and he would prevent Poland from joining the ERM II. "Regardless of who is governing Poland, for as long as I am in charge of the central bank, we will not enter the euro zone" and "We will not give up on the zloty (currency), because it will dramatically limit growth opportunities for the Polish economy", are some of the statements made by the Governor of the Polish Central Bank (Reuters, 2019).

The Polish Prime-minister, Mateusz Morawiecki, agrees with the Governor of the Polish Central Bank. In 2019, at the regional convention of the Law and Justice Party (Pis), that took place in Lublin, he stated that it would not be profitable for Poland to join the Eurozone at the moment, and he gave the example of other countries that he considered were too hasty to adopt the Euro, which led to their economic stagnation. "These are countries, like Greece, which in 2007 had an economy 10 times smaller than the Germans, and today their economy is 18 times smaller"; "It is worth drawing conclusions for Poland from the failure of these countries, because today we are confronted with this subject", Morawiecki said, as he was quoted on April 13, 2019, by the Polish Press Agency (Polish Press Agency, 2019).

During the same congress, the Pis leader, Jarosław Kaczyński, was tougher about joining the Eurozone, and he stated: "We say no to the Euro, we say no to European prices"; "The EU membership treaty doesn't specify the date of euro adoption. Someday we will join, but only when our level of wealth comes close to that of Germany" (Emerging Europe, 2019).

On August 2, 2021, the Hungary Today newspaper cited some opinions on joining the Eurozone of the Hungarian National Bank Governor, György Matolcsy, initially published by the Magyar Nemzet newspaper. He maintains that the current pandemic crisis can be managed better with the national currency, and during 2020-2021, the National Bank of Hungary has used several "targeted tools", in order to deal with the economic crisis, tools which the Eurozone couldn't offer: "It is a historical fact that all countries in the euro zone had already achieved their level of development by the time of joining [the common currency], they became highly developed and rich without the euro. It was not the euro that brought wealth but the national currency", end quote from the statement of the Hungarian National Bank Governor (Hungary Today, 2021).

The Prime-minister of Czechia, Andrej Babiš, made the following statement for the Harvard International magazine: "The Czech Republic is ready to enter the Eurozone. But in this situation, when we expect some reforms to EU governance, we choose to wait. The euro is more of a political than an economic project." and "Besides that, we are now seeing serious structural challenges that are potentially very dangerous: tensions between the prosperous northern members of the EU and the stagnating south were clearly visible during the post-pandemic recovery package negotiations. And while the 19 states of the Eurozone have a common currency, they still have different economic approaches and follow different budget strategies." (Prague Morning, 2021)

Between the Brussels institutions and the ones from Poland and Hungary, there are different opinions about the rights of sexual orientation minorities, which have lately led to certain disputes. During the last few years, the European Union decision making forums have extended the rights of LGBT people (people who have other sexual orientations, besides heterosexuality), but Hungary has done the opposite. In June 2020, the Hungarian Parliament passed a law that bans homosexual references in front of children. The European Commission President, Ursula von der Leyen, drew Hungary's attention to the fact that this issue violates European law and she threatened to notify the EU Justice Court and to impose financial sanctions on Hungary.

During a TV interview, Czech President Milos Zeman stated that he agreed with the Hungarian law, as he considered it necessary for the prevention of children and parents manipulation through sexual education (BBC News, 2021).

From the judiciary point of view, there are different approaches between the European Commission and Poland, as regards the justice system reform in Poland, which entered into force in February 2020. This law prevents Polish judges to send requests to the European

Court of Justice to obtain legal opinions. Based on this law, the Disciplinary chamber was created, which is meant to supervise and financially penalize Polish judges.

Unfortunately, there are many disagreements between EU institutions and Hungary and Poland, on economic, social, cultural, legal issues; there are different ways of thinking when it comes to minority rights, and also past issues, such as relocating a certain immigrant quota that EU was imposing on these states. All of these may be an obstacle when it comes to these states adopting the Euro in the near future.

In the Substantiation Report of the National Plan for the Adoption of the Euro, written in 2018, Romania had set 2024 as the target for adopting the Euro, but so far, they haven't even requested to participate with their national currency (the leu) in ERM II. An article published by Mediafax on February 18, 2021, quotes the Romanian Prime-minister, Florin Cîțu: "Our roadmap to the Euro has been a little delayed by this crisis in 2020. We need real convergence. We will recover in 2021-2024, but we must acknowledge the fact that joining the Eurozone will happen after 2024" (Mediafax, 2021).

The economic crisis of 2008-2010 and the recent pandemic crisis have made these member states' wish to adopt the euro disappear for the moment.

4. Nominal convergence criteria

To adopt the Euro, any EU member state must meet the nominal convergence criteria, as they were established through the Maastricht Treaty. The convergence criteria refer to meeting the 5 economic indicators: the average annual inflation rate must not be more than 1.5 percentage points over that of the three best EU members on price stability, public budget deficit should not exceed 3% of GDP, public debt should be under 60% of GDP, the average annual long-term interest rate should not be more than 2 percentage points above the best three EU Members States in terms of price stability, and the national currency/Euro exchange rate must be maintained inside an interval of fluctuation of ±15% in relation to a fixed but adjustable central rate, within ERM II for at least 2 years, and without devaluing the exchange rate of their own initiative.

The nominal convergence indicators have worsened at the end of 2020, compared to 2019, when the Covid-19 pandemic had not yet entered Europe (Table 2).

In 2019, all these states, except Romania, had met the budget deficit convergence criterion (Bulgaria, Czechia and Croatia had a budget surplus of 2.1% of GDP – Bulgaria, and 0.3% of GDP – Czechia and Croatia). At the end of 2020, none of these states met this criterion anymore, as the highest deficits were recorded in Romania (9.2% of GDP), Hungary (8.1% of GDP) and Croatia (7.4% of GDP).

Table 2. *General government net lending (ESA, % of GDP)*

GEO/TIME	2019*	2020*	2021**	2022**
(criteria ≤ 3% of GDP)				
Bulgaria	2.1	-3.4	-5.6	-2.7
Czechia	0.3	-6.2	-8.8	-5.9
Croatia	0.3	-7.4	-3.8	-2.6
Hungary	-2.1	-8.1	-7.5	-5.9
Poland	-0.7	-7.0	-6.9	-4.2
Romania	-4.4	-9.2	-8.0	-6.2

* Eurostat Database (Last updated: 22.04.2021).
** Estimated data collected from the National Convergence Programs developed in 2021 by Bulgaria, the Czech Republic, Croatia, Hungary, Poland, and Romania.
Source: Eurostat, National convergence programs developed in 2021.

The high budget deficit of 9.2% registered by Romania in 2020 was not only determined by the pandemic crisis that started in Europe in March 2020, but also by the expansionary fiscal policy started in 2019, which affected the budget deficit of 2019, taking it to 4.4% of GDP, and thus surpassing the maximum threshold of 3% provisioned by the Stability and Growth Pact.

Within the context of the pandemic, which generated many financial issues, "the general escape clause" was activated in 2020, as it was introduced through the "Six-pack" that reformed the Stability and Growth Pact in 2011, which allows EU member states to temporarily move away from the fiscal adjustment requirements, and they would not be placed under the Excessive Deficit Procedure. The aforementioned clause can be activated in certain extraordinary situations, when the deterioration of financial positions happens as a result of events that were out of the member state's control.

Out of all EU member states, it is only Romania who is under the EDP – Excessive Deficit Procedure, as of April 2020, based on the budget deficit of 2019. Considering the pandemic, "the European Commission indicated that no decision on further steps in Romania's EDP could be taken at this juncture" (Haroutunian et al., 2020).

As per the Council's recommendation of June 2, 2021, addressed to Romania, in order to eliminate the excessive public deficit, Romania should ensure the complete application of the national taxation framework and to take a set of extra measures, meant to end the excessive budget deficit by 2024, by reducing the deficit to 2.9% of GDP in 2024.

According to the National Convergence Programs elaborated in 2021 by Bulgaria, Czechia, Croatia, Hungary, Poland and Romania, the previsions for the next 2 years are not optimistic, as the budget deficit of many of these states will continue to be over the limit of 3% of GDP.

At the end of 2020, the pandemic has forced most EU states to borrow money, in order to finance their large budget deficits, as public debt increased in EU member states outside the Eurozone. Croatia and Hungary had a public debt of over 60% of GDP before the start

of the pandemic crisis, and the Polish public debt is near the reference threshold. According to the National Convergence Program of Poland (2021 edition), this state's public debt is estimated to reach 60% of GDP in 2021 (Table 3).

Table 3. *General government gross debt (ESA, % of GDP)*

GEO/TIME	2019*	2020*	2021**	2022**
(criteria ≤ 60% of GDP)				
Bulgaria	20.2	25.0	27.4	28.6
Czechia	30.3	38.1	44.8	48.2
Croatia	72.8	88.7	86.6	82.5
Hungary	65.5	80.4	79.9	79.3
Poland	45.6	57.5	60.0	59.2
Romania	35.3	47.3	50.8	52.9

* Eurostat Database (Last updated: 22.04.2021).

** Estimated data collected from the National Convergence Programs developed in 2021 by Bulgaria, the Czech Republic, Croatia, Hungary, Poland and Romania.

Source: Eurostat, National convergence programs developed in 2021.

In 2020, only Bulgaria and Croatia met the price stability criterion. Bulgaria had an average annual increase in prices (IAPC) of 1.2%, and Croatia kept prices the same all year. However, according to all previsions in national convergence programs, and in European Commission reports, the annual average inflation rates would increase by the end of 2021, as a result of the increase in energy and fuel prices, as the inflation is also sustained by aggregated demand.

In 2019, five out of six states met the medium term interest rate criterion, but in 2020, their number decreased to four, as Hungary slightly surpassed the maximum level (Table 4).

Table 4. *HICP inflation rate and long-term interest rates (%, annual average)*

	Inflation rate (HICP)		The interest rate	
GEO/TIME	2019	2020	2019	2020
	(criteria: < 1.9)	(criteria: < 1.5)	(criteria: <3.47)	(criteria: <2.12)
Bulgaria	2.5	1.2	0.43	0.25
Czechia	2.6	3.3	1.55	1.13
Croatia	0.8	0.0	1.29	0.83
Hungary	3.4	3.4	2.47	2.22
Poland	2.1	3.7	2.35	1.50
Romania	3.9	2.3	4.54	3.89

Note: In 2019, the average annual inflation rate of the top 3 EU Member States as regards price stability (Portugal, Greece, Cyprus) is 0.4% (resulting in a criterion of 1.9%) and the average long-term interest rate in the 3 states is 1.47% (resulting in a criterion of 3.47%).

In 2020, the average annual inflation rate of the top 3 EU Member States as regards price stability (Croatia, Luxembourg, Latvia) is 0.0% (resulting in a criterion of 1.5%) and the average long-term interest rate in the 3 states is 0.12% (resulting in a criterion of 2.12%).

Source: Eurostat, Own calculations to find out the maximum criteria.

The analysis of the presented data shows that at the end of 2019 and 2020, none of the six member states outside the Eurozone met four out of the five nominal convergence criteria. The exchange rate criterion is not analyzed, because Czechia, Hungary, Poland, and Romania did not join the ERM II, and Bulgaria and Croatia only joined on July 10, 2020, and the ERM II participation time of at least 2 years hadn't yet been reached.

5. The evolution of the Gross Domestic Product

At the end of 2019, all six states registered a real GDP increase, but the pandemic crisis, which came to Europe at the beginning of 2020, brought by an economic contraction not only in these six states, but throughout most EU member states. Out of 27 member states, it was only Ireland that registered an economic growth of 4.7% of GDP at the end of 2020. So, at the end of 2020, Croatia registered the highest economic decline, as its real GDP dropped by 8%, while the Polish economy suffered least, with a 2.7% real GDP degrease, at the end of 2020 (Table 5).

Table 5. *Real GDP growth (%)*

GEO/TIME	2019*	2020*	2021**	2022**
Bulgaria	3.7	-4.2	4.6	4.1
Czechia	3.0	-5.8	3.9	4.5
Croatia	2.9	-8.0	5.4	5.9
Hungary	4.6	-5.0	6.3	5.0
Poland	4.7	-2.7	4.8	5.2
Romania	4.1	-3.9	7.4	4.9

* Eurostat Database (Last updated: 30.07.2021).
** Estimated data according to the "European Economic Forecast – summer 2021" of the European Commission.
Source: Eurostat, European Commission.

According to the European Economic Forecast from Summer 2021, the European Commission estimates an economic recovery in most EU member states, as a result of an increase in vaccinated people, a lift of travel ban and other restrictions previously imposed on tourism, art, entertainment, hospitality and restaurants, which made private consumption constantly grow, but also due to the Recovery and Resilience Plan, which will support investment.

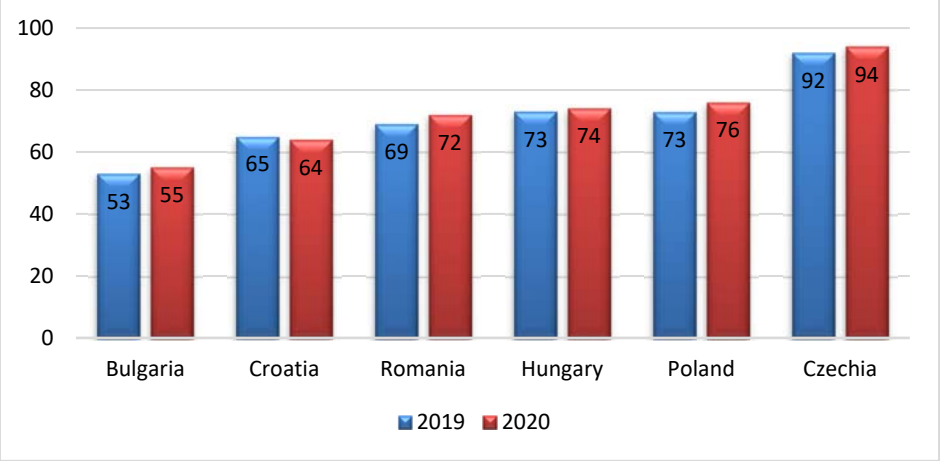
As a result of negative financial effects of the Coronavirus pandemic, on the road to economic recovery, on May 27, 2020, the European Commission has proposed the creation of the Recovery plan called NextGenerationEU, of 806.9 billion euros (the value of 806.9 billion euros is expressed in current prices in 2020; it amounts to € 750 billion in 2018 prices), and it was approved on July 21, 2020 by the EU member state presidents and prime-ministers. The Recovery and Resilience Plan is the main tool of NextGenerationEU, and it consists of loans and grants valued at 723.9 billion euros, which will be granted to EU

member states, to support reform and investment. (European Commission website. Recovery plan for Europe).

The European Commission estimates significant increases in the real GDP of the six analyzed states. It is expected that Bulgaria's real GDP will increase by 4.6% in 2021 and by 4.1% in 2022, Croatia – 5.4% in 2021 and 5.9% in 2022, Czechia – 3.9% in 2021 and 4.5% in 2022, Hungary by 6.3% in 2021 and 5.0% in 2022, Poland – 4.8% in 2021 and 5.2% in 2022, and Romania by 7.4% in 2021 and 4.9% in 2022 (European Commission, 2021a).

At the end of 2020, out of the six states, Czechia registered the highest level of real convergence to the EU, as their GDP per capita at PPC was at 94% of the EU average (EU – 27 states), and the 2 states that recently joined ERM II, Bulgaria and Croatia, had the lowest, with a GDP per capita at PPC of 55% of EU27 average for Bulgaria, and a 64% for Croatia (Figure 1).

Figure 1. *GDP per capita in PPS in 2019 and 2020 (% of EU 27 average)*



Source: Eurostat (Latest update: 27.07.2021).

From a real convergence perspective, we can reference the 75% of GDP per capita at PPC registered by Lithuania in 2015, when it joined the Eurozone. If we look at statistics, we can consider that, from this point of view, Poland and Czechia would be ready to join the Eurozone, but their political leaders are not willing to give up their national currency any time soon.

6. Citizens' opinions regarding life after the pandemic and their wish to join the Euro

It is noticeable that the effects of the pandemic have led to a decrease in citizen optimism as regards the economic situation of their country. According to the report "Public opinion in the European Union", which presents the results of the Eurobarometer poll, conducted in Winter 2020-2021, if in 2019 35% of Romanians considered the economic situation of their country as relatively good, this percentage dropped to 26% in 2020, and in Croatia it dropped from 23% in 2019, to 20% in 2020. Large decreases were registered in Czechia – 60% in 2019, to only 31% in 2020, in Poland – from 58% to 38%, and Hungary, from 54%

to 42%. In 2020, only Bulgaria showed a 4 percentage points increase compared to 2019, but the percentage of people who view their country's economic situation as good is still low in 2020, at only 20%.

But the pandemic and the difficult economic situation of the six member states outside the Eurozone, did not lead to a decrease in their citizens' willingness to adopt the Euro as their national currency. According to Flash Eurobarometer 492, from May 2021, Romanian citizens are most willing to join the Eurozone – in 2021, 75% of them are pro adopting the euro in their country. From 2020 to 2021, this percentage has increased from 64% to 75% in Romania; in Bulgaria – from 48% to 54%, in Croatia, from 55% to 61%, in Poland, from 48% to 56%, in Hungary, from 66% to 69%, and in Czechia, a one percentage point decrease, reaching 33% in 2021. As we can observe, the citizens in five out of six states are pro adopting the Euro.

"In a year dominated by the Coronavirus pandemic, European citizens see the European Union as best placed to respond to present challenges and secure future opportunities... Europeans consider that the EU's respect for democracy, human rights, and the rule of law (32%) and its economic, industrial and trading power (30%) are its main assets" (European Parliament website. Eurobarometer: Future of Europe survey).

7. Conclusions

Bulgaria, Czechia, Croatia, Hungary, Poland, and Romania must prioritize the structural fiscal reform in order to reach long term sustainability of public finances.

Economic recovery needs further national investments, through EU funds, especially those available through the Recovery and Resilience Plan.

Bulgaria and Croatia – even though they have been participating in ERM II for over a year, and they are within the band of fluctuation of ± 15% around the central rate for each of the national currencies, the pandemic crisis prevented them from meeting many of the nominal convergence criteria in 2020. Considering the current and future economic situation, the 2-year period that must be spent under ERM II might have to be extended by at least one more year for these two states. Bulgaria and Croatia will have to honor the commitments they made to the European Commission and to ECB when the accepted to participate in ERM II, commitments which consist of continuously improving the general quality of their institutions and governance.

Even though some of these states have reached a GDP per capita at PPP close to the EU average (EU27), considering the economic situation created by the pandemic crisis, and the fact that many of these states registered high budget deficits, and also the not so optimistic economic perspectives (a high increase in prices is to be expected), they should not give up on their national currency over the next few years, so that the national banks may use their own monetary policy instruments, to provide a successful reaction to external shocks.

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Revealing the effects of competitiveness and innovation on economic growth: Evidence from European leading and following countries

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Abstract. *This article deals with the indispensable factors determining the effects of competitiveness and innovation on economic growth by investigating the connection between crucial indicators. The competitiveness and innovation of the European leading and following countries are strongly connected to its economic growth. The aim of this article is to explore the significance of competitiveness and innovation in boosting economic growth per capita in selected European countries. In order to explore the effects among the factors of competitiveness and innovation on economic growth per capita, differsified methodological evaluation tools have been used. The data were collected from both primary and secondary sources. Comparative analysis of European leading and following countries was utilized by the statistical software package SPSS 25. The research results highlight the crucial competitiveness and innovation factors for prospected economic growth in selected economies. The corresponding measures bounded for economic growth are associated to the high composite indices of competitiveness and innovation achievement. Admission the diversities between relevant indicators and recognition of vulnerability is the base for the ensuing acknowledgement of appropriate economic performances for progress the demanding segments.*

Keywords: revealing the effects, competitiveness, innovation, economic growth, European leading and following countries.

JEL Classification: C8, E0, O40, O57.

1. Introduction

In recent years, competitiveness has turned into the most used phrase in modern theory of economics, as well as in the national and international economic policy. Even though the entire scientific society's increasing affection in competitiveness, a clear interpretation of competitiveness has not been conclusively proved in the economic literature. Generally, this is because of the diversity of its measurement, along with other associated factors. The various determinants of competitiveness, innovativeness and economic growth are determined, principally by the structure convolution and the other constraints that measure the extensive influences between the dimensions of the structure, such as multinational companies, different regions or countries (Freudenberg, 2003; Snowdon and Stonehouse, 2006; Berger and Bristow, 2009; Grossman and Helpman, 2015; Bukowski et al., 2021).

Nonetheless, this paper specifically deals with the interdependence between competitiveness, innovation and economic growth in the selected leading and following European countries. Innovation is defined as one of the important drivers of the national competitiveness and growth (Atkinson, 2013; Aiginger, 2006; Goerge, McGahan and Prabhu, 2012; Helpman, 2004; Aghion et al., 2005; Petrakis et al. 2015; Terzić, 2017).

According to the World Economic Forum (2020), competitiveness has powerful effect on the national economies, especially on their economic growth, macroeconomic stability, financial systems, institutions, infrastructure, innovation capability, etc. The primary goal of the new WEF' Global Competitiveness Index (GCI) 4.0, eminent indicator of national competitiveness, is to provide an exhaustive view on the competitiveness, a phenomenon, that cannot be apprehended by only one particular measure without any questioning.

The primary aim of this paper is to explore the effects of competitiveness and innovation on economic growth and presented research results of comparative analysis conducted in selected European countries with special emphasize on the new competitiveness index 4.0. This paper is classified into four parts. The first part deals with theoretical overview of the empirical literature related to new elements of global competitiveness index 4.0 and innovation factors. The second part demonstrates methodological approach connected to the indicators of competitiveness and innovation. The third part of the paper is dealing with aggregated data and applied research methodological access. The fourth part illustrates comparative analysis and research utilized by statistical software package SPSS 25.

2. Theoretical overview of the literature: Competitiveness, innovation and economic growth

The theoretical foundation in answering the questions why do some countries are more competitive, innovative and grow quicker than other countries started by economists Solow (1956) and Romer (1986), leaving some crucial elements unexplained. In the recent years, many researchers have increasingly concentrated their focus to explore competitiveness, innovation and other relevant national outcomes (Porter, 2008; Edquist, 2004; Howells 2005; Malerba and Brusoni 2007; Foray, 2009; Atkinson and Ezell 2014; Grossman and

Helpman 2015; Terzić, 2017; Bukowski et al., 2021). They indicated different outlook and factors influencing competitiveness of countries, innovation performances or economic growth.

Economic theory and policy which defines, explains and determines economic phenomenon such as competitiveness and innovation is apprehending performances of spreading labour dispersion at national enterprises are also combined with international transfer of economic performances. Those activities, in the widest impression, are connected to dispute of economic performers at national and international product and labour markets establishing on innovation capability and business sophistication appearing from labour dispersion.

The eminent economists Porter (2008), Cho and Moon (2013), Martens et al. (2015), Pérez-Moreno, Rodríguez and Luque (2016) indicate that national economies, integration associations or multinational companies, if they want to achieve higher competitiveness, they must develop innovative performances that are important for their international rankings and comparative analysis of countries. Therefore, national economies efficient in responding to new competitiveness and innovation challenges, that are basis for future economic growth, are identified as the leading competitive countries.

The phenomenon specified as national competitiveness represents the possibility to enhance in competition or competition position. The phrase "competitiveness" includes two dimensions. The first dimension is competition and the second one is competence that presents – to be efficient to compete at national or international level.

Rozmahel, Grochova and Litzman (2014) emphasize the competitiveness evaluation of the EU member countries', based on their infrastructure. Önsel et al. (2008) explore the competitiveness of countries, affirming the thesis that Gross Domestic Product represents the variable with specific constraints in conditions of countries' classification.

Costanza et al. (2009) investigated the historical dimension where GDP appeared as the mostly authorized indicator of economic growth. In order to eliminate or diminish economic vulnerabilities after the past crisis, GDP per capita dominated as the reliable indicator for measuring economic growth of economies. GDP per capita is recognized as the basic measure of economic growth by the World Economic Forum, the World Bank and the International Monetary Fund.

Browne, Di Battista, Geiger and Verin (2016) debate that competitive and innovative performances create economic performances that affect the competitiveness of a specific field or an overall national competitiveness. National competitiveness has been involved into the important field in the world affiliations as linked to international labour aggregation, that acknowledged the significance in the globalized world. It is expected, during the period, that competitiveness and innovation of the national economy are the cause of the higher economic growth.

Sala-i-Martin et al. (2016) indicate importance of the new Global Competitiveness Index 4.0, developed by the World Economic Forum, for each country. The GCI includes 12 pillars of competitiveness that are classified into three sub-indicators. By calculating the GCI, it is crucial to acknowledge the development stage in which the economy is positioned so the scales can be set for the particular sub-indicators. The economies are grouped into particular levels based on the GDP per capita. The particular levels are defined as fundamental conditions, factors that regulate efficiency, and factors of innovation and business sophistication.

Constant fluctuations in economic existence, new challenges linked with the Fourth Industrial Revolution (4IR), new observational evidence and new data, were the basic intentions for the World Economic Forum's deliberation about modifications in the methodology of the global ranking of countries. The aim was to provide that the index captures an applicable source of information for multinational stakeholders and economic policymakers in the upcoming years (WEF, 2019.).

The twelve competitiveness pillar scores are averaged to create the total GCI score, with each pillar that is equally weighted (8.33%). The GCI 4.0 includes less indicators (99) than earlier GCI methodology (114). The pillars are organised into four groups: enabling environment, human capital, markets and innovation ecosystem. These four groups of the new GCI 4.0 indicator are applicated only for presentation and they do not have influence on the GCI calculation.

3. Data and research methodology

The elements that create the Global Competitiveness Index (GCI) and the Global Innovation Index (GII) were identified and measured via SPSS 25 analysis, using secondary data on economic growth (GDP per capita – Purchasing Power Parity) in selected leading and following European countries, and Economic Opinion Survey data. The raise of the new GCI 4.0 has been leaded by the evolution of the new basic changes in the operating of national economies with the appearance of the Fourth Industrial Revolution (4IR).

The new GCI 4.0 is a "composite indicator"; its calculation is founded on ensuing scores' aggregations, from the indicator level (the most disaggregated level) to the overall score (the highest level). Every indicator, at all levels, is calculated by the average of the scores of its constitutive elements. The overall GCI 4.0 score is the average of the scores of the 12 competitiveness elements (pillars). There are 103 different indicators distributed over the twelve competitiveness pillars. Indicators are sourced from World Economic Forum, the World Intellectual Property Organisation (INSEAD-WIPO) and other international and academic institutions. The data that are used to calculate the GCI 4.0 and GII for leading and following European countries came from Eurostat national accounts database for analyzed countries.

The model that is commonly applicated in exploring the economic growth of countries was given by economist Romer (1986), which indicates the effect of high-tech knowledge on the economic growth. That model could be embossed by categorizing countries in two sections. It can be especially used to highlight the effect of innovation, as a dimension of competitiveness, on the economic growth. This model may be presented by dividing analyzed countries into two sections (e.g. leading and following countries). The first section (e.g. leading countries) demonstrate production of innovative outputs and the second section (e.g. following countries) represents innovation capability that leads to higher country's competitiveness and innovation. The following equalization can be employed to specific two sections of the countries:

$$Y = INN\ K_y^{\alpha} L_y^{\beta} HC_y^{1-\alpha-\beta} \quad 0 < \alpha < 1;\ 0 < \beta < 1.$$

$$INN = INN^{\varphi} K_{INN}^{\varphi} L_{INN}^{\varphi} HC_{INN}^{1-\varphi-\mu} \quad 0 < \varphi < 1;\ 0\ \mu < 1.$$

where:
variable Y is the quantity of determinant used for production activities, K is capital, L represents labour, HC demonstrates human capital, variable INN presents the quantity of measure implicated for innovation capability that is created by the Research & Development section.

Economists Hall and Jones (1999) evaluated the level of productivity in the countries by decreasing the level of capital and human capital level from the GDP level. They assumed that the production function accepts the model of Cobb-Douglas:

$$Y_{it} = A_{it} * K_{it^{\alpha}} * L_{it^{1-\alpha}}$$

where:
Y_{it} represents GDP for selected country (*i*) at time (*t)*.
K_{it} represents the capital stock of selected country (*i)* at time (*t)*.
L_{it} represents the human capital level for country (*i)* at time (*t)*, and
α represents the capital share (1 – α presents the labour share).

Then the logarithms can be taken of each side:

$\ln(Y_{it}) = \ln(A_{it}) + \alpha\ln(K_{it}) + (1 - \alpha)\ln(L_{it})$.

It could be possible to detect a gauge of $\ln(A_{it})$ by deducting $\alpha\ln(K_{it}) + (1 - \alpha)\ln(L_{it})$ from every side to gain $\ln(A_{it}) = \ln(Y_{it}) - \alpha\ln(K_{it}) + (1 - \alpha)\ln(L_{it})$.

To confess the indicator aggregation of various characteristics, every particular indicator of the GCI 4.0 is transferred into a "score of progress", ranging from 0 to 100 applying the minimum-maximum evolution. Formally, each indicator is re-scaled according to the following formula:

$$Score_{ie} = \left(\frac{Value_{i,e} - Lp_i}{MaxValue_i - Lp_i} \right) * 100,$$

where:

$Value_{ie}$ represents the "raw" value of economy for indicator (i).

Lp_i is the lowest acceptable performance value for indicator (i).

$Value_i$ is the best possible outcome.

Rely upon on the indicator, the borderline can be a policy objective or ambition, the maximum achievable value, or a number exploited from the distribution analysis. If a value is beneath the lowest performance value, its score is 0; if a value is overhead the maximum value, its score is passed at 100. If a logarithmic transformation is executed on a particular indicator, the same transformation can be applied to the highest value and lowest performance values. In the case of indicators extracted from the Executive Opinion Survey, $Value_i$ and Lp_i are consistently 7 and 1, accordingly. These values are equal to the two ultimate answers of every question.

$GCI_{ij} = Weight_j1 * Basic_i + Weight_j2 * Efficiency_j + (1 - Weight_j1 - Weight_j2) * Innovation_j$

for country *i* and its stage of economic development *j*, where $Basic_i$, $Efficiency_i$ and $Innovation_j$ are sub-indices, and *Weight(j)1* are *Weight(j)2* are weights of sub-indices.

The Global Competitiveness Index 4.0 incorporates crucial indices and sub-indices in order to determine rank of countries, foundated on the level to which the performances of the governments and other institutions foster or block the economic growth. The GCI 4.0 then creates the fundamental appraisal of the relevance of the various elements relative to one another. Actually, the GCI 4.0 tries to demonstrate the fields important for boosting economic growth. Aggregation of the definite indicator is beyond the bounds of this paper. Nonetheless, on the GCI substructure, the accessible secondary data from the global development indicators were utilized. Standardized measures have been used to design different indices correlated to various dimensions of competitiveness.

The variables are classified into twelve sub-indicators, that are averaged using equal weights (8.33%). The twelve competitiveness sub-indices are: Institutions (INST), 2. Infrastructure (INFR), 3. ICT adoption (ICTA), 4. Macroeconomic Stability (MACS), 5. Health (HEAL), 6. Skills (SKIL), 7. Product market (PROM), 8. Labour market (LABM), 9. Financial System (FINS), 10. Market size (MARS), 11. Business Dynamism (BUSD), and 12. Innovation capability (INNC).

4. Revealing the effects of competitiveness and innovation on economic growth in European leading and following countries: A comparative analysis of crucial indicators

Table 1 presents the competitiveness, innovation and economic growth ranks with its' values in European leading and following countries. The comparative analysis was employed in 16 countries (Switzerland, Sweden, Netherlands, Denmark, Finland, Germany, France, Austria, Norway, The Czech Republic, Estonia, Hungary, Latvia, Poland, Lithuania, Romania), and the collected data for each economy are covering the period 2019-2020.

Table 1. *Ranks and values of European leading and following countries by employing different methodologies and indicators of innovation, competitiveness and economic growth in 2019-2020*

Leading European countries	GII		GCI 4.0		GDP pc (PPP)	
	Rank	Value 1-100	Rank	Value 0-100	Rank	Value (USD)
Switzerland	1	66.08	2	82.3	2	57.791,1
Sweden	2	62.47	4	81.2	4	47.691,9
Netherlands	3	58.76	1	82.4	3	50.933,1
Denmark	4	57.53	5	81.2	5	47.040,4
Finland	5	57.02	6	80.2	8	41.883,3
Germany	6	56.55	3	81.8	6	46.765,5
France	7	53.66	7	78.8	9	41.226,7
Austria	8	50.13	9	76.6	7	46.758,1
Norway	9	49.29	8	78.1	1	66.947,8
Following European countries						
The Czech Republic	10	48.34	10	70.9	10	33.903,0
Estonia	11	48.28	11	70.9	12	31.300,6
Hungary	12	41.53	15	65.1	13	29.723,4
Latvia	13	41.11	14	67.0	15	27.415,1
Poland	14	39.95	12	68.8	14	29.587,4
Lithuania	15	39.18	13	68.4	11	32.040,8
Romania	16	35.95	16	64.4	16	24.442,9

Note: GII –The Global Innovation Index, GCI 4.0 – The Global Competitiveness Index 4.0, GDP pc (PPP)-Gross Domestic Product per capita (Purchasing Power Parity).
Source: Calculation is performed on data announced by the World Economic Forum, The Global Competitiveness Report 4.0 for 2019-2020., the World Intellectual Property Organization (INSEAD-WIPO), the Global Innovation Index Report 2020 and Eurostat database.

Netherlands has achieved the leading position in economic competitiveness, while Norway is positioned as the first country according to the main indicator of economic growth – GDP per capita (measured by Purchasing Power Parity). Switzerland has accomplished the leading position in innovation performance by the global innovation index (GII) and the second position according to the global competitiveness index (GCI) and GDP per capita (PPP), in comparison with the analyzed countries.

Table 2 presents the selected European countries' classification according to different competitiveness indicators in the 2019-2020 period. The competitiveness sub-indicators in selected economies are valuable indicators for each country, that include: 1. Institutions (INST), 2. Infrastructure (INFR), 3. ICT adoption (ICTA), 4. Macroeconomic Stability (MACS), 5. Health (HEAL), 6. Skills (SKIL), 7. Product market (PROM), 8. Labour market (LABM), 9. Financial System (FINS), 10. Market size (MARS), 11. Business Dynamism (BUSD), 12. Innovation capability (INNC).

Table 2. *Ranking of European leading and following countries according to competitiveness indicators in 2019-2020*

Economy	INST	INFR	ICTA	MACS	HEAL	SKIL	PROM	LABM	FINS	MARS	BUSD	INNC
Switzerland	3	2	8	1	1	1	7	1	1	5	7	2
Sweden	6	7	1	2	3	7	4	8	3	6	4	3
Netherlands	2	1	9	3	6	4	1	3	6	3	1	5
Denmark	4	6	2	4	8	2	3	2	4	12	2	6
Finland	1	9	5	5	7	3	5	6	2	13	5	7
Germany	8	3	12	6	9	5	2	5	8	1	3	1
France	10	4	10	14	2	14	8	13	5	2	8	4
Austria	7	5	14	7	4	8	6	11	9	9	10	8
Norway	5	14	3	8	5	6	10	4	7	11	6	9

Economy	INST	INFR	ICTA	MACS	HEAL	SKIL	PROM	LABM	FINS	MARS	BUSD	INNC
Czech Republic	12	8	13	9	10	12	13	12	10	8	11	10
Estonia	9	15	7	10	11	9	9	7	11	16	9	14
Hungary	16	11	16	15	13	15	16	16	13	10	16	12
Latvia	13	13	6	11	15	10	11	10	15	15	12	15
Poland	15	10	15	12	12	13	12	15	12	4	14	11
Lithuania	11	12	4	13	16	11	14	9	14	14	13	13
Romania	14	16	11	16	14	16	15	14	16	7	15	16

Note: 1. Institutions (INST), 2. Infrastructure (INFR), 3. ICT adoption (ICTA), 4. Macroeconomic Stability (MACS), 5. Health (HEAL), 6. Skills (SKIL), 7. Product market (PROM), 8. Labour Market (LABM), 9. Financial System (FINS), 10. Market size (MARS), 11. Business Dynamism (BUSD), 12. Innovation capability (INNC).
Source: Calculation is performed on data announced by the World Economic Forum, The Global Competitiveness Report 4.0 for 2019-2020.

Switzerland has achieved the highest rank in the 2019-2020 period, according to the calculated competitiveness indicators: Macroeconomic Stability (MACS), Health (HEAL), Skills (SKIL), Labour Market (LABM) and Financial System (FINS). Sweden attained the highest position according to ICT adoption (ICTA), while Hungary achieved the lowest position. According to sub-indicator Institutions (INST), Finland scoped the highest rank and Hungary achieved the lowest position. Germany has displayed the highest rank in Market size (MARS) and Innovation capability (INNC). Romania has obtained the lowest rank in the following fields: Infrastructure, Macroeconomic Stability, Skills and Financial System. The improvement of competitiveness and innovation in the European leading and following countries was calculated on data from 2019-2020 period.

Table 3 presents the interdependence between variables of competitiveness, innovation and economic growth indicator – GDP per capita in analyzed European leading and following countries. Spearman's correlation coefficients have indicated correlations among the Global Competitiveness Index 4.0 (GCI 4.0), the Global Innovation Index (GII), different competitiveness factors and GDP per capita (GDP pc). The data were collected from primary and secondary sources. The empirical research was utilized by applying the SPSS 25 statistical software package.

Table 3. *Interdependence between variables of competitiveness, innovation and economic growth in the European leading and following countries*

	GCI 4.0	GII	GDP pc	INST	INFR	MACS	SKIL	PROM	LABM	FINS	BUSD	INNC
GCI 4.0	1,000	,941**	,871**	,844**	,821**	,876**	,818**	,897**	,771**	,882**	,918**	,921**
GII	,941**	1,000	,844**	,835**	,782**	,891**	,800**	,844**	,709**	,938**	,856**	,891**
GDP pc	,871**	,844**	1,000	,841**	,618*	,821**	,794**	,709**	,788**	,821**	,818**	,794**
INST	,844**	,835**	,841**	1,000	,524*	,856**	,909**	,812**	,868**	,844**	,871**	,656**
INFR	,821**	,782**	,618*	,524*	1,000	,632**	,521*	,718**	,406	,674**	,618*	,874**
MACS	,876**	,891**	,821**	,856**	,632**	1,000	,918**	,821**	,818**	,806**	,826**	,729**
SKIL	,818**	,800**	,794**	,909**	,521*	,918**	1,000	,797**	,938**	,759**	,832**	,638**
PROM	,897**	,844**	,709**	,812**	,718**	,821**	,797**	1,000	,715**	,744**	,935**	,785**
LABM	,771**	,709**	,788**	,868**	,406	,818**	,938**	,715**	1,000	,659**	,826**	,547*
FINS	,882**	,938**	,821**	,844**	,674**	,806**	,759**	,744**	,659**	1,000	,794**	,856**
BUSD	,918**	,856**	,818**	,871**	,618*	,826**	,832**	,935**	,826**	,794**	1,000	,771**
INNC	,921**	,891**	,794**	,656**	,874**	,729**	,638**	,785**	,547*	,856**	,771**	1,000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
Source: Author's own calculation.

The following recommendations can be derived from the conducted research in the European leading and following countries:

- The very powerful positive interdependence is revealed between the Global Competitiveness Index 4.0 (GCI 4.0) and the Global Innovation Index (GII), as presented by Spearman's correlation coefficient of 0.941.
- It is revealed very significant positive intercorrelation between Innovation capability (INNC) and the Global Competitiveness Index (GCI 4.0) represented by correlation coefficient of 0.921.
- Very powerful positive interdependence is conferred between the Global Innovation Index (GII) and the competitiveness sub-indicator – Financial System (FINS), diagnosed by 0.938 correlation coefficient.
- Very strong positive intercorrelation is diagnosed between the GCI 4.0 and the following sub-indicators: Innovation Capability (INNC) and Business Dynamism (BUSD), with the correlation coefficients 0.921 and 0.918, respectively.
- Very strong positive interdependence is revealed among the Institutions and Skills, presented by Spearman's correlation coefficient of 0.909.
- Very significant positive correlation is identified between the Labour Market and Skills, with the correlation coefficient of 0.938.
- The powerful interdependence is determined among the basic measure of economic growth (GDP pc) and the following variables of competitiveness and innovation: the Global Competitiveness Index (0.871), the Global Innovation Index (0.844), respectively, which highlights that economic growth in selected leading and following European countries relies upon competitiveness and innovation.
- There is a powerful positive linkage among GDP per capita (GDP pc) and the competitiveness sub-indicator – Institutions (INST), presented by correlation coefficient 0.841.
- Powerful positive connection is conferred between GDP per capita and the following competitiveness sub-indicators: Macroeconomic Stability (0.821) and Financial System (0.821), accordingly.
- The strong positive correlation is determined among the Global Innovation Index (GII) and following competitiveness sub-indices: Macroeconomic Stability (MACS) and Innovation Capability (INNC), with the correlation coefficients 0.891, respectively.
- The strong positive interdependence is identified between the Global Innovation Index (GII) and the competitiveness sub-indicator – Business Dynamism (BUSD), diagnosed by 0.856 correlation coefficient.
- Powerful positive intercorrelation is diagnosed between the GII and the following competitiveness sub-indicators: Product market (PROM) and Institutions (INST), with the correlation coefficients 0.844 and 0.835, respectively.
- The positive correlation is determined among the GDP per capita and competitiveness sub-indices: Skills (SKIL) and Innovation Capability (INNC), with the correlation coefficients 0.794, respectively.
- The positive interdependence is conferred between the GDP per capita and the competitiveness sub-indicator – Labour Market (LABM), diagnosed by 0.788 correlation coefficient.

5. Conclusions

The objective of this article was to explore the effects of competitiveness and innovation on economic growth per capita in the European leading countries (Switzerland, Sweden, Netherlands, Denmark, Finland, Germany, France, Austria, Norway) and European following countries (Czech Republic, Estonia, Hungary, Latvia, Poland, Lithuania, and Romania). Alongside the goal of determining relationship between the variables of competitiveness, innovation, and economic growth, varied methodological tools have been enforced. The exploration results have indicated positive correlations among the new Global Competitiveness Index 4.0, The Global Innovation Index and GDP per capita, Institutions, Infrastructure, Macroeconomic Stability, Skills, Product market, Labour Market, Financial System, Business Dynamism and Innovation capability. Empowering to the determined significant correlations, it may be terminated that economic growth is affected by competitiveness and innovation that depend on the macroeconomic stability, developed institutions, powerful infrastructure and financial system, better conditions for skills development, and an upgraded level of business dynamism and innovation capability in selected European countries.

Recently, European leading countries have recognized the significance of competitiveness and innovation for boosting economic growth, and already have focused their ambitions to achieve higher business sophistication and innovation capability of its economies. The survey recommends that in order to enhance economic growth, focus must be directed to adequate economic policies which could increase national competitiveness through reliable institutions, stronger infrastructure, assuring macroeconomic stability, skilled workers, product and labour market, strong financial system, higher level of business interactions and innovation activities in the analyzed countries. The operated exploration has offered the comprehensive theoretical overview and empirical investigation related to the effect of competitiveness and innovation variables on economic growth per capita. Aforementioned could help to provide not only a powerful framework for obtaining the complexity of competitiveness and innovation factors, but also to increase the forthcoming theoretical foundation for suitable economic policies and particular countries' surveys. Furthermore, competitiveness and innovation indicators are important for an extensive investigation regarding the overall competitiveness accomplishment beneficial to input or output scope. The article has declared an inequality between European leading and following countries' rankings that are declared in each observed indicator.

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Public service delivery dilemma and economic growth challenges in the MENA Region

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Abstract. *The present paper investigates the impact of public service quality on economic growth in 15 MENA countries over the period 1996-2018, through the use of panel data analysis, including Fixed Effects Model, Random Effects Model and Hausman test. The Hausman test favors the fixed effect model, which clarifies that the government effectiveness index exerts a highly significant positive impact on economic growth in 15 MENA countries. While the government spending (freedom from government) exhibits a statistically insignificant positive effect on economic growth in the selected countries. Based on these findings, it could be concluded that the ideal reconciliation between delivering high-quality public services and keeping public spending low and efficient, is the perfect recipe for the MENA region's economic success. It is also recommended that MENA governments should foster their cooperation with the private sector in the delivery of education and health care services, besides tackling administrative reforms in alignment with the goal of providing efficient public goods and services. Furthermore, anti-corruption policies should be knitted, taking into serious consideration the promotion of institutional quality and optimization of government size.*

Keywords: the quality of public service provision, economic growth, MENA countries, panel data analysis.

JEL Classification: H40, O43, O50, C23.

1. Introduction

The quality of public services has been hitherto considered as the key underlying factor that steers nations towards a brighter economic future. Indeed, the provision of high-quality public services is commonly viewed by economists as one of the necessary ingredients of the recipe for economic success. According to Lips, A.M.B. (1998), Public service delivery can be perceived as "the relationship between the administration and its environment, in which the administrative organization supplies public products, services, and information". Furthermore, Esfahani (2005) defined the public service efficiency as "the amount of output per unit of an input used in the process, and added that the effectiveness is the degree to which the outcomes achieve the goals set for the activity".

There are two conflicting points of view about the public expenditure. On the one hand, the neo-liberal economists stated that the government spending on specific areas (such as education, health, and social security) should be reduced as far as possible, but this will generate the exclusion and marginalization of poor people, and on the other, many agreed that the public spending should be increased, but this will crowd out the private sector (Skerritt, 2012). In general, an effective government achieves the idyllic blend of taxation, public spending and public service quality, to respond to citizens' expectations (Matthew Andrews, 2008); because it is axiomatic that all residents have the right of equal access to efficient public services (Pretorius and Schurink, 2007). The looming problem of inefficient public spending is often caused by political and economic myopia (Sarte, 2001). For instance, many developing countries have kept the improvement of public service delivery off the political agenda for a long time (Shen and Zou, 2014).

The present study provides a further illustration of the links between the quality of public service delivery and economic growth, and attempts to advance beyond the existing literature, by shedding more light on the intrinsic role played by 'government effectiveness' and 'freedom from government' in fostering economic growth. Moreover, it sheds light on the Middle Eastern and North African countries that have embarked on substantial reforms of their public services and administration apparatus for enhancing the quality and availability of public service delivery, as well as improving productivity and promoting economic growth, but economic agents, foreign investors and international organizations state that the public service delivery remains inefficient and sands the wheels of growth, and this obvious fact leads us to investigate empirically the public service quality-growth nexus using a panel data analysis over the period 1996-2018. For this purpose, the remainder of this paper is organized as follows:

Section 2 presents a theoretical and empirical review on the quality of public service provision and economic growth, section 3 discusses the quality of public service delivery and economic growth in the MENA region, section 4 introduces the data and analyzes the empirical results and finally section 5 concludes the paper.

2. Theoretical and empirical review on the quality of public service provision and economic growth

A growing body of research has highlighted the essential role played by the quality of public service delivery in enhancing the growth prospects, as well as it is broadly perceived that the public spending on infrastructure, education and health care is a prerequisite for sustained economic growth (Irmen and Kuehnel, 2009). Many basic public goods (i.e., good roads and drainage, portable drinking water, steady electricity supply, etc.) are considered as fundamental investments that can boost the potential growth rates (Akpan and Effiong, 2012; Heritage Foundation, 2014).

Also, the efficient delivery of public goods and services is a crucial underlying factor for human capital formation, and hence it is an incentive to boost productivity and economic growth (Ghatak, 2010), for instance the labor force quality relies on the quality of education, which in turn counts on public spending (Fisher, 1997). Moreover, the dominance of education and R&D expenditures in the public spending composition reflects the government's willingness to boost growth prospects; additionally, the actual government spending contributes to shape the future economic growth (Mandl et al., 2008). Bartik (1991) claimed that the public services exhibit a substantial role on bolstering economic growth through affecting the business costs, for example a well-developed infrastructure and public education are generally unpriced, lowering the costs of production and private inputs. Also, Easterly (1997) argued that the public spending is the major source of finance for investments that are conducive to higher growth rates.

Furthermore, higher economic growth in turn heartens delivering better public services, because it prompts economic agents to call for sound institutions and high-quality public services (Subramanian, 2007). It is assumptive that all segments of society should reach high quality of basic goods and services, otherwise, the full participation of individuals in the growth process will be impeded (Muralidharan, 2007), because the misallocation of public investment may exert a counteractive effect on the regional growth and poverty reduction (Ollé and Moré, 2005), likewise a substantial and abrupt reduction in public spending engenders numerous risks to the most vulnerable sections of the population, and provokes negative public reactions (D'Arcy, 2012).

Usually, the ineffective public sector is associated with various issues like task evasion, corruption, misallocation of resources, bureaucratic impediments and delays (Ghatak, 2010). Thus, enhancing the quality of basic public goods and services is doubtless welcome, and even more it acts as a catalyst for inclusive growth (Muralidharan, 2007). Also, the efficiency of public expenditure hinges on the government's ability to convert public resources into socially and economically valuable outputs (Grigoli and Ley, 2012).

Oftentimes, a large proportion of public expenditure is driven into inefficient and unproductive directions, and over and above that, the increased government spending shifts resources away from the private sector and suppresses it, reducing the extent of freedom in the economic environment (Erdal, 2004). Generally, taxes are the main source of financing

public spending, but they outweigh the production costs and decrease the firms' profits, they also crowd out the private sector through transferring some of this sector's resources to the government's grip (Onakoya and Somoye, 2013).

In addition, using higher taxation in fueling the increased public spending definitely generates an opportunity cost similar to the private consumption or investment that would have happened if the resources had hitherto been left to the private sector (Heritage Foundation, 2014). Thus, the use of tax revenues in financing the government spending should not cause economic distortions (Skerritt, 2012).

As well as, the state must ensure that the private sector operates in a more effective manner, but it should not act to supersede the market mechanism. Moreover, leaving room for free competition between public and private sectors to deliver services can reduce the incentives for engaging in corruption (Kulshreshtha, 2008).

Otherwise, the withdrawal of government from the market mechanism will lead to lower productivity and higher debts in the foreseeable future (Heritage Foundation, 2014).

An effective government is keen to enhance the efficiency of public spending (especially on education, health and infrastructure) and provide high-quality public goods and services without hindering the private sector development (Matthew Andrews, 2008), it can also hear and better answer the citizens' needs, as well as it enjoys an enhanced self-respect among its citizens (Cristina, 2014).

The difficulty of gauging the quality of public services was often deemed to be the biggest snag to research on public service delivery (Banerjee et al., 2007). For this reason, Daniel Kaufmann and his colleagues introduced the government effectiveness index which measures "perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies", and it is scaled between -2.5 and +2.5, where a higher score indicates better government effectiveness (Kaufmann et al., 2008).

The government effectiveness index encompasses all features of government spending and associated policies, and it refers to the ability of government to find effective ways to handle issues properly even under changing circumstances, and hence it is the best index that can act as a proxy for the quality of public service provision (Jalilian et al., 2007; Andrews, 2008; European Commission, 2013).

In 1995, Heritage Foundation and Wall Street Journal introduced the Index of Government Spending (Freedom from Government), which is one of the ten components of Economic Freedom Index, it indicates to the extent of freedom from burdensome public expenditures, and it is scored on a scale of 0 to 100, where higher scores reflect lower level of public spending and greater freedom from government (Heritage Foundation, 2014; Cebula, 2011).

Many 'good governance' proponents incline more towards small government in regard to public goods provision, because the increased government size associated with inefficient government intervention induces further corruption and wasteful rent-seeking behavior (Alesina and Angeletos, 2005; Andrews, 2008).

Decentralization raises many questions about the responsible party for providing public goods and services, and the best way of exerting pressure on policymakers to serve the citizens' needs (Hewett and Montgomery, 2001). Moreover, decentralization can be a potent strategy for enhancing public expenditure management, strengthening the decision-making process and moving it closer to those potentially affected by decisions, because this strategy contributes to building close ties between local governments and their constituencies; further, the genuine proximity to the electorate persuades the local authorities to provide high-quality public services (Okojie, 2009; Shen and Zou, 2014). As well as, the decentralization process gives citizens access to information and empowers them to feel more involved in service provision and in control processes, and thus it holds public service providers more accountable and helps them escape the corruption trap by putting them under strict scrutiny, and consequently this process will properly align politicians' incentives with those of the population as a whole (Okojie, 2009; Ghatak, 2010; Xu, 2013).

In contrast, some opinions indicated that the decentralized political system encourages governments and sub-governments to slough off their responsibilities, and it leads also to the capture of public resources by local elites (Hewett and Montgomery, 2001; Okojie, 2009). Sometimes, decentralization and flattening of hierarchies drive many local governments in necessitous areas to spend much less than required for delivering high-quality public services. Such a situation will further increase the inefficiency of delivering public goods and services. Additionally, the lack of minimum measures needed to provide core public services, makes the decentralized system more vulnerable to predation by the growing chorus of voices against inequality, as a result of large provincial divergence in economic development (Shen and Zou, 2014).

Therefore, a promising decentralization process requires careful reconciliation between resources and financial obligations at each government level (Shen and Zou, 2014). Governments often pursue decentralized systems to mollify regional resentment from provinces seeking more autonomy (Okojie, 2009). Wherefore, greater local autonomy must be tied up with a qualified staff and vigorous performance, over and above that, policy makers should establish a proper and efficient division of labor between various levels of government and allocate relevant financing tools to match spending responsibilities (Shen and Zou, 2014). Furthermore, altering the contractual structure of employment for improving the employees' performance in the public sector could exert positive influence on the efficiency of public service delivery (Muralidharan, 2007).

In general, efficient decentralization enhances democratic institutions that enable people to lobby for their rights that may be vulnerable to the risk of corruption (Okojie, 2009).

Corruption is a two-edged sword, on one side it boosts the potential growth rate through enabling economic agents to circumvent the cumbersome public sector, but on the other side it hampers economic growth by weakening the efficiency of government spending and destroying the productivity cells (Dzhumashev, 2014). Moreover, the pervasive corruption distorts the composition of public spending and lowers the quality of public service delivery and thus frustrates the growth prospects (Deininger and Mpuga, 2004).

Mauro, P. (1998) demonstrated that countries with widespread corruption attempt to reduce their social spending, thereby decreasing the growth rate. Thence, designing and implementing effective anticorruption strategies can enable countries to plug corruption loopholes in the public sector, and hence provide high-quality public goods and services (Kulshreshtha, 2008).

Méon and Sekkat (2005) indicated that the negative growth effect of corruption will be intensified in a prosaic governance framework. Furthermore, Freytag and Pehnelt (2006) pointed out that good governance is deemed as an intrinsic criterium in determining the foreign investment decision-making process, multilateral and bilateral aid flows.

Additionally, the quality of public service delivery is also influenced by many other factors (i.e. the pre-existing infrastructure and institutional background, staffing levels and more) (Deininger and Mpuga, 2004). More precisely, the poor institutional quality bolsters the poor provision of essential public services, aggravating economic and social stress (North, 1990; Easterly, 2001).

Also, Grigoli and Ley (2012) stated that spending on education and health could be ineffective in a feeble institutional context. In the same vein, Dzhumashev (2014) argued that the institutional quality is the major driving force behind the efficient public sector and effective public spending, and hence it propels the public inputs towards enhancing productivity and competitiveness. It is also worth noting that the delivery of quality public goods and services gives a clearer impression of dignity and good governance (OECD, 2008).

Moreover, the past ignorance of institutional importance in the public sector caused the current quality of public services (Kulshreshtha, 2008). For instance, most developing countries suffer from misdirected public sector and wasteful pursuits that represent an enormous hurdle to effective service delivery. Quite often, such cases are linked with insufficient impetus for public officials to provide high-quality services and goods. Thence, these developing countries must gear their strategies towards promoting their institutions for enhancing transparency and accountability, which decrease the service delivery bias (Kulshreshtha, 2008).

The impact of public service quality on economic growth has received a great deal of attention from economists especially in last decades, and the table below summarizes the empirical studies that have investigated this impact.

Table 1. *Empirical evidence on the impact of public service quality on economic growth*

Authors	Sample	Empirical approach	Results
Jalilian et al. (2007)	96 countries 1980-2000	OLS regression	Government effectiveness contributes positively to GDP per capita growth.
Fayissa and Nsiah (2010)	28 African countries 1995-2005	OLS estimation	Government effectiveness has a salient positive influence on the Sub-Saharan Africa's economic growth.
Zhuang et al. (2010)	33–37 developing Asian economies 1998-2008	OLS panel regression	Government effectiveness is highly and positively associated with the real per capita GDP growth.
Grigoli and Ley (2012)	24 countries 1998–2002	Panel data analysis	Government effectiveness is positively correlated with economic growth.
Braşoveanu (2012)	27 European Union member states 1990-2012	OLS estimation	Government effectiveness displays a positive effect on accelerating economic growth.
Silaghi and Mutu (2013)	20 emerging economies 2000-2010	The first-differenced GMM estimator	Government effectiveness substantially raises the rate of economic growth.
Ahoure (2013)	32 Sub-Saharan Africa countries 2002-2006	The System Generalized Method of Moments (System GMM)	Government effectiveness exerts a significant positive impact on economic growth.
Lipari (2013)	172 countries 1996-2012	OLS cross-sectional regressions	Strong government effectiveness delivers high rates of economic growth.
Freytag and Pehnelt (2006)	127 developing countries 1995-1999, 2000-2004	Tobit estimation	Government effectiveness appears to significantly accelerate the debt relief process.
Campbell (2013)	10 randomly-selected countries 1999-2010	OLS panel regression	Government effectiveness seems to affect economic growth negatively and insignificantly.
Reinikka and Svensson (1999)	171 Ugandan establishments 1997-1998	OLS estimation	Poor public capital significantly lowers the firms' productive investments.
Hong (2014)	288 Chinese prefecture-or-above-level cities 1992-2010	Panel data analysis, fixed effects model	The presence of crude oil induces local governments to deliver fewer public services.
Rajasalu (2003)	European Union member states 1994-2001	Pooled ordinary least squares (OLS) technique	There is a positive but insignificant relationship between government spending (freedom from government) and economic growth.
Cebula et al. (2012)	OECD nations 2002-2006	Fixed-effects estimation	Economic growth is significantly positively influenced by government spending index.
Onakoya and Somoye (2013)	Nigeria 1970-2010	Three-stage least squares (3SLS) technique	Public capital spending enhances the Nigeria's prospects for economic growth.
Cebula (2011)	OECD nations 2003-2007	PLS and P2SLS estimations	Government spending (freedom from government) has a negative and insignificant impact on growth rates.

Source: Constructed by author.

3. The quality of public service delivery and economic growth in the MENA Region

3.1. Economic growth in the MENA Region

MENA region's economic growth has been characterized by sharp fluctuations. In general, the MENA oil monarchies have succeeded to bolster their growth rates, particularly the GCC countries have skillfully utilized the increased oil revenues to feed the growth requirements such as infrastructure modernization, human capital formation and R&D, moreover these countries have made valuable contributions to the manufacturing and services sectors (Iradian and Abed, 2013). Likewise, Morocco, Egypt, Jordan, Lebanon and

Turkey have boosted their growth prospects through strengthening the tourism sector, developing the human capital and pursuing macroeconomic stability (Nabli and Véganzonès, 2004; Anthony O'Sullivan, Marie-Estelle Rey and Jorge Galvez Mendez, 2011).

The region, as a whole, has been far below its enormous potential, and even more it has hardly missed outstanding opportunities to keep up with the pace of globalization by failing to diversify its export base away from oil and to attract substantial inflows of FDI into the non-oil sectors (Askari, 2006). Furthermore, the inability of the oil-exporting MENA countries to diversify their economies, made them more vulnerable to predation by the 2008 financial crisis, as shown in the figure below. It is also observed that the economic growth of GCC countries has been shrunk by the financial meltdown, because of these countries' close ties with global financial markets (World Bank, 2010).

In 2011, a first-of-its-kind phenomenon known as the Arab Spring has swept Tunisia, Egypt, Yemen and Syria, causing cracks in some surrounding countries like Lebanon, Jordan and Algeria, further this unexpected turmoil has caused a growth collapse in the worst-hit countries (Anthony O'Sullivan, Marie-Estelle Rey, and Jorge Galvez Mendez, 2011). Moreover, the manufacturing and tourism sectors in Egypt and Tunisia have been hardly slashed due to the escalating rebellion and security threats (World Bank, 2013).

Additionally, the Arab Spring has unveiled a number of economic, political and social problems that have been hidden all these years, besides highlighting other crucial issues such as political pressures, inequality and high unemployment and poverty traps (House of Commons, Foreign Affairs Committee, 2012).

In general, the deeper institutional reform will be the key building block for establishing a vigorous economy. Likewise, creating more jobs, reviving the agricultural sector, relying on renewable energies, will without doubt catalyze the MENA region's long-term growth potential (World Bank, 2010; IMF, 2013a).

The Arab Spring uprisings caught the international community completely by surprise, unleashed political instability and toppled longstanding dictators. The devastating consequences of these upheavals nullified all the achievements made in war-torn countries over the last few decades, and millions of people sank ever deeper into the pit of poverty and became reliant on international humanitarian assistance for survival. Not only did uprisings quickly become brutally violent in Libya, Syria, and Yemen, but they also facilitated external interventions in Libya, Syria, and Yemen, and what Lynch (2016) argues is that foreign interventions brought these countries to the brink of chaos and destruction through supporting and arming rebel groups. The Arab Spring was a highly visible aspect of hidden cracked models of government in the MENA region, especially when macroeconomic performance of Arab Spring countries showed an overall positive image and indicated that authoritarian governments were able to deliver economic development, and most MENA countries have intensified their efforts towards the achievement of the Millennium Development Goals (MDGs) and have made a noticeable

progress in cutting the proportions of hunger, reducing child mortality rates and expanding primary school enrollment (Iqbal and Kiendrebeogo, 2016). Further, it is worth noting that expenditure inequality was fairly stable with a slight dip in most MENA countries, and inequality of opportunity has indeed lessened in Egypt and some other MENA economies (Hassine, 2012; Hassine, 2015; Assaad et al., 2016), therefore it can be said that there was a broad sharing of the benefits of growth in these countries.

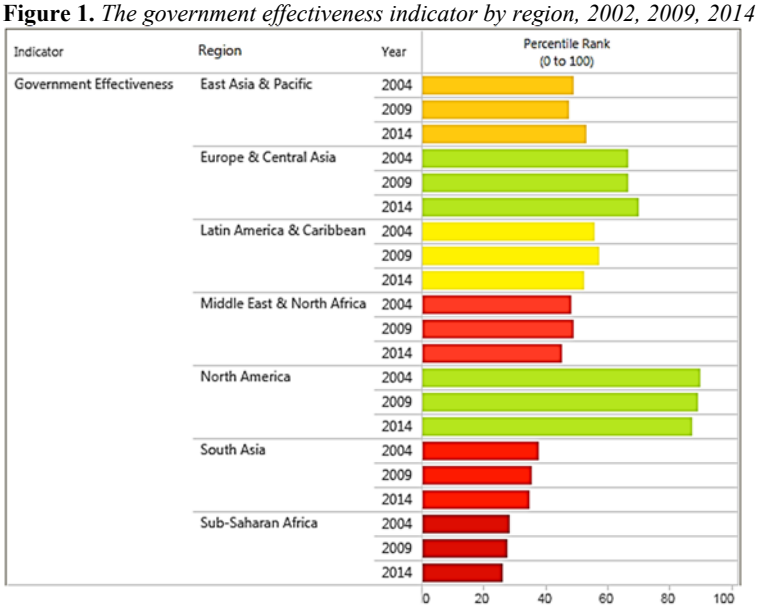
The Arab uprisings started in Tunisia in December 2010 and began to sweep through the Arab world in early 2011 in ways that defied all previous predictions and analysis. The Arab world entered an era of chronic political instability and black unrest in the aftermath of the Arab uprisings. The public opinion surveys by the Arab Barometer revealed that the average protestor was highly educated, male, young, living in urban areas, and having a middle-class background. There were vigorous protests against injustices, discrimination, poor service delivery, government failure and corruption. On the eve of the Arab revolts, scholars, civil society activists and journalists began analyzing what may have caused the Arab Spring. High income inequality threatens political stability and often results in conflicts because it makes political consensus between higher- and lower-income groups so difficult, and instability, in turn, could frustrate future investments, disrupt growth and have damaging effects on human development (Burger et al., 2016).

Some economists have even gone further and dealt with the 'paradox of unhappy growth' which describes the case in which an increase in growth rates does not automatically result in an increase in citizens' happiness (Arampatzi et al., 2015), this paradox interprets conflict as stemming from a broken social contract between government and citizens. This paradox describes the situation of Arab Spring countries, albeit at varying levels. Given the complexity of the Arab Spring and its tragic aftermath, analyzing data on subjective wellbeing and its determinants can provide consistent information and a more solid basis for understanding and explaining transitions occurring across the MENA region. The years preceding the Arab Spring masked a growing middle-class squeeze, this class worries about its future, finds itself working more for less, becomes far less willing to accept privations, and feels more angry than happy (Dang and Ianchovichina, 2016).

Even prior to the events of the Arab Spring, life dissatisfaction became rampant among the middle and working classes in Arab Spring countries. In turn, life satisfaction in these countries has been negatively impacted by several factors such as poor public service delivery, deteriorating labor market conditions, pervasive corruption connected to the use of influential personal connections with powerful elites (wasta) to gain privileged access to resources and opportunities including employment, and these are mostly the same factors that implied social contract has been broken (Arampatzi et al., 2015). Protestors maintained high levels of participation, insistently demanded political change greatly supported political change, and continued to proclaim their grievances and grudges against the broken social contract in Arab Spring countries (Tunisia, Egypt, Libya, Yemen, and Syria), while participation rates in protests against authoritarian regimes were lowest in Algeria, Jordan, Lebanon, and Morocco, because the majority of people didn't care about protesting.

3.2. The MENA Region's government effectiveness

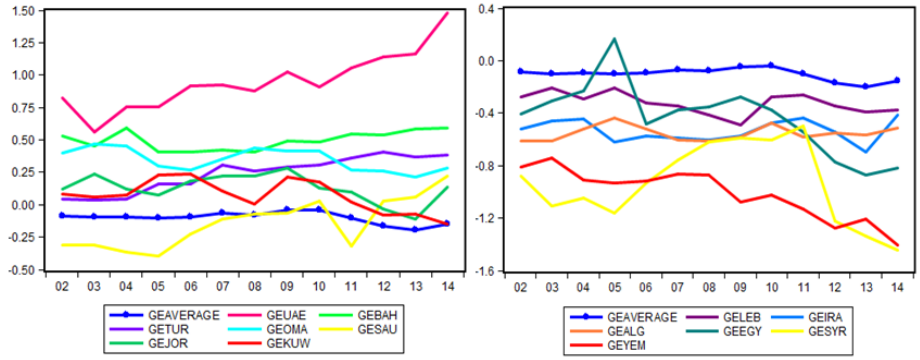
Figure 1. *The government effectiveness indicator by region, 2002, 2009, 2014*



Source: World Bank Governance Indicators, the data are available online at: http://info.worldbank.org/governance/wgi/index.aspx#reports (accessed 01/06/2018).

The graph above shows that the MENA region has failed to narrow the government effectiveness gap with its American, European and Central Asian counterparts. Moreover, the MENA region is in danger of falling further back, because it has lagged behind other countries in enhancing good governance in general and improving government effectiveness in particular over discrete time periods, and even more it's still stuck in the bottom half of the government effectiveness scale and it is worthwhile to note that the MENA countries can draw on the experience and best practices of comparable European, Latin American and Asian countries that continue to deliver high-quality services and better respond to the needs of their citizens.

Figure 2. *Government effectiveness in the MENA countries, 1996-2014*

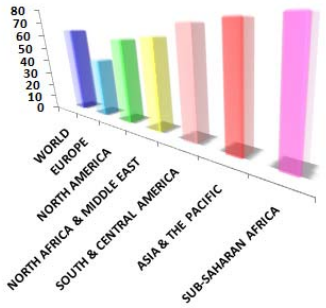


Source: World Bank Governance Indicators, the data are available online at: http://info.worldbank.org/governance/wgi/index.asp (accessed 01/06/2018).

UAE clearly outpaces the other MENA nations in terms of government effectiveness indicator, as a result of its intention to provide high-quality services and enhance the related policies. Moreover, the UAE government has made significant strides forward in the field of e-government in order to facilitate serving citizens and reinforce the government's credibility through enhancing transparency and accountability. Likewise, Bahrain, Turkey and Oman are considerably above the regional average, due to their efforts in improving the quality of public service delivery. Whilst, most of the remaining MENA countries still occupy the negative field reflecting the terrible public sector performance and the delayed efforts aimed at upgrading the level of government effectiveness, especially Yemen and Syria.

3.3. The government spending (Freedom from Government) in the MENA Region

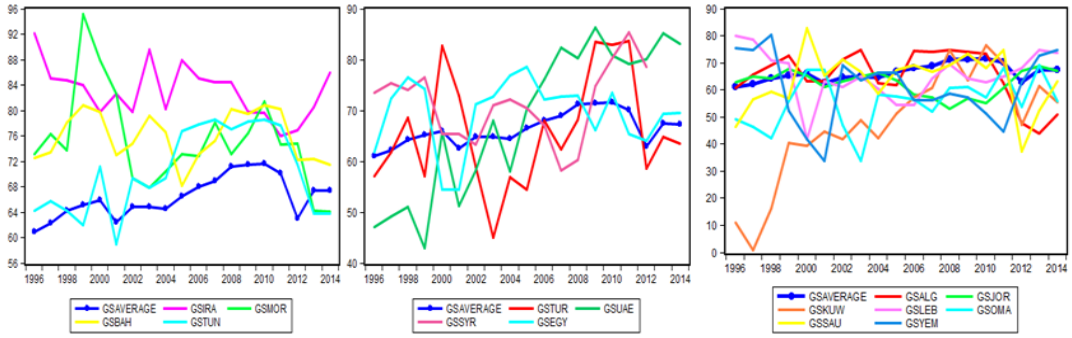
Figure 3. *The 2016 index of government spending by region*



Source: Heritage Foundation's *Index of Economic Freedom*, the data are available online at: http://www.heritage.org/index/explore?view=by-region-country-year (accessed 01/06/2018).

The graph above clearly shows the six regions' government spending scores in the 2016 Index of Economic Freedom. More particularly, the Middle East and North Africa region has come in fourth place, and the reduction of the state's role in the economy is clearly the greatest challenge facing the MENA countries, while the last two places have been occupied by North America and Europe, respectively. Moreover, this graph illustrates that the more developed regions are characterized by low government spending scores, for instance most European countries continue to increase spending on education, R&D, health care, unemployment insurance and pension payments, because of their goals of providing high-quality services to their citizens (Heritage Foundation, 2016).

Figure 4. *Government spending score in the MENA Countries, 1995-2014*



Source: Heritage Foundation's *Index of Economic Freedom*, the data are available online at: http://www.heritage.org/index/explore?view=by-region-country-year (accessed 01/06/2018).

As is clearly visible in the graph above, Iran, Morocco, Bahrain and Tunisia have recorded the highest government spending scores; likewise, these countries have significantly exceeded the regional average, due to the wise management of public expenditures as compared to other MENA countries. Whilst, Turkey, UAE, Syria and Egypt have fluctuated up and down around the average regional government spending; however, a significant progress has been achieved by UAE in reducing the public spending and reconciling it with the delivery of high-quality services. Whereas, Algeria, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia and Yemen have trended below the regional average in recent years, as a result of their failure to curb excessive public spending (Heritage Foundation, 2013).

In general, government spending has expanded in most MENA countries, because it has been steered by consumption expenditures and subsidies, and the underlying cause behind this is the attempt to quell the social unrest and alleviate the high prices of imported goods, and it is worthwhile to note that the large oil revenues continue to fuel the broad-based public expenditures particularly in oil-abundant countries (IMF, 2013b).

4. Data and empirical results

4.1. Data

This study investigates the impact of public service quality on economic growth in 15 MENA countries (Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates and Yemen) throughout the period 1996-2018 using the following variables:

GDP – GDP growth (annual %) is used as a proxy for economic growth, from the World Development Indicators database.

GE – Government Effectiveness which measures the quality of public services, and it is obtained from the World Bank Institute's Worldwide Governance Indicators database (WGI).

GS – Government spending (freedom from government) compiled by the Heritage Foundation jointly with the Wall Street Journal.

POPD – denotes the population density (people per sq. km of land area), from the World Bank's World Development Indicators (WDI).

4.2. Data analysis tools

The panel data estimation is employed in order to test the effect of public service quality on economic growth in 15 MENA countries using Eviews 8.0 software package. Because the panel data analysis has several advantages, such as controlling for both observed and unobserved heterogeneity, increasing the degree of freedom and reducing the collinearity problems, hence improving the efficiency of econometric estimates (Hsiao, 2003), there are three main models as follows:

Pooled OLS Model indicates that all the data are pooled in the OLS regression; moreover, it assumes that all coefficients are the same across countries and time periods (Wooldridge, 2002; Brooks, 2008).

$$y_{it} = \alpha + \beta x_{it} + u_{it}; \qquad \begin{cases} t = 1, \dots\dots, T; \\ i = 1, \dots\dots, N. \end{cases}$$

Where: α denotes the intercept term;

β is a $k \times 1$ vector of parameters to be estimated on the independent variables;

and $x_{i\,t}$ is a $1 \times k$ vector of observations on the independent variables;

$u_{i\,t}$ is the disturbance term.

Fixed Effects Model assumes that the intercept differs across cross-section units (Brooks, 2008). In other words, it recognizes only the within-group variation (Allison, 2005).

$$y_{it} = \alpha + \beta x_{it} + u_{it} + v_{it}; \qquad u_{it} = u_i + v_{it} \qquad \begin{cases} t = 1, \dots\dots, T; \\ i = 1, \dots\dots, N. \end{cases}$$

μ_i denotes the individual specific effect

$v_{i\,t}$ represents the remainder disturbance that varies over time and entities (Brooks, 2008).

Random Effects Model assumes that a random variable (which differs across cross-section units but is constant over time) is added to the intercepts for each cross-sectional unit (Brooks, 2008).

$$y_{it} = \alpha + \beta x_{it} + \omega_{it}; \qquad \omega_{it} = \epsilon_i + v_{it} \qquad \begin{cases} t = 1, \dots\dots, T; \\ i = 1, \dots\dots, N. \end{cases}$$

ϵ_i measures the random deviation of each entity's intercept term from the 'global' intercept term α

Hausman test

This test is usually used in order to choose the appropriate model between fixed and random effects models, and the Hausman statistic is given by:

$$H = (\hat{B}_{FE} - \hat{B}_{RE}\acute{)}\,(Var(\hat{B}_{FE}) - Var(\hat{B}_{RE}))^{-1}\,(\hat{B}_{FE} - \hat{B}_{RE})$$

Which is distributed as χ^2 under the null hypothesis with k degrees of freedom, and $\hat{B}_{FE}, \hat{B}_{RE}$ represent the vectors of parameter estimates of the fixed effects and random effects models, respectively; $Var(\hat{B}_{FE}), Var(\hat{B}_{RE})$ represent the variance-covariance matrices of FE and RE estimators, respectively; there are two hypotheses as follows:

H_0: α_i is not correlated with x_{it}.

H_1: α_i is correlated with x_{it}.

If the null hypothesis is rejected, the fixed effects model is favored (Wooldridge, 2002; Maki, 2011).

4.3. Analysis of empirical results

Table 2. *Summary statistics*

	GDP	GE	GS	POPD
Mean	4.443077	-0.075806	67.00553	169.2 185
Medlan	4.373000	-0.072916	68.20000	67.19619
Maximum	17.32000	1.477285	92.10000	1768.740
Minimum	-10.47967	-1.275783	10.90000	7.014976
Std. Dev.	3.088630	0.521619	12.13428	339.1734
Skewneas	-0.443051	0.040842	-1.010669	3.401419
Kurtoals	6.745393	2.64229 1	5.281768	14.07758
.Jarque.Sera	145.04 54	1.318231	90.98684	1654.708
ProbablIlty	0.000000	0.517309	0.000000	0.000000
Sum	1044.123	-17.81436	15746.30	39766.35
Sum Sq.Oev	2232.274	63.66823	34454.32	26919035
Observations	235	235	235	235

Source: Author's computation using Eviews 8.0.

The table above shows the descriptive statistics for all the variables included in the empirical study, covering 15 MENA countries over the period 1996-2018. As can be readily seen from the data, GDP has an average of 4.44 and a maximum value of 17.32, reflecting that specific countries in the region enjoy substantial economic growth, also the average of government effectiveness is -0.07, which means that almost all countries in the MENA region suffer from low-quality public services, and the maximum value of 1.47 belongs to UAE, which is keen to deliver world-class public services to its citizens and residents, while the mean of government spending index (67) points out that the region as a whole is classified as 'Moderately Free' in terms of government spending.

Table 3. *Regression results for 15 MENA countries*

Dependent Variable : GDP			
Coefficient Estimates (P-value)			
Independent Variables	Pooled OLS Model	Fixed Effects Model	Random Effects Model
Constant	4.611321 (0.0000) ***	3.720031 (0.0000) ***	4.135211 (0.0000) ***
GE	0.649036 (0.0000) ***	0.565088 (0.0007) ***	0.546906 (0.0632) *
GS	-0.001729 (0.5315)	0.010149 (0.2707)	0.004173 (0.7571)
POPD	0.000219 (0.0880) *	0.000507 (0.0669) *	0.000289 (0.1575)
R-squared	0.205118	0.260910	0.013145
Prob (F-statistic)	0.000000	0.000000	0.381964

Significant at 1% (***), 5% (**), 10% (*).
Source: Author's computation using Eviews 8.0.

Table 3 epitomizes the main findings of the following models: Pooled OLS, Fixed Effects and Random Effects. As expected, the government effectiveness index and government spending have a positive influence on accelerating economic growth in all regressions, except the pooled OLS which reveals that there is an insignificant negative relationship between government spending and economic growth. Likewise, the population density

appears to be positive in all models. The next step involves applying the Hausman test which is worthy in selecting between fixed and random effects models.

Table 4. *Hausman test*

Correlated Random Effects - Hausman Test			
Equation : Untitled			
Test period random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	7.877604	3	0.0486

Source: Author's computation using Eviews 8.0.

The Hausman chi-square test statistic is significant at the 5% level of significance (Prob (0.048 < 0.05)), on this basis, the null hypothesis can be rejected, in other words the Hausman test suggests that the fixed effects model is the most suitable one, so we focus on it in this empirical study.

The fixed effects model clarifies that the government effectiveness index displays a highly significant positive impact on economic growth in 15 MENA countries, and this is consistent with theory, that highlighted the intrinsic role played by efficient public service delivery in boosting economic growth. While the government spending (freedom from government) exhibits a statistically insignificant positive effect on economic growth in the selected countries. Likewise, the population density has a significant positive relationship with economic growth. Moreover, the probability (p) of the F statistic is equal to zero which means that the model as a whole is statistically significant, further it confirms the joint impact of explanatory variables on economic growth.

To sum up, the provision of high-quality public services is deemed a catalyst for the MENA region's economic growth. In addition, the ideal reconciliation between delivering high-quality public services and keeping public spending low and efficient, is the perfect recipe for the MENA region's economic success.

5. Conclusion

This study examines the impact of public service quality on economic growth in 15 MENA countries (Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates and Yemen) over the period 1996-2018, through the use of panel data analysis, including Fixed Effects Model, Random Effects Model and Hausman test. As expected, government effectiveness and government spending (freedom from government) exert a positive influence on economic growth. According to Hausman test, the fixed effects model is the most suitable one, and it clarifies that the government effectiveness index displays a highly significant positive impact on economic growth in 15 MENA countries, and this is consistent with theory. The government spending (freedom from government) exhibits a statistically insignificant positive effect on economic growth in the selected countries. To sum up, the provision of high-quality public services is deemed a catalyst for the MENA region's economic growth.

Based on these findings, it could be concluded that the ideal reconciliation between delivering high-quality public services and keeping public spending low and efficient, is

the perfect recipe for the MENA region's economic success, and it is worth noting that many promising policies and practices can be drawn from the experiences of other developing countries that succeeded to advance on the effectiveness ladder, especially those with similar political systems. Moreover, tangible results could have been extracted from understanding access problems to public services.

It is also recommended that MENA governments should foster their cooperation with the private sector in the delivery of education and health care services, besides tackling administrative reforms in alignment with the goal of providing efficient public goods and services. Furthermore, the anti-corruption policies should be knitted; taking into serious consideration the promotion of institutional quality and optimization of government size, and it is worthwhile to note that these goals can be achieved progressively.

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Hidden Markov Model using transaction patterns for ATM card fraud detection

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Abstract. *ATM card fraud is causing millions of naira in losses for the card payment business. The most accepted payment mode in today's world is ATM card for online and regular purchasing; hence frauds related with it are also increasing. To find the fraudulent transaction, this study proposes a hidden Markov Model (HMM) based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]), and the Gaussian distribution (HMM[Gauss]) with the forward-backward algorithm which detects the fraud by using customers spending behavior. The proposed estimation procedure based upon the three distributions for the HMM model is used to construct a sequence of operations in ATM card transaction processing, and detect fraud by studying the normal spending behavior of a cardholder, followed by checking an incoming transaction against spending behavior of the cardholder. If the transaction satisfies a predefined threshold value, then the transaction is decided to be legitimate else, the transaction is declared as fraudulent. The evaluation statistics used shows that the HMM[Gauss] is the most appropriate model in detecting ATM card fraudulent transactions.*

Keywords: Hidden Markov Model, Gaussian distribution, generalized Poisson, optimal detection, forward-backward algorithm, estimation, simulation.

JEL Classification: C02, C13, C15, C18.

1. Introduction

Automated teller machine (ATM) card fraud can be defined as a term for theft and fraud committed using a payment card, such as a credit card or debit card in various kind of transaction. The purpose may be to obtain goods without paying, or to obtain unauthorized funds from an account or to avail some kind of service. Prevention and detection of fraud in systems are two important aspects that are to be considered so as to avoid frauds and losses due to fraudulent activities.

Science and technology have really made human life less cumbersome through invention of the ATM cards which contains confidential details such as the Card Number details, Card Member name, and other pieces of information related to the Card owner. These cards are used everywhere for deposits, withdrawals, account information, online shopping, regular purchasing and other forms of transactions. Due to its convenience, there is steady increase of its use. The convenience notwithstanding, the use of the cards is also susceptible to fraudsters who, if care is not taken, can cause enormous loss of money both for the card holder and the issuing banks.

A quite number of techniques have been developed in the bid to detect and curb ATM card fraudulent transactions. Some of these techniques are based on Artificial Intelligence, Data mining, Fuzzy logic, Machine learning, Sequence Alignment, decision tree, neural network, logistic regression, naïve Bayesian, Bayesian network, Genetic Programming etc.

This work strives to discover patterns which appear and reappear over a space of time as it concerns the pattern of commands someone uses in instructing a computer, sequence of words in sentences, and sequence of phonemes in spoken words. By finding these patterns, there is high probability of predicting the possible behavior or habits of ATM users, making it easy to spot cases that deviate from normal transaction pattern of the user. It is our reasoned opinion that such calculations can provide extra security on the ATM system.

Consequently, this research consider an extension from several different propose approaches to detecting fraudulent transaction of the model. Hidden Markov Model (HMM) based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]) and the Gaussian distribution (HMM[Gauss]) for which optimal detection of patterns of variances using the forward-backward algorithm is developed for the analysis of the spending profile of the card holder and to find out any inconsistency in the spending patterns. HMM model identifies transaction patterns of the user. Accordingly, it can assist in preserving and updating a database that defines the operational behavior of the identified user in the form of the pattern. The behavioral pattern of the user will be checked once there is a transaction of user to see if it aligns with previous patterns. Once there is nonconformity with the person's behavioral pattern, the transaction will be blocked. For the card to be unblocked, the user will have to prove ownership through a stipulated pattern. Various techniques proposed for the detection of ATM card fraud transaction are briefly explained in section 2.

2. Related literature

ATM card fraud detection has generated a handful of literatures from scholars worldwide. These scholars, in one way or the other, strived to showcase a number of techniques that have been developed to detect fraudulent transactions using the credit/debit card.

Ehramikar (2000) revealed that the most predictive Boosted Decision Tree classifier is one that is trained on a 50:50 class distribution of fraudulent and legitimate credit card transactions. The study also shows that training decision tree classifiers on datasets with a high distribution of legitimate transactions leads to high fraudulent cases classified as legitimate (a high false negative rate). This means that predictive model over fitting occurs when the training dataset has a majority of legitimate transactions.

To reduce the number of fraud investigations in the credit approval process, Wheeler and Aitken (2000) came up with a case-based reasoning system which consists of two parts, a retrieval component and a decision component. The retrieval component uses a weighting matrix and nearest-neighbor strategy to ascertain and extract the right cases to be used in the final diagnosis for fraud, while the decision component utilizes a multi-algorithm strategy to evaluate the retrieved cases. The nearest-neighbour and Bayesian algorithms were used in the multi algorithm strategy. Initial results of 80% non-fraud and 52% fraud recognition from Wheeler and Aitken indicate that their multi-algorithmic case-based reasoning system is capable of high accuracy rates.

Through the observation of uncharacteristic spending behavior and occurrence of transactions, Bolton and Hand (2001) suggested an unsupervised credit card detection system. The mean amount spent over a specified time window was used as the comparison statistic. The study recommended the Peer Group Analysis (PGA) and the Break Point Analysis (BPA) techniques as unsupervised outlier detection tools. The results of the study indicated that the PGA technique was able to effectively identify local anomalies in the data, and the BPA technique can efficiently determine fraudulent behavior by comparing transactions at the beginning and end of a time window.

To improve the learning proficiency of a neural network, Kim and Kim (2002) came up with a fraud density map technique. The fraud density map (FDM) looks at the inconsistent distributions of legitimate and fraudulent transactions between the training data and real data. It modifies the bias found in the training data by reflecting the distribution of the real data onto the training data through the changing of a weighted fraud score.

To address the credit card fraud problem, Chen et al. (2004) developed a questionnaire-responded transaction (QRT) data of users. To develop the QRT models, the study applied the support vector machine algorithm to the data, which were then used to decide if new transactions were fraudulent or genuine. The research results showed that even with very little transaction data, the QRT model has a high accuracy in identifying fraud.

Chiu and Tsai (2004) identified the problem of credit card transaction data having a natural skewness towards legitimate transactions. The ratio of fraud transactions to normal transactions is extremely low for an individual financial institution (FI), and this makes it difficult for FIs to maintain updated fraud patterns. The study proposed web service

techniques for FIs to share their individual fraud transactions to a centralized data center and applied a rule-based data mining algorithm to the combined dataset to detect credit card fraud. Foster and Stine (2004) used a fully automated stepwise regression model to predict personal bankruptcy. The results from this thesis indicate that standard statistical models are competitive with decision trees. The benefit of this model is that it can easily understand the procedures in the prediction process. But the disadvantage lies in the fact it is difficult to follow the process from input to the output prediction. Joshi and Phoba (2005) have examined the capacities of HMM in detection of irregularities. They classify transmission control protocol (TCP) network traffic as an attack or normal using HMM. Cho and Park (2003) proposed an HMM-based intrusion detection system which strives to improve the modeling time and performance through an exclusive consideration of the privilege transition flows based on the domain knowledge of attacks. Ourston et al. (2003) studied the detection of multistage network attacks through the application of HMM. Hoang and Hu (2004), tackle the issue of irregularity detection using HMM via a new method to process sequences of system calls. The idea is to develop a multilayer model of program behaviors based on both HMMs and enumerating methods for anomaly detection. Lane (1999) has used HMM to model human behavior. Once human behavior is appropriately modeled, any identified anomaly is a cause for concern since we do not anticipate an invader to have the same behavioral pattern as the genuine user. Hence, an alarm is raised in case of any deviation.

Quah and Sriganesh (2007) evaluated a neural network based approach called SOM (Self Organizing Map) to detect spending pattern of the customer in credit card database and SOM is a multilayer approach that consists of: The initial Authentication, Screening layer, Risk Scoring layer, Behavior Analysis layer (Core Layer) and Decision making layer and The main purpose of SOM approach is to classify and cluster input data, to detect and derive hidden patterns in input data.

Srivastva et al. (2008) proposed Hidden Markov Model to detect fraudulent transactions which is initially trained with the normal behavior of a cardholder therefore if an incoming credit card transaction is not accepted by the HMM with sufficiently high probability, it is considered to be fraudulent and K Mean Clustering algorithm is used to identify spending behavior of a customer.

Panigrahi et al. (2009) combined three approaches: Rule-based filtering, Dempster-Shafer theory and Bayesian learning in which Dempster rule is used to match customer current behavior compared with the previous behavior, rule based filtering approach is used to determine the suspicious level of each incoming transaction and Bayesian learning approach is used to update the suspicious score of transaction using history database of both genuine cardholder as well as fraudster.

Sanchez et al. (2009) used Association rules to detect new or undesired behavior of bank customer in the online verification process. The Association Rules (Fuzzy Rules) are applied in the area of Business Management and planning to extract data of fraudulent transaction from a large database.

Farvaresh and Sepehri (2010) proposed a framework to detect fraud telecommunication subscribers by using various techniques such as data cleaning, dimension reduction, clustering and classification. The main problem in this framework is that it requires the historic data to identify whether the customer is fraudster or genuine. Bhattacharyya et al. (2010) evaluated two advanced data mining approaches, decision tree approach, support vector machines and random forests together with logistic regression to detect credit card fraud and examines the performance of these techniques with the varying level of data under sampling and These techniques only detects few fraudulent transaction when it is applied to a real world data set. Duman and Ozcelik (2011) used genetic algorithm and scatter search to score each transaction and based on these scores the transaction ae classified as fraudulent or genuine transaction. Dharwa and Patel (2011) proposed Transaction Risk Score Generation Method was used to calculate certainty factor to identify whether the transaction is fraudulent or genuine and Risk score is analyzed by identify spending profile of customer of a bank by implementing density-based spatial clustering of application with noise (DBSCAN) algorithm and address mismatch in which it will identify whether the customer billing and shipping is same.

Chuang et al. (2007) combined mining as a general approach to extract informative knowledge in complex data to solve telecom fraud detection and cross-market surveillance in stock markets and a framework that is flexible and customizable for handling a large amount of complex data.

Joris et al. (2012) a tool was proposed extract data for relational regularities and corresponding outliers in relational data based on WARMR algorithm whose input consist of interpretations, a background knowledge and a language bias, generated from the end user's data selection and mining preferences, so this tools assists a geographic content providing company in reasoning about the structure of the data and about the data itself and this tool is able to extract previously unknown knowledge in an automated way, which can be integrated in the quality maintenance process directly.

Li et al. (2012) proposed an advanced data mining techniques and algorithms such as contrast pattern mining, neural network and decision forest and their outcomes are integrated with an overall score measuring the risk of an online transaction being fraudulent or genuine. Clifton et al. (2012), used two new layers such as Communal Detection (CD) and Spike Detection where CD is a white list oriented approach on a fixed set of attribute and finds real social relationships to reduce the suspicion score and SD is attribute oriented approach on a variable size set of attribute and find spikes in duplicates to increase the suspicion score to detect more types of attack on and remove the redundant attribute. Edge and Sampaio (2012) presented a rule-based policy modeling language where financial fraud modeling language (FFML) is an architecture for facilitating the conceptual level expression implementation of proactive fraud controls within multi-channel financial service platforms by using approaches such as data mining, neural network, and machine learning techniques to identify suspicious transaction and these techniques supports real time monitoring component that finds financial fraud in areas of stock market, money laundering etc.

Huang et al. (2012) a hybrid model recommended for online fraud detection of Video-on-demand system to improve the current Risk Management Pipeline (RMP) by adding Artificial Immune System (AIS) based fraud detection for logging data in which AIS based model combines two artificial immune system algorithms with behavior based intrusion detection using Classification and Regression trees (CART),so the proposed approach can help e-commerce better understand the issues and plan the activities involved in a systemic approach to E-fraud. Drezewski et al. (2012) implemented six algorithms that detect criminal act by gathering information from different sources may be of quantitative character such as billing or bank account transactions but also of qualitative character such as eyewitnesses testimonies and the results obtained by using these algorithms can be visualized so that they can be easily explored by the police analyst and trace the criminals. Chang and Chang (2012) author recommended an early fraud detection method, i.e. based on the accuracy and timeliness simultaneously; this method prevents from online fraud in which fraudster deceive the individual, business or the organization by performing fraudulent transaction and early fraud detection method can be implemented by constructing decision trees or by instance-based learning. Wu and Wang (2013) proposed two practical for outlier detection methods named information-theory-based step-by-step (ITB-SS) and information-theory-based-single-pass (ITB-SP) to solve real world problem such as Intrusion Detection, Criminal activity detection in E-Commerce etc. and these methods does not require user defined parameter to decide whether an object is outlier. Sahin et al. (2013) developed a security mechanism, CHIP and personal identification number (PIN), for credit card system that does not prevent from fraudulent credit card usages over online fraud. They further developed and implemented a cost sensitive decision tree approach to detect fraudulent transactions and this approach is compared with the traditional classification models on a real world credit card data set. Lee et al. (2013) recommended digital forensics techniques to analyze system intrusion incidents used to detect anomaly transactions that may occur in the user environment during electronic financial transactions. The risk point calculation model is proposed by scoring anomaly transaction cases in the detection step by items.

Kim et al. (2013) proposed two methods based on the finite fixture model to detect fraudulent items automatically without the requirement of labeled items and modeled the dependency between the description and the price of an item by considering the possible combinations of the item description and price clusters according to item clusters and a real-world dataset to evaluate the effectiveness of the proposed models and compared them to existing outlier detection methods. The proposed model significantly identifies the fraudulent transactions. The proposed model requires further enhancement by utilizing historical logs to more accurately analyze the customer behavior.

Hajian and Ferrer (2013) a new pre-processing discrimination prevention methodology consisting of different data transformation methods that can prevent data discrimination, indirect discrimination or both of them at the same time; in order to attain this objective the first step is measure discrimination, and identify categories and groups of individuals that have been directly and/or indirectly discriminated in the decision-making processes; the second step is to transform data in the proper way to remove all those discriminatory biases and finally discrimination free data model can be produced from the transformed data set

without damaging the actual data. The proposed technique is successful in removing discrimination and preserving data accuracy.

Yeh (2013) in this paper, online oversampling principal component analysis algorithm (OSPCA) was recommended to solve real world applications problem such as intrusion detection or credit card fraud detection and the aim of the author is to detect the presence of outliers from a large amount of data via an online updating technique. The author proposed framework is favored for online applications which have computation and memory limitations. The author compared OSPCA algorithm with other anomaly detection algorithm and OSPCA algorithm provides better accuracy and efficiency as compared to other anomaly detection algorithms. The issues in proposed anomaly detection algorithm are: normal data with multiclustering structure, and data in an extremely high dimensional space.

Through the application of artificial neural networks (ANN) and Bayesian belief networks (BBN) to a real world dataset, Maes et al. (2014) discovered that by performing a correlation analysis on the features and removing the feature that was strongly correlated with many of the other features clear improvements to the results were obtained. In addition, the results of the study revealed that BBNs yield superior fraud detection results and their training period is shorter. On the other hand, ANN was found to be able to compute fraud predictions faster in the testing stage.

Pozzolo (2014) AP, AUC and Precision Rank as performance measure for a fraud detection task method was recommended. The proposed algorithm reduces the risk i.e. faced by the customer of a bank due to fraudulent transaction of credit card fraud and to reduce the losses the algorithm depends on advanced machine techniques to assist fraud investigator. The author proposed the algorithm to solve the problem of non-stationary distribution of data, highly imbalanced classes distributions and the continuous stream of transactions. There are three main issues: unbalancedness, non stationarity and assessments and the advanced machine learning technique depends on three main factors: data distribution, classifier used and assessment. The proposed framework addresses the problem of non-stationary in data streams by creating a new model every time a new chunk is available. Lately, Ashphak et al. (2013), Bhusari and Patil (2011), Mohdavesh et al. (2014), Jadhav and Bhandari (2013), Singh and Singh (2015), and Sonawne et al. (2016) have investigated the capabilities of HMM in anomaly detection.

3. Methodology

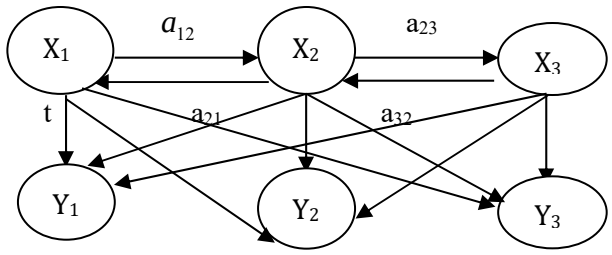
3.1. Hidden Markov Model

The HMM is a stochastic finite *state,* a web of relations associated with a probability distribution. Transitions among the states are ruled by a set of probabilities known as *transition probabilities.* In a specific state, according to the associated probability distribution, an *observation* can be generated. The outcome is visible, but not the state. In other words, the states are "hidden" to the outside; hence the name Hidden Markov Model. It is a statistical model which comprises a set of observations which are produced by an

unobservable set of states (Elliot et al., 1995; Rabiner, 1989; MacDonald and Zucchini, 1997). For Rabiner and Juang (1986), a HMM can be thought as a doubly-embedded stochastic process with an underlying state sequence $\{X_k\}_{k\geq 0}$ that is not observable or hidden. The sequence of state is Markovian and hidden because it can only be seen through another set of stochastic processes $\{Y_k\}_{k\geq 0}$ that produce the sequence of observation where each observation is a probabilistic function of the corresponding state.

In HMM, the true state $\{X_k\}_{k\geq 0}$ is hidden, but leads to observable consequences $\{Y_k\}_{k\geq 0}$ as shown in Figure 1.

Figure 1. *Graphical representation of the dependence structure of a HMM*



where y_1, y_2, y_3 are the observable states and x_1, x_2, x_3 are the hidden states.

A set of states $(x's)$

A set of possible output symbols $(y's)$

A state transition matrix $(a's)$, probability of making transition from one state to another:

$P = \{p_{ij}\}, \quad p_{ij} = p(X_{t+1} = j \mid X_t = i), \quad p_{ij} \geq 0, \quad 1 \leq i, j \leq N, \quad X_t$, denotes the current state.

Output emission matrix $b_i(k)\}$, probability of emitting or observing a symbol at a particular state:

$B = [b_i(k)], \quad b_i(k) = p(y_t = v_k \mid x_t = i), \quad 1 \leq i \leq N, \quad 1 \leq k \leq M$, v_k, denote the k^{th} observation symbol per state.

Initial probability vector, probability of starting at a particular state: $\pi_i, i \in S$, $\pi_i = p(X_1 = s_i)$.

The key point of Figure 1 is that these *observable states,* y_1, y_2, y_3 are directly dependent on some *hidden state,* x_1, x_2, x_3. These hidden states are what actually dictate the outcome of the observable states. The challenge is to figure out the hidden states, the emission probabilities and transition probabilities.

An application of HMM needs specification of two model parameters $(N \text{ and } M)$, and of the three probability measures $\{P, B, \pi\}$. For expediency, we use the compact notation $\lambda = \{P, B, \pi\}$ to designate the complete parameter for HMMs.

Two assumptions can be detected in the model.

Firstly, is the Markov assumption, which states that the current state is dependent only on the previous state,

$$p(X_{t+1} \mid X_1^t) = p(X_{t+1} \mid x_t) \tag{1}$$

Secondly, the independence assumption states that the output observation at time t is dependent only on the current state; it is independent of previous observations and states:

$$p(Y_t \mid Y_1^{t-1}, X_1^t) = p(Y_t \mid X_t)$$

3.1.1. Model parameter estimation

With the model and the observation sequence in consideration, the model parameter is estimated with the following estimation algorithm. The first two are pattern recognition problems: Finding the probability of an observed sequence given a HMM (evaluation); and finding the sequence of hidden states that most probably generated an observed sequence (decoding). The third problem is generating a HMM given a sequence of observations (learning). It deals with the training of the model which is of most significant interest.

Evaluation: Given a model $\lambda = (A, B, \pi)$, and a sequence of observations $O = (o_1, \Lambda\ , o_t)$, q_t hidden states how do we compute $p(O \mid \lambda)$? We use the forward algorithm to calculate the probability of an observation sequence given a particular HMM.

The forward variable $\alpha_{(t)}(i)$ is defined as:

$$\alpha_t(i) = P(o_1 o_2 \Lambda\ o_t, q_t = s_i \mid \lambda) \tag{2}$$

$\alpha(t)$ stores the total probability of ending up in states s_i at time t, given the observation sequence $o_1 o_2 \Lambda\ o_t$ then the sum of $\alpha_t(i)$ gives the probability of the observation, given the HMM, λ.

$$P(O \mid \lambda) = \sum_{i=1}^{N} \alpha_T(i) \tag{3}$$

The forward variable at each time t is calculated inductively as follows:

1. Initialisation: $\alpha_1(i) = \pi_i b_i(o_1),\ 1 \le i \le N$

2. Induction: $\alpha_{t+1}(j) = \left[\sum_{i=1}^{N} \alpha_t(i) a_{ij}\right] b_j(o_{t+1}), 1 \le t \le T-1, 1 \le j \le N$

3. Update time set $t = t + 1$; Return to step 2 if $t < T$; else terminate algorithm.

4. Termination: $P(O \mid \lambda) = \sum_{i=1}^{N} \alpha_T(i)$

Full details of the procedure as well as the various implementation issues, are described in Bhar and Hamori (2004) and Rabiner (1989).

Decoding: Similarly, a model estimate that finds the most probable sequence of hidden states given a sequence of observations is the use of the Viterbi algorithm. Let

$$\delta_t(i) = \max P(q_1 q_2 \Lambda\ q_t = s_i, o_1, o_2, \Lambda\ o_t \mid \lambda) \tag{4}$$

be the maximal probability of state sequences of the length *t* that end in state *i* and produce the *t* first observations for the given model. The variable $\delta_t(i)$ stores the probability of observing $o_1, o_2, \Lambda\ o_t$ using the most probable path. The calculation is similar to the forward algorithm, except that the transition probabilities are maximized at each step, instead of summed.

The Viterbi algorithm is as follows:

1. Initialization: $\delta_1(i) = \pi_i b_i(o_1), 1 \le i \le N, \phi_1(i) = 0$

2. Recursion: $\delta_t(j) = \max[\delta_{t-1}(i) a_{ij}] b_j(o_t), 2 \le t \le T, , 1 \le j \le N$

$\phi_t(j) = \arg\max[\delta_{t-1}(i) a_{ij}], 2 \le t \le T, 1 \le j \le N$

3. Completion: $q_T^* = \arg\max[\delta_T(i)]$

4. Most probable state sequence backtracking: $q_t^* = \phi_{t+1}(q_{t+1}^*), t = T-1, T-2, \Lambda\ , 1$

Learning: If we define $\lambda = (A, B, \pi)$ to signify set of HMM, then the algorithm developed by Baum and Welch for signal processing application (see Rabiner, 1989) are applied to estimate the model parameters $\lambda = (A, B, \pi)$ that best explains the observation. Implementation of the forward-backward algorithm (Baum-Welch algorithm) works iteratively to improve the likelihood of $p(O \mid \lambda)$. This iterative process is the training of the model. The algorithm is calculated as follows;

1. Initialisation: Input initial values of λ and calculate $p(O \mid \lambda)$ using the forward algorithm.

2. Estimate new values of λ iterate until convergence:

calculate $\gamma_t(i, j) = p(q_t = s_t, q_{t+1} = s_j \mid O, \lambda)$ for each t, i, j using the current λ

$$\gamma_t(i, j) = \frac{\alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)} \tag{5}$$

(a) Calculate new λ parameter estimates using $\gamma_t(i, j)$.

(b) Calculate $p(O \mid \lambda)$ with new λ values.

3. Go to step 4 if two consecutive calculations of $p(O|\lambda)$ are equal. Else repeat iterations.

4. Output λ .

The parameters of the HMMs are estimated by using equation (3). Rabiner (1989) extensively describes the Baum-Welch procedure for parameter estimation, as well as the various implementation issues, are described in Rabiner (1989).

3.2. HMM for ATM card fraud detection

In this study, we propose an ATM card fraud detection system based on Hidden Markov Model, taking the cardholder's spending habit as our point of departure. Basically, we take three different spending profiles of the card holder into consideration [depending upon price range, named High (H), Medium (M) and Low (L)]. In this set of symbols, we define Y = {L, M, H} and N =3. The price range of proposed symbols has taken as low (0, N20,000], medium (N30,000, N90,000] and high (N100,000, up to ATM card limit). After finalizing the state and symbol representations, the next step is to determine different components of the HMM, i.e. the probability matrices $\lambda = (A, B, \pi)$ so that all parameters required for the HMM is known. These three model parameters are determined in a training phase using the forward-backward algorithm (Baum-Welch algorithm) Welch (2003).

Overall, the procedure of the HMM-based approach can be summarized as follows:

A. Training Phase

Step 1: Train the HMM parameters assuming a probability distribution for the counts for each (hidden) spending profile.

This is important phase of the fraud detection system. In this phase the HMM training starts which follow the following steps:

i. Initialization of HMM parameters
ii. Forward procedure
iii. Backward procedure

For training the HMM, we convert the cardholder's transaction amount into observation symbols and form sequences out of them. At the end of the training phase, we get an HMM corresponding to the cardholder.

B. Detection Phase

At this phase, the proposed model based on HMM will verify fraudulent transactions. It includes two modules as follows:

3.2.1. Clustering

Clustering algorithm is a learning algorithm for grouping a given set of data based on the similarity in their attribute (often called feature) values. The group formed by Mean Clustering algorithm is called cluster. The grouping is formed based on the square of distance and centroid of their data values.

Step 1. Compute the centroid of the cluster

Step 2. Compute the distance between the object to the centroid

Step 3. Grouping is done on the basis of minimum distance between each point.

After the HMM parameters are learned, we form an initial sequence of the existing spending behavior of the card holder. Let $o_1, o_2, \Lambda\ o_Q$ be the sequences of transaction done by the card holder, of length Q. This recorded sequence is formed from the cardholder's transactions up to time t. We put this sequence in HMM model to compute the probability of acceptance.

Let the probability be b_1, which can be calculated as follows.

$$b_1 = P(o_1, o_2, \Lambda\ o_Q)$$

Let O_{Q+1} be the new generated sequence at time t + 1, when a transaction is going to process. To form another sequence of length Q, we drop O_1 and append O_{Q+1} in that sequence, generating $O_2, O_3, \Lambda\ , O_Q\ , O_{Q+1}$ as the new sequence. We input this new sequence to the HMM and calculate the probability of acceptance by the HMM.

Let the probability of new Q sequences be b_2.

$$b_2 = P(O_2, O_3, \Lambda\ O_{Q+1})$$

Hence, we find the differences in both the old and new sequences to identify whether the transaction is genuine or not. That is,

$$\Delta b = b_1 - b_2$$

If $Diff\ b > 0$, it means that the new sequence is accepted by the HMM with low probability, and therefore, this transaction will be considered a fraudulent transaction if and only if percentage change in probability is greater than a predefined threshold value.

$$\frac{\Delta b}{\Delta b_1} > 0 \quad Threshold\ \ value$$

Otherwise, O_{Q+1} is added in the sequence permanently, and the new sequence is used as the base sequence for determining the validity of the next transaction so as to capture the changing spending behavior of a cardholder.

Additionally, the underlying distributions of the states which generate the observed time series (price range) are a priori unknown. Three distributions are of specific interest when we talk about modeling ATM card holder using the transaction pattern. They are as follows: The first HMM is based on the Poisson distribution, which is typically used to model counts. The second HMM uses the generalized Poisson distribution (Joe and Zhu (2005) that includes a further variance parameter to allow for a larger or smaller variation than the one

assumed for a standard Poisson distribution and the Gaussian based HMM. The Gaussian (or Normal) distribution is the most common (and easily analysed) continuous distribution. It is also a reasonable model in many situations.

In a HMM[Pois] one considers a sequence of discrete observation $\{Y_k\}_{k\geq 0}$ which are assumed to be generated from a sequence of unobservable finite state Markov chains $\{X_k\}_{k\geq 0}$ with a finite state spaces = 1, 2, …m, and the random variable Y_t conditioned on X_t has a Poisson distribution for every t ; when X_t is in state i $(i \in S_x;\ t \in M)$, then the conditional distribution of Y_t is a Poisson random variable with parameter λ_i; for any $y \in M$, the state dependent probabilities are given by

$$p_{ij} = p(Y_t = y \mid X_t = i) = \frac{e^{-\lambda}\lambda_i^y}{y!}$$

The generalized Poisson distribution has the density

$$p(x) = \lambda_1(\lambda_1 + \lambda_2 . x)^{x-1}\frac{\exp(-\lambda_1 - \lambda_2 . x)}{x!}$$

for $x = 0, 1, 2, \Lambda\ b$

with $E(X) = \frac{\lambda_1}{1-\lambda_2}$ and variance $\text{var}(X) = \frac{\lambda_1}{(1-\lambda_2)^3}$

The output probability distribution $b_i(o)$ of the observational data of state *i* can be discrete or continuous depending on the observations. In continuous distribution HMM for the continuous observational data, the output probability distribution is modeled by a mixture of multivariate Gaussian distributions as follows:

The Gaussian distribution with μ^i and covariance matrix $\sum^i$

$$b_i(o) = p(Y_t = y \mid X_t = i) = N(y, \mu^i, \sum^i)$$

4. Application of HMM in credit card fraud detection

4.1. Data

We apply the above-described methodology to model the ATM card fraud detection on last 100 transactions of a card holder and also calculate percentage of each transaction (low, medium and high) based on total number of transactions. Table 1 contains the transaction that is done by the customer. The amount that is spent by the customer based on which the transaction can be considered as genuine or fraudulent. The most recent transaction is placed at the first position and correspondingly first transaction is placed at the last position in the table and so-on.

Table 1. *List of transaction amount of different state*

No. of transaction	Amount	No. of transaction	Amount	No. of transaction	Amount	No. of transaction	Amount
1	6996	26	76891	51	59323	76	587
2	8126	27	78232	52	13392	77	10983
3	12075	28	498209	53	9907	78	5840
4	14478	29	299826	54	10311	79	12120
5	15460	30	442832	55	14748	80	4248
6	80864	31	112918	56	19972	81	13828
7	64953	32	19348	57	19780	82	4636
8	46779	33	10825	58	18316	83	10879
9	50736	34	12467	59	4748	84	2537
10	57514	35	15472	60	5942	85	393704
11	114475	36	2624	61	11004	86	118614
12	196502	37	5769	62	214973	87	68268
13	18975	38	7589	63	173755	88	68309
14	88842	39	4598	64	176584	89	56644
15	17995	40	9885	65	43282	90	36955
16	70722	41	5728	66	36000	91	9752
17	496551	42	61603	67	32856	92	17133
18	11709	43	44904	68	56183	93	8167
19	10924	44	40192	69	84947	94	1210
20	15174	45	88675	70	53091	95	13717
21	16395	46	46527	71	86288	96	11672
22	10303	47	50121	72	80385	97	7824
23	62787	48	83036	73	35119	98	10466
24	81386	49	74197	74	73916	99	16615
25	44722	50	38480	75	13635	100	4609

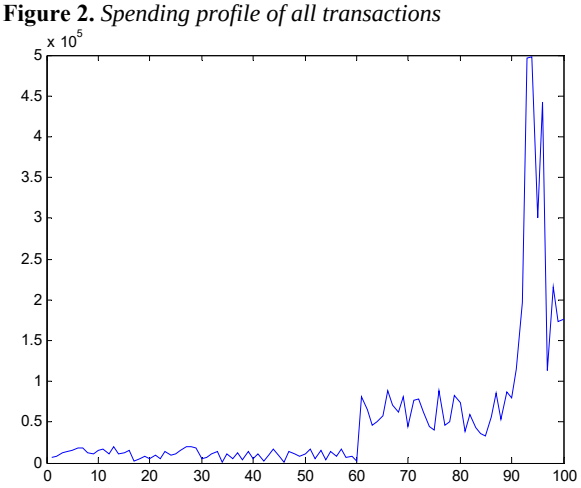
As indicated in Table 2, to find the observation symbols matching with the cardholder's transactions dynamically, we run a clustering algorithm Montague (2010) on the values of the cardholder's transaction with cl, cm, and ch as the respective centroids. It may be noted that the naira amounts (0, N20,000] have been clustered together as cl resulting in a centroid of 10797.94. The percentage (p) of total number of transactions in this cluster is thus 52 percent. Similarly, naira amounts (N30,000, N90,000] have been grouped in the cluster cm with centroid 61214.69, whereas amounts (N100,000, up to ATM card limit) have been grouped together in cluster ch with centroid 269911.9. cm and ch, thus, contain 36 percent and 12 percent of the total number of transactions.

Table 2. *Output of k-means clustering*

Cluster mean/centroid name	Cl	Cm	Ch
Observation symbol	$o_1 = L$	$o_2 = M$	$o_3 = H$
Mean value	10797.94	61214.69	269911.9
Percentage of total Transactions	52%	36%	12%

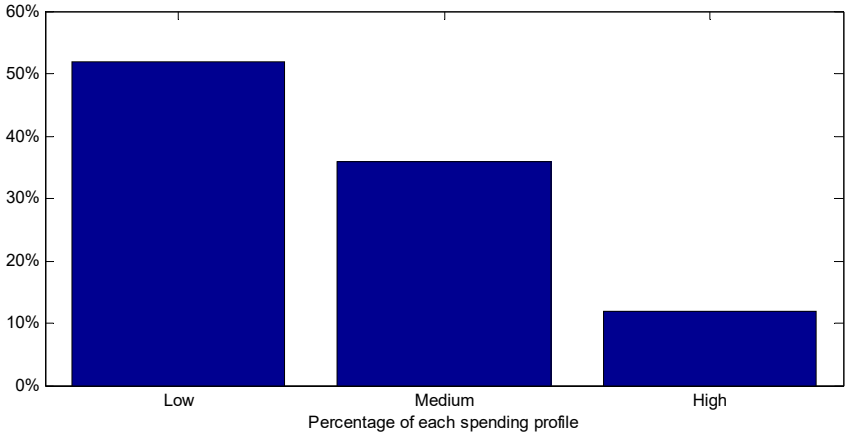
The pattern of spending profile of the card holder is shown in Figure 2 based on all transactions done.

Figure 2. *Spending profile of all transactions*



The percentage calculation of each transaction (low, medium and high) of the card holder based on price distribution range as mentioned earlier is shown in Figure 3.

Figure 3. *Spending profile of all transactions*



It has been noticed that low spending profile has maximum percentage of 52, followed by medium profile 36% and then 12% of high spending profile as per details of transactions in Table 1. Thus, we conclude that the user comes under the cluster 1 or he/she is in low spending profile.

4.2. Evaluation statistic-distribution comparison on technique based on poisson, Generalised Poisson and Gaussian distribution

By calculating the spending pattern of customer Fraud detection of incoming transaction by transition probabilistic calculation, HMM discovers whether the transaction is genuine or fraudulent.

Here, three distribution were used, namely Poisson, Generalised Poisson and Gaussian distribution. The performance of the HMM based on the Poisson distribution (HMM[Pois],

the generalized Poisson distribution (HMM[GenPois]) and the Gaussian distribution (HMM[Gauss]) for which optimal detection of patterns of anomalies is computed. If it justifies a predefined threshold value then the transaction is decided to be legitimate else declared as fraudulent. In other words, if it is not accepted by our proposed HMM with sufficiently high probability, then it would be a fraudulent transaction.

The performance of all three distributions was assessed in terms of sensitivity (i.e. the fraud detection rate) and false positive (i.e. the misclassification rate- MCR). All models are assessed via measures: "sensitivity" and "false positive". While sensitivity measures the number of correctly classified positive samples (e.g. fraud) as a proportion of all positive samples in the data, false positive calculates the number of negative samples.

Table 3. *Evaluation statistics distribution comparison*

Measure	HMM[GenPois]	HMM[Gauss]	HMM[Pois]
Sensitivity (%)	70.2	85.6	10
False Positive (MCR) (%)	29.8	14.4	90

Figure 4. *Spending profile of all transactions*

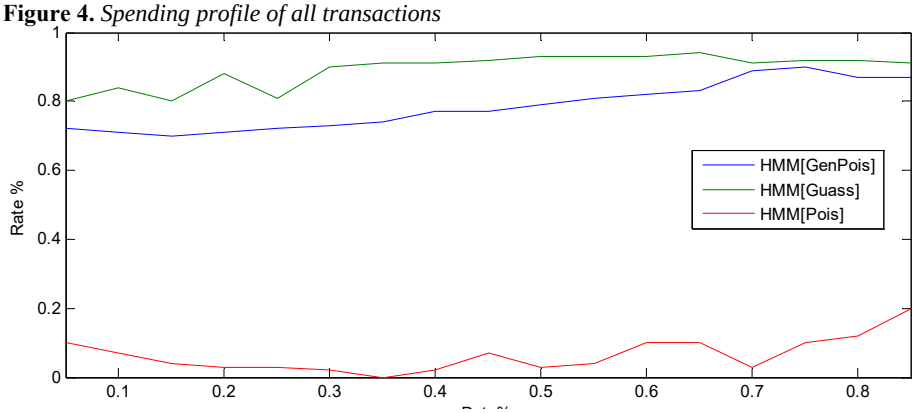


Figure 4 reveals how HMM[Gauss] outperforms both the HMM[GenPois] and the HMM[Pois] for the dataset. HMM[Gauss] and HMM[GenPois] attain 85.6% and 70.2% sensitivity consistently after seeing 40% of the database, whereas HMM[Pois] displays the lowest sensitivity rate of 10%. This result shows the ability of HMM[Gauss] search to employ link analysis to consistently detect fraudulent activity and focus on it as the dataset increases.

The MCR shows that less than 15% for HMM[Gauss] along with HMM[GenPois] with about 30% and the HMM[Pois] which shows the highest misclassification rate with about 90%; which means it misclassifies non-fraud samples frequently.

5. Conclusions

This study puts forward how HMM will facilitate to stop fraudulent transaction through ATM card. It modeled the sequence of transactions with a HMM based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]), and the Gaussian distribution (HMM[Gauss]) for which optimal detection of patterns of anomalies is computed using the forward-backward algorithm. The suggested estimation procedure

based upon the three distributions for the HMM model is used to construct a sequence of operations in ATM card transaction processing, and detect fraud by studying spending profile of the cardholder. If the transaction satisfies a predefined threshold value, then the transaction is confirmed legitimate; else, the transaction is declared fraudulent.

In our implementation, we took three observation symbols which are spending ranges of a cardholder that are low, medium, and high. To find the observation symbols corresponding to the cardholder's transactions dynamically, we run a clustering algorithm on the values of each cardholder's transaction with cl, cm, and ch as the respective centroids. An HMM is trained with forward-backward algorithm (Baum-Welch algorithm) for the cardholder.

The functions offered by MATLAB facilitated us to develop the techniques based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]), and the Gaussian distribution (HMM[Gauss]) for fraudulent ATM card use. The experimental result of the data analyses confirms that the proposed method is viable. The evaluation statistics are calculated to compare the fit of distributions. Of the HMM-based techniques, HMM[Gauss] proved to be the most suitable choice in detecting ATM card fraudulent transactions as demonstrated by the sensitivity value, having 85.6% sensitivity consistently after seeing 40% of the database and MCR value having the best MCR with less than 15%.

Furthermore, this research has

1. Introduced the a HMM techniques based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]), and the Gaussian distribution (HMM[Gauss]) and a strategy for estimation of the above models by using the forward-backward algorithm.
2. Utilized the forward-backward algorithm which makes it possible to construct a sequence of operations in ATM card transaction processing, and detect fraud by studying the normal spending behavior of a cardholder. Thus, provided easy and security to Online transaction.
3. Shown that the existing results (Mohdavesh et al., 2014) for dealing with the problem of fraudulent transaction using a HMM can be improved/extended using techniques based on the Poisson distribution (HMM[Pois]), the generalized Poisson distribution (HMM[GenPois]), and the Gaussian distribution (HMM[Gauss]).

Future research can be directed towards adding more parameters in addition to spending behavior and geographical location.

List of abbreviations

ATM: Automated Teller Machine
HMM: Hidden Markov Model
HMM [Pois]: HMM based on the Poisson distribution
HMM[GenPois]): HMM based on the generalized Poisson distribution
HMM[Gauss]): HMM based on Gaussian distribution (HMM[Gauss])
PGA: Peer Group Analysis and
BPA: The Break Point Analysis
FDM: Fraud Density Map

QRT: Questionnaire-responded transaction
FI: Financial institution
TCP: Classify transmission control protocol
SOM: Self Organizing Map
DBSCAN: density-based spatial clustering of application with noise
CD: Communal Detection
RMP: Risk Management Pipeline
AIS: Artificial Immune System
CART: Classification and Regression trees
FFML: financial fraud modeling language
PIN: personal identification number
OSPCA: oversampling principal component analysis
ANN: artificial neural networks (ANN) and
BBN: Bayesian belief networks

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Portfolio selection problem: Issues, challenges and future prospectus

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Abstract. *Portfolio management is the process of deploying funds in returns earning avenues. Portfolio selection is a process of construction of portfolios by selecting assets from the stock market with the aim of highest returns on least risk simultaneously. This paper presents the insight on portfolio selection history issues and challenges which are faced by investors while making investment decisions. It also discusses prospects that will be available in the future to investors.*

Keywords: portfolio selection problem, expected return, risk, modern portfolio theory.

JEL Classification: G1, G110, G120.

1. Introduction

The art and science of selecting an investment combination and approach is known as portfolio management, matching investments to objectives, allocating funds for individuals and organizations, and managing risk and return. Portfolio management is all about identifying strengths, limitations, opportunities, and challenges in the trade-offs of debt vs. equity, domestic vs. foreign, development vs. protection, and a slew of other trade-offs in the quest to maximize return while minimizing risk.

Portfolio management offers the following advantages to investors

Makes right investment choice. Portfolio management facilitates the investor in selecting the appropriate asset mix. It allows for more precise decisions about investment strategies that are in line with the objectives and objectives.

Maximizes return. One of the most critical functions of portfolio management is to maximize returns. It offers a formal system for conducting assessments and deciding on the best asset class. With limited funds, investors can receive high returns.

Averts disaster. Portfolio management averts the disaster of investors taking big risks. Rather than investing only in one asset class, it advises on diversifying one's portfolio. If an investor invests in only one form of security and that security fails, the investor would incur significant losses that could have been prevented if he had invested in a variety of assets.

Monitor performance. Portfolio management aids management in measuring the performance of their investment portfolio. A portfolio's consolidated investment can be analyzed more objectively, and any deficiencies can be found very easily.

Liquidity management. Portfolio management helps investors to arrange their assets in a structured way. Investors should choose assets in such a way that they can easily sell any of them when they need cash.

Decreases risk. Investing in stocks is risky due to the market's uncertainty, which raises the risk of losses. Portfolio management aids in risk reduction by distributing risk across a wide number of securities.

Enhances financial understanding. Portfolio management aids in the enhancement of investors' financial knowledge. They came across various financial principles and learned how a financial market functions when managing their portfolio, which will improve their overall financial understanding.

Limitations of portfolio management

Risk of over diversification. Fund managers often invest in broad categories of assets over which they have little control. In his attempts to diversify risk, he goes beyond the point that he can handle effectively. The risk of loss in such circumstances is very high, and it can have severe consequences.

No downside protection. Portfolio management decreases risk by diversifying it, but it does not offer complete protection. The definition of portfolio management becomes redundant during market downturns.

Inaccurate forecasting. Portfolio management evaluates the returns of securities for investment purposes using historical evidence. Sometimes the historical data gathered is inaccurate or unreliable, resulting in inaccurate forecasts.

Portfolio management process

Portfolio management is a complicated process that covers the following activities below.

Defining investment practices and constraints. Investors' usual targets are current income, capital appreciation, and principal security. It is necessary to specify the relative value of these goals. It's also necessary to specify liquidity, time horizon, tax, and special circumstances constraints. Objectives of portfolio management are Return, income, growth, stability with a minimum level of risk. There are some factors affecting risk i.e. financial situation, temperament. Constraints of investment management are Liquidity, Investment horizon, Taxes, Regulation, unique circumstances.

Capital market expectations quantification. To tackle the asset-mix issue, we need long-term returns and risk estimates for different asset types. Put differently, we have to quantify capital market expectations.

Asset mix selection. The selection of asset mix is the most crucial decision in investment management. This is a general term that refers to the proportions of financial assets in a portfolio. The optimal mix of financial assets is primarily determined by the investor's risk tolerance and investment horizon.

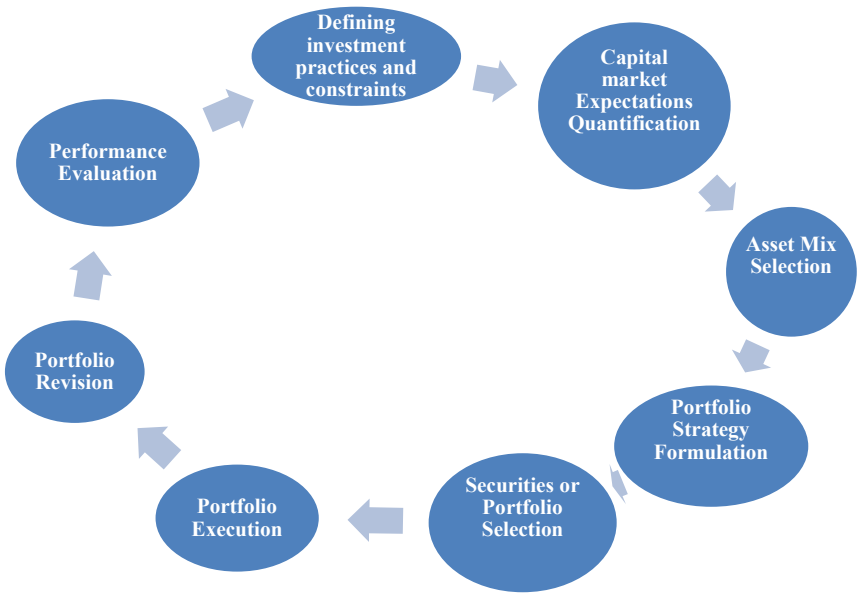
Portfolio strategy formulation. Following the selection of an asset mix, a portfolio strategy must be formulated. The two options are an active and a conservative investment plan. An active portfolio plan seeks to achieve better risk-adjusted returns by restoring the timing of the market, rotating sector, selecting security, or any combination of these. A passive investing approach, on the other hand, involves maintaining a well-diversified portfolio while limiting risk exposure.

Securities or portfolio selection. When it comes to security selection, most investors take a proactive approach. Fundamental analysis and technical analysis are widely used by investors when selecting stocks. When selecting securities, maturation yield, credit score, and conditions at maturity, tax haven, and cash conversion ability are all factors to consider.

Portfolio execution. It is the part of investment management where you bring your portfolio plan into practice by trading individual securities in a predetermined proportion.

Portfolio revision. As equities and bonds fluctuate not only the valuation of a portfolio but also its mix, or the relative proportion of equities and debt elements, will become different. Periodic readjustment of the portfolio is needed in response to such changes.

Performance evaluation. A portfolio's performance should be measured regularly. Risk and return are the two most important variables to consider when assessing a portfolio's efficiency, and the key question is whether the return on the portfolio is proportional to the risk it entails. An analysis like this could offer valuable input for improving the portfolio management process regularly.



Portfolio management process

This paper is divided into five sections. The first section introduces portfolio management. Section two briefs about portfolio selection and its historical background. Section three briefs about the methodology used in the paper. The next section examines various issues and challenges faced by investors in portfolio management. Next section proposes future opportunities those will be available to investors in near future. The last section concludes the paper.

2. Portfolio selection problem

Portfolio construction aims to create a portfolio with the highest return and the lowest risk. The optimum portfolio is a portfolio that meets all of these criteria. Portfolio selection is the method of determining the best portfolio. Generally, a rational investor maximizes the expected return level for a given risk level or minimizes the risk for a fixed expected return level.

The mathematical formulation is given below-

To maximizing the return for a given level of risk:

Max E $[W_1X_1+W_2X_2+\ldots+W_nXn]$

With subject to

$W_1+W_2+\ldots+W_n = 1$

$W_i \geq 0$, i = 1, 2, …, n,

where:
E = expected return of portfolio.
W_1 = Proportion of security 1 in portfolio.
W_2 = Proportion of security 2 in portfolio.
$X_1, X_2, \ldots, X_n$ = return of individual security.

To minimize the risk for a given level of return

$$\text{Min } \sigma 2p = \sum_{i=1}^{n} . \sum_{j=1}^{n} . \text{WiWj } \sigma ij$$

where:
$\sigma^2 p$ = Portfolio variance.
Wi = proportion of funds invested in security *i*.
Wj = proportion of funds invested in security *j*.
σ_{ij} = The covariance between the pair of securities *i* and *j*.
n = Total number of securities in the portfolio.

3. Constraints of portfolio selection problem

Cardinality constraint: cardinality constraint is a constraint that restricts the number of assets in a portfolio in this is assumed that there is a fixed transaction cost on each item in a portfolio, this limits on the total number of assets in the portfolio. It also sets lower and upper limits on the amount that can be invested in each item.

Boundary constraints. Boundaries constraints include the lower and upper limit of money that can be invested in a portfolio, this is represented by a feasible set of portfolio boundaries called efficient frontier of portfolio selection. The efficient set of portfolios was defined as those that fell between the global minimum variance portfolio and the maximum return portfolio on the efficient frontier boundaries.

Transaction cost. The capital asset pricing model assumes that there is no transaction cost for validation of CAPM but in practice, this is not possible because every transaction in the stock market includes some charges. This encompasses commissions paid to stockbrokers for performing stock transactions and booking fees charged while buying tickets to a concert. Travel cost and the time it takes to complete a transaction are also examples of transaction costs. This transaction cost affects portfolio selection, therefore, should be considered by investors while investing their funds.

Transaction lots. The transaction lot includes the minimum number of shares that can be traded in the stock exchange. Transaction lots are created to avail of the investment opportunity to all classes of investors. The worth of each transaction lot equal to

$T_c = N_i . P_i$
where:
T_c = worth of each transaction lot.
Ni = number of minimum units of security *i* in a lot.
Pi = market price of security *i*.

Liquidity constraints. Liquidity refers to the ability to convert in cash. Portfolio liquidity is the ability to adjust positioning in a portfolio in response to changing market conditions. There are three ways liquidity constraints in portfolio selection, first one is pre-filtering means only assets with defined minimum liquidity should consider in portfolio selection. The next constraint is an individual constraint on an asset, which takes into account the financial value assigned to each asset in the portfolio. The maximum amount that can be invested in a particular asset is determined by its liquidity. Last but not least, weighted average liquidity considers the weighted average liquidity of assets in a portfolio.

4. Background

Before 1952, diversification existed; however, there was no suitable investment theory that looked at the impact of diversification when risks are correlated, differentiated between good and bad portfolios, and calculated risk-reward trade-offs across the entire portfolio.

Markowitz introduced the predicted return (mean) and variance of return (V) of the portfolio as parameters for portfolio evaluation in a 1952 article on portfolio selection, both as a potential surmise and as an axiom about possible behaviour. Markowitz was named the "Father of Modern Portfolio Theory" as a result of his work. For this work, he received the Nobel Prize in Economics in 1990.

Roy (1952) also suggested making decisions based on the portfolio's overall mean and variance. He suggested picking a portfolio that maximizes the E-F/D ratio. Where; E = expected return of the portfolio F = fixed return and D = standard deviation of return.

Tobin (1958) showed that the proportion of risky stocks in productive portfolios with any cash is always the same for a given set of means variance and covariance. He was interested in the money market rather than other financial assets. “Monetary assets are those that are marketable, have a fixed monetary value, and are not subject to default risk”. The risk associated with monetary assets was market risk rather than default risk.

Tobin and Sharpe (1964) proposed a model with n risky and one riskless safe, which is similar to Tobin (1958).

Hicks (1962) derived the Tobin conclusion that among portfolios that include cash, there is a direct relationship between portfolio return and risk, and the proportion of risky stocks remains static along this linear portion of the efficient frontier.

Hicks (1935) made no distinction between productive and poor portfolios, didn't draw an efficient boundary, and didn't even hint at a theorem that all effective portfolios that involve cash have an equal proportion of risky assets.

The deterministic calculus approach is sufficient for determining how to maximize a consumer utility under budget constraints. Making a decision under uncertainty is part of portfolio selection (Marschak, 1938).

Investors diversify their investments among all securities that have the greatest anticipated return. The rule of large numbers would ensure that the portfolio's real yield is virtually equal to the estimated yield (Williams, 1938).

Leavens discovers the use of a covariance model and how it can be applied to the investment process. He did not, however, include it in his thorough investigation.

The present study deals with the review of "issues challenges and future prospectus of portfolio management. The number of studies based on expected return and portfolio risk from the domain has been presented in this section.

A mathematical formulation of the problem is needed for a formal approach to making investment decisions in order to obtain an optimum portfolio with a specific goal. The mathematical validation of the models is unquestionably difficult and necessitates extensive information. Mathematical models are often validated using computational models and algorithms using empirical evidence as computational capacities and data volumes increase. This part, standing on the shoulders of giants, will examine their research by presenting a literature review of conceptual advances and mathematical techniques to the issue.

Given the broad range of advances in the field of computational sciences, the study and empirical validation of mathematical and statistical models are geared toward examining these expanded computational capacities, in terms of multiple computation paradigms, high-performance computing technology, and methodical simulation techniques. The remainder of this section's literature focuses on general computational advances rather than numerical forms of the investment objective function. Traditional numerical methods for analytical and non-analytical measurements, probabilistic modelling via simulation investigating multi-period hypothetical conceptions, probabilistic modelling and probabilistic optimization using information retrieval methods, genetic computational methods and swarm optimization using inhabitants quantitative growth, and stochastic optimization via simulations exploring multi-period scenario generations, as well as stochastic optimization via simulations exploring multi-period scenario generations are among the advancement.

Modern portfolio theory by Markowitz (Markowitz, 1952) is widely regarded as a defining moment in asset allocation and portfolio optimization. It takes rational investors into account and models the problem using the mean-variance analysis process, which reduces the portfolio's variance by setting a specific value for the estimated return. The model also assumes that the economy has no taxation or transaction costs that short trading is illegal and that securities are indefinitely separately and can be exchanged with any positive fractions. Markowitz said that investors should opt for an efficient portfolio. He said there are techniques to compute efficient portfolios subject to expected returns and covariance between security returns, but he did not explain these techniques in this article.

To solve the quadratic model Markowitz used the critical line technique subject to linear constraints. This technique is also used in the computation of efficient portfolios (Markowitz, 1956), this process yet requires very much time and calculations.

William Sharpe developed a model which can analyze a large number of securities at an extremely low cost. He used few parameters to study the relationship between security returns. It also requires low cost and less information. This model simplifies the complexities of the Markowitz model. This model is called as “single index model” (Sharpe, 1963).

Return on securities can be divided into two parts, risk free return means return available on securities that are free from risk. The best measure of the risk-free rate is the return on zero beta portfolios. The market risk premium, which is the difference between the average return on security and the risk-free return, is another example. This model is called Capital Asset Pricing Model, which says No one can earn abnormal returns because the market is perfect (Sharpe, 1964).

CAPM has wide acceptability in the finance world but it has some challenges. Even after adjusting for risk as calculated by beta, it is possible to depend on certain firm or security characteristics and gain superior returns. Financial economist felt there are some other factors besides market beta which affect security returns. Stephan Ross developed the arbitrage pricing theory that can include any number of risk factors. The market realized return is influenced by a number of factors such as GDP, inflation level, corporate profitability, investor sentiment, etc. Further, these factors affect different groups of stocks in different ways. So, one could specify the expected and realized returns on individual stocks as a function of different fundamental economic factors (Roll and Ross, 1980). Portfolio optimization based on historical security returns includes estimation error, which can weaken a portfolio's desirable properties. A Bayesian framework is introduced to address estimation error. Portfolio selection in this context is based on maximizing expected utility by the use of probability distributions of security returns. By adding an insightful prior that lowers estimation risk, portfolio performance can be improved. All securities have the same estimated returns, variances, and pairwise correlation coefficients according to an insightful prior. To mitigate estimation error, prior measurements of each stock’s average return, volatility, and pairwise coefficients of correlation are derived toward the expected yield, average volatility, and average correlation coefficient of the

entire population, respectively (Frost and Savarino, 1986). Portfolio selection may be undertaken at the international level to take advantage of the possible benefits of international diversification when exchange rates are flexible. Exchange rate uncertainty is a largely undiversifiable factor that has a harmful impact on international portfolio results.

To control exchange rate volatility, Cheol S. Eun and Bruce G. Resnick employed two types of exchange rate reduction at the same time the first one was multi-currency diversification and the other was hedging via forward exchange contract. Their results show that foreign portfolio selection strategies that manage both approximation and exchange risks outperform domestic portfolios in the United States almost every time (Eun and Resnick, 1988).

A basic linear programming problem can be used to determine an optimal portfolio. It employs the minimum return as a risk indicator, and in this approach, a portfolio is opted that minimizes the total risk over all previous measurement periods for a particular rate of return. The logical problem of a quadratic utility function suggested by the mean-variance model is solved by this function. When we treat portfolio selection as a linear optimization model, we can always constrain decision variables to be integers, or 0-1, values, making it simpler to use more complicated judgment models, such as those with fixed transaction costs and Boolean-type constraints (Young, 1998). Expert knowledge in portfolio selection can be identified by possibility distribution. Upper and lower probability distributions are the two types of possibility distributions. Quadratic programming problems are used to formulate portfolio selection models based on these two types of distributions. It was found that upper possibility distribution portfolios perform better than lower possibility distribution, in this case, portfolio risk is defined as the difference between the spread of returns of upper and lower possibility distribution portfolios (Tanaka and Guo, 1999).

For selecting portfolios at a large scale Baye's theorem of statistics is used, This approach applies to portfolio sorting problems at the large scale where the number of potential holdings is large in relation to the estimation time given by historical data. In this study, the authors used the S&P 500 index as a benchmark index and discovered that portfolios sorted by them outperformed the benchmark index (Polson and Tew, 2000). Lubos Pastor used a Bayesian method to assess portfolio selection, which included a previous level of trust in an asset pricing model. They propose a method for calculating optimal weights in an asset pricing model when there is a nontrivial level of prior trust. They evaluated the value and size effect on US data and also evaluated Fama French book to market portfolios in tandem with the market (Pastor, 2000).

Selection of portfolio is a common multiobjective problem; for private investors, an optimal portfolio can be selected based on liquidity, risk, and return. These targets were dealt with in fuzzy terms, fuzzy goal programming approach was applied to solve this problem (Arenas et al., 2001). A simulated annealing method can be used to solve the portfolio selection problem; this method is a mixed-integer quadratic programming problem that occurs in the Markowitz model (Crama and Schyns, 2003). When Gorden and Alexandre used the mean-variance model to compare VaR and CVaR constraints on

investment choice, They discovered that if the CVaR and VaR bounds converge, a CVaR constraint is more beneficial than VaR for a given confidence level, but that in the non-existence of risk-free security, it has the detrimental effect of forcing highly risk-averse agents to choose portfolios with higher variance (Alexander and Baptista, 2004).

Traditional quadratic or linear programming models are used to solve portfolio selection problems; however, the solutions obtained by these models are difficult to implement. Based on the fundamental model of 1952, three alternative models for portfolio selection problems with minimum transaction lots are presented, along with a genetic algorithm for finding a solution. The empirical results show that the proposed algorithms generate portfolios that are very similar to the efficient frontier, meaning that the presented approach can produce near-optimal and technically practical remedies to the portfolio selection problem in a reasonable period (Lin and Liu, 2008). When the mean value and variance are the same, investors prefer a portfolio return with a higher degree of asymmetry, according to a number of studies. The skewness concept is used to measure the asymmetry of fuzzy portfolio returns as the third central measure, and fuzzy simulation is developed for empirical studies (Xiang et al., 2010). The fuzzy portfolio selection problem can be solved using a proposed method of different interest rates for borrowing and lending. In this model, investment risk is assessed using the possibilistic semi absolute variance of the return (Chen et al., 2011). Ana González · Gonzalo Rubio studied the effect of liquidity on portfolio selection; they discuss how to introduce liquidity in the mean-variance model; found a strong effect of liquidity on portfolio selection (González and Rubio, 2011).

A holistic approach for stock analysis and portfolio selection was presented in which fuzzy set is used for stock evaluation and to deal with financial market and behaviour of investors (Kiris and Ustun, 2012), multifactor capital asset pricing model for financial portfolio selection is used (Dicle, 2013), Possibilistic Sharpe Ratio Based Portfolio Selection Model was presented in which possibilistic mean and possibilistic variance is used for selecting portfolio (Bhattacharyya, 2013), inverse portfolio problem with mean deviation model was solved (Grechuk and Zabarankin, 2014), DEA cross efficiency evaluated in portfolio selection in Korean stock market and found that proposed model outperform benchmark (Lim et al., 2014), Although the Markowitz model assumes that investors are rational and homogeneous, irrationalities, over and under reaction, and mental accounting have all been demonstrated in investors; portfolio selection was solved considering these variables and new model was proposed and it showed promising results in relation to market and mean-variance model (Chang et al., 2015), Two volatile assets with evenly distributed returns can be chosen for an investment portfolio (Kibzun and Ignatov, 2015), The financial market is viewed as a network, stocks are nodes, and returns are linked by connections, according to a network approach to portfolio selection. Under the Markowitz system, they show that the significance of assets in this financial market network has a negative relationship with their optimum proportion (Peralta and Zareei, 2016); Mean-downside Risk-Skewness model solves three objective portfolio optimization problems. It considers the multifaceted nature of the portfolio selection problem as well as the needs of investors to optimize the portfolio's expected return, risk, and skewness while keeping budget and cardinality

constraints in mind (Saborido et al., 2016), estimation of covariance matrix of Markowitz model is done by non-linear shrinkage estimator, this nonlinear shrinkage estimator is asymptotically optimal for portfolio selection when the number of assets is of the same magnitude as the sample size, with historical stock returns it perform better than previous models (Ledoit and Wolf, 2017), for online portfolio selection transaction cost optimization was proposed (Li et al., 2018), a new bi-objective portfolio selection is proposed in which Sharpe ratio and Value-at-risk were selected as objectives, Sharpe ratio is an important non-systematic risk measurement that tests the investment risk by aspiring the diversification of the capital allocation and Value-at-Risk measures the systematic risk, this model is solved using multi-objective genetic algorithms (Kar et al., 2019), a hybrid approach for portfolio selection was introduced with skewness and kurtosis as third and fourth order moments, model was tested on shanghai stock exchange returns provides better results than traditional (Chen et al., 2020).

5. Research methodology

The research design used for the study is of the descriptive form, which meets the requirements of the study's objectives. This research design was chosen in order to enhance the precision and scope of the research sample. The analysis relies on secondary data from articles, journals, books, and websites.

6. Issues and challenges of portfolio selection

In this section, some of the issues faced by the various stake holders in the stock market are listed and explained in detail as follows:

- *To determine expected return of portfolio.* The estimated return of the portfolio is calculated using a weighted average of the returns of the portfolio's individual securities. Weight is the percentage of the security in that portfolio.

Constraints

The proportion of security in the portfolio should be non-negative: A portfolio consists of many securities. The risk of the portfolio will be diversified as many as securities in a portfolio, but while selecting security investors should remember that portion which is invested should not be negative.

$$Xi \geq 0$$

The Sum of weights should be 100. The sum of proportion invested in all securities should be equal to 100.

$$\sum W_{i=0}$$

Risk of portfolio. Variability of return is called risk of security. The portfolio's variance or risk is higher than the weighted average of the individual securities' variances. The

covariance of return must also be considered, which evaluates the association between each stock in the investment lot and any other stock.

Diversification should be applicable. Diversification is the method of mixing securities in a portfolio. Diversification tends to lower overall risk while maintaining portfolio return.

A feasible set of portfolios. By combining a small number of stocks in various proportions, a large number of portfolios can be created. These are the various portfolios into which an investor could invest. The word for this is portfolio opportunity setup.

An efficient set of portfolios. Portfolio with maximum expected return and minimum variance known as an efficient portfolio. This is unlikely to get a portfolio that has both features simultaneously, therefore portfolio should be selected by the following criteria:

- An investor would prefer the lower-risk option between two portfolios with an equal estimated return.
- If an investor is provided two portfolios of the same risk, he will opt for one with a higher expected return.

Assumptions of the above criteria

- Investors are rational; they would go for a higher return over a lower return, for example, two securities A and B are offering 15% and 17% respectively. In this case, investors would prefer security B.
- Investors are risk-averse; they would select lower risk over a higher risk; for example, there are two securities A and B having risk associated with them 5% and 7% respectively; an investor would go for security A.

All of the above issues were taken from the fundamental work of Markowitz's portfolio selection. This selection model has the following limitations

- *Calculations require a significant amount of input data*. For each pair of assets in the portfolio, a holder of the portfolio must obtain estimates of all securities' returns and variances, as well as return covariance.
- *Computations required are numerous and complex in nature*. There is a problem with identifying an effective portfolio since it necessitates the use of quadratic programming, which is a difficult technique.
- *To compute the technique for a set of efficient portfolios.* In the 1952 paper Markowitz suggested an efficient frontier for selecting an efficient portfolio. This computing technique is presented in 1956 work. Adoption of this technique can be used for problems of maximizing or minimizing quadratic forms subject to linear constraints (Markowitz, 1956).
- *Model of the relationship among securities and with market.* There is some relationship among the return of securities. This relation can be found by the covariance of return among the securities; Markowitz does not provide any method for that, Due to this relation risk of the portfolio cannot be zero. William F. Sharpe provided a model for this in 1963. This made Markowitz's portfolio analysis more practical. Simplification is achieved through index models.

Single index model

The single index model is based on the idea that stock market fluctuations affect all stocks. As the market rises, most share prices rise, and when the market falls, most share prices decline. This implies that a common reaction to market changes may be one cause why security returns are correlated and co-movements exist between them.

To investigate the co-movement of stocks with a market index, a simple linear regression analysis with the returns on individual shares taken as the dependent variable and the returns on the market index as the independent variable may be used.

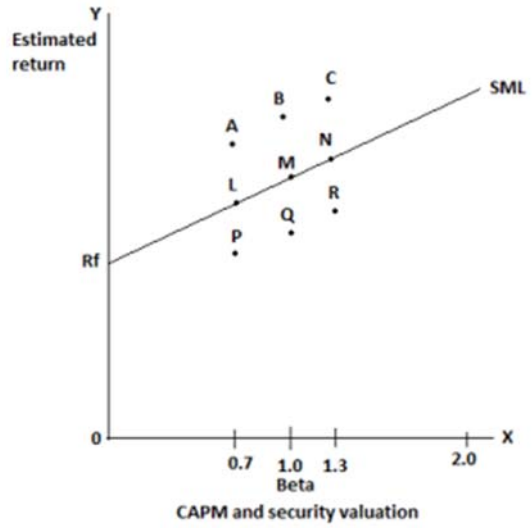
By neglecting the covariance of each security with each other security and replacing it with the relationship of each security with a benchmark, William Sharpe proposed a satisfactory simplification of the data inputs and data tabulation needed for the Markowitz model of portfolio selection. The Single index model calculates the market index. The Sharpe index model is what it's called.

Relation of security return with other factors

Stocks shift together due to a variety of factors other than the market return. *Multi-index models* try to figure out what non-market variables cause securities to shift in lockstep. There are economic factors that account for common stock price movement. Inflation, real economic growth, interest rates, and exchange rates are examples of these causes.

A multi-index model adds these variables as an external independent variable to a single index model.

Systematic risk. Investor diversifies his portfolio to reduce risk. Risk can be minimized but not removed by diversification; even a portfolio of all available securities in the market has some risk. Since it affects all of the securities in the market, this risk is known as *market risk or systemic risk*. This is demonstrated by a security's vulnerability to market fluctuations, which is calculated by the security's beta coefficient. The *capital asset pricing model* defines the relationship between a security's potential return and its systematic risk.



CAPM and security valuation

▪ *Perfect competition.* There is a challenge in portfolio selection that the relationship of security return with systematic risk will apply only in perfect competition. This means that investors in total determine prices by their actions. Features of perfect completion are as follows:

a) A large number of buyers and sellers: Both buyers and sellers are numerous. In perfect competition, so that individual is not able to influence the price of market or production.
b) Product homogeneity: Each firm should produce and sell a homogeneous product such that no buyer has a preference for one seller's product over another. If the products are all the same, the price would be the same everywhere.
c) Free entry and exit of players: There is free entry and exit of business entities in the perfect competition so that no one is able to earn abnormal profits. If in any industry there are abnormal returns more firms will enter that industry and profits will reduce to normal, on the other hand, if any industry suffers losses some firms will leave the industry.
d) Full market awareness: Since market prices are uniform, buyers and sellers have a complete understanding of the prices at which commodities are offered and purchased.
e) Ideal mobility of production factors and products: Goods and factors should be able to move freely between industries. Goods should be able to migrate to the highest-paying markets.
f) Absence of price control: There is no price regulating authority in perfect competition. Prices are decided freely by market forces of demand and supply conditions.
g) No selling cost: Since there is price similarity perfect knowledge therefore no need for advertising of products.

Short sale. A short sale is when a seller sells an asset or stock that he or she does not own. It's a deal in which an investor sells borrowed securities in expectation of a price drop, with the seller obligated to return an equivalent number of shares at a later date. A seller, on the other hand, owns the security or stock in a long position. CAPM is applicable in case of investor can short sell.

Risk-free assets. Portfolio theory is concerned with a volatile asset portfolio. It is later believed that a risk-free asset is available for investment. A risk-free asset is one with a guaranteed return, such as government bonds; the risk associated with such security is zero. An investor can put a portion of his money into a riskless asset, which is the same as lending at the riskless asset's rate of return. He would be putting his money into a mix of volatile and risk-free properties.

Security pricing behaviour in a multifactor framework. Modern securities market is a complex phenomenon involving the simultaneous operation of many factors. These all factors play an important role in the return generating process. Arbitrage pricing theory is such a model which attempts to explain security pricing behaviour in a multifactor framework. These factors may be growth in GDP, inflation, change in interest rate, etc. The impact of a specific factor on a specific security return is measured by the factor-specific beta coefficient.

Identification of factor structure. APT proposes that a set of multiple factors is needed to explain security return and security pricing. But the theory does not identify the factor structure that affects security returns. Identifying the factor structure is a serious challenge in the application of the APT model for asset pricing.

Probability distribution. Knowledge of the probability distributions of common stock returns is needed both as input information for asset selection procedures and as a benchmark for evaluating the performance of these asset selection models. Security return is uncertain so probability must be used where the outcome is uncertain (Breen and Savage, 1968).

Yield to maturity. This factor is under consideration while selecting fixed-income security. It is the rate of return that an investor will receive if he invests in a fixed income investment and retains it until it matures. At the time of the end of the maturity period investor gets repayment of capital. The investor has to decide whether he should go which security.

Default risk. Default risk refers to the possibility that a corporation or person may be unable to meet their debt obligations' payment obligations. Almost all types of credit extensions expose lenders and investors to default risk. A higher required return and, as a result, a higher interest rate is correlated with a higher level of risk. At the time of selecting fixed-income security, investors should access the risk of default. He can look at the credit ratings. If no rating is available, examine relevant financial ratios of the firm and access the general prospectus of the related industry.

Tax savings. Investment in debenture, bonds, etc. provides tax savings to investors. In past years several avenues offered tax savings, but very few do so. Debenture and bonds provide interest and it is deductible at the time of calculating profit and losses for the enterprise. Tax is payable at a profit after interest therefore it saves tax payment which is not available to shareholders as they get voting right in management and dividend which is the appropriation of profit not charge to profit.

Liquidity. Securities that pay a fixed return may be transformed entirely or partially into cash at a moment's notice, resulting in high liquidity. Liquidity is the degree to which an asset can be converted into cash quickly. Sometimes an investor can need cash before the maturity date, at that time he can sell his investment at minimum loss. This can be called flexibility to convert into cash.

Mean-Absolute deviation. Portfolio performance can be measured by absolute deviation instead of standard deviation as a measure of risk. Many difficulties of the Markowitz model can be removed by using this model such as a large amount of data etc. while maintaining its advantages. In this method, returns are calculated by mean but the risk of security is calculated as the standard deviation of returns.

Peer firm's earning predictability. Stock selection depends on the earning capacity of peer firms. Peer firms are those firms that have similar features and objectives. If a company offers initial public offer investors can anticipate the return from its peer performance. Peer

firm financial statements can be analyzed for that purpose. A comparative study can also be done. Some of the strategies that can be used for it are trend analysis, comparative statement, common size statement, ratio analysis, cash flow statement, and fund flow statement.

Market timings. Market timing is a trading or investment technique. It is the act of entering or exiting the financial market, as well as the selection of asset classes based on future forecasting methods**.** These forecasting methods are both quantitative and qualitative. Qualitative methods include jury of executive opinion, salesforce opinion, expert opinion, etc. The quantitative technique includes time series analysis, moving average. Investors have to keep in mind the various price and return forecasting techniques while selecting securities for the portfolio.

7. Opportunities or future prospectus of portfolio selection

Despite many challenges, there are many areas of future prospect for the problem under study. These areas are as follows:

- *Factor structure may be identified.* As stated earlier APT does not provide the structure of factors affecting security returns. Studies may be done to identify this structure.
- *Stability of factors.* Empirical studies can be done on the stability of factors over time. To know whether the factor affecting security returns and price are stable over time or not, if not researcher should try to find out the reason behind it. Does the same set of factors explain security returns and prices at different points in time?
- *Midyear performance.* In the past portfolios are evaluated based on performances at the end of the financial year or year. Nowadays there is a new way to measure performance is midyear performance, a portfolio can be revised, risk can be shifted in the second half of the financial year (Lee et al., 2019).
- *Penny stocks.* Penny stocks are those that have a high risk, low liquidity, and a high knowledge gap. When penny stocks are included in a portfolio, it produces a higher return than conventional models. Penny stock price ranges could be separated into various groups in the future study, and the peculiar characteristics and instability of penny stocks, such as transaction abnormalities and abrupt price peaks, could be thoroughly studied (Song and Park, 2019).
- *Equity crowdfunding*. It's a modern investment format in which investors can buy unlisted shares from a business that doesn't meet the criteria for an initial public offering. It has benefits, but it also has the possibility of fraud, hearings, insolvency, and shareholder equity dilution. Regulation is a natural response to negative externalities such as systemic risk and adverse selection induced by asymmetric information (Lee, 2019).
- *Online portfolio selection.* Online portfolio selection includes receiving financial data and making portfolio selection through an online platform. The benchmark approach is the first of four strategies for choosing an online portfolio. The second strategy is to pursue the winner, which means that more profitable assets will continue to do well in

the future and will be given more weight in the portfolio. The third strategy is to pursue the losers, believing that the best-performing assets will not continue to perform well in the future and increasing the weight of low-performing assets in the portfolio. Last but not least, there's the pattern matching strategy, which makes portfolio decisions based on similar patterns rather than explicit instructions? In the future, more advanced artificial intelligence techniques and machine learning to improve portfolio performance can be introduced in this area (Gaun and Zhiyong, 2019).

- *Market timing and global portfolio performance.* Many studies have been done regarding the relation of market timing and the Indian stock market but there is a need to evaluate the performance of portfolios at a global level in relation to market timing. Studies would be done about the superior timing skills of foreign institutional investors. A study about the security selection skills of foreign institutional investors may be conducted (Badhani and Kumar, 2019).
- *Deep learning technique.* The portfolio selection problem can be solved by neural network technology. For this learning-based strategy for optimum selection is used. In the future deep learning technique can be applied for the prediction of volatility (Chen and Ge, 2021).

8. Conclusion

Portfolio management is choosing the right mix of assets that have the highest expected return and minimum risk. Portfolio management began with Markowitz's modern portfolio theory. His work is extended by William Sharpe and Stephan Ross and many others. It has many issues like diversification and a feasible set. Security return depends on market return and other economic and political factors. Investors face challenges like systematic risk which cannot be diversified. Investors have to be also decided about tax saving and liquidity. More research needs to be done in the future in the area of midyear performance, equity Crowdfunding, online portfolio selection.

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Productivity growth in Chinese cities: The agglomeration effect for cross-regional industrial structures

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Abstract. *Since industrial development patterns in China are different across regions and sectors, this paper firstly estimates total factor productivity growth rate through two-stage-least-square method and then investigates the effect of agglomeration in city-industry productivity growth for 7 sectors located in 101 Chinese cities over period 2005-2013, with consideration of cross-regional effect such as knowledge spillovers between regions. Our results indicate there is no significant effect of agglomeration on city-industry TFP if the impact of cross-regional effect on agglomeration are taken into considerations. From spatial Durbin model (SDM), cross-regional effect significantly inhibits the city-industry TFP growth resulted from diversification.*

Keywords: China, TFP growth, Knowledge Spillovers, agglomeration externalities, spatial Durbin model.

JEL Classification: O180, R11, R12.

1. Introduction

Starting from 2010, the growth rate of the economy has been slow down and China has reached another era of development. To boost the growth of the economy, China decides to restructure its industrial pattern and cross-region links to gain the benefit of agglomeration externalities, and industry clusters are one of the products of this plan. Thus, total factor productivity (TFP hereafter) – an index measuring overall productivity and a vital source of sustaining output growth in the long run (Mahadevan, 2003) – requires more attention and precise estimation. Several researchers find out the TFP in China decreases in both the secondary and tertiary sectors (Wu, 2013; Huang and Zhang, 2015; Li, Liu and Xie, 2017), which may imply a gloomy long-run growth in these two sectors. This paper provides a TFP estimation method with precision and analyze the effect of agglomeration externalities with consideration of cross-regional effect such as knowledge spillovers between regions.

In the past a few decades, the trend of industrial agglomeration of production activities has been generally observed, especially for high-tech industries. The specialized industrial structure showed in Silicon Valley in the U.S. and the Yangtze River Delta in China are two examples. As more urban agglomerations emerge, there is a resurgence of interest in the economics of industrial agglomerations. Researchers find the pattern of firms' allocation could influence TFP growth through knowledge spillover. There are two main existing theories on dynamic externalities: MAR (Marshall-Arrow-Romer) externalities, and Jacobs' externalities. MAR (Marshall, 1890; Arrow, 1962; Romer, 1986) externalities suggest the cluster of firms in the same industry within a region facilitates knowledge spillover because of flexible labor mobility. Workers reveal a firm's technical progress to workers in other firms, so the other firms get the knowledge for free. However, Marshall indicates that a local monopoly market structure is better for transmissions of knowledge than competitions because the ease of copying knowledge and ideas hinders the motivations for innovation. Contrary to MAR externalities, Jacobs (1969) externalities emphasize the knowledge spillover across local industries. However, the results of empirical studies vary from different sample periods and targeted regions. The mechanism behind it is still puzzling.

In the existing literature on dynamic externalities of knowledge spillover, studies considering spatial correlation between regions are mainly seen in empirical analysis of Europe and the United States, but few discussions of Chinese cities and sectors. Many empirical practices suggest that geographical location affect regional growth, that is, the technological progress of a region will affect its surrounding areas through knowledge spillover effect (LeSage and Fishcer, 2012; Bottazzi and Peri, 2003). Scherngell, Borowiecki, and Hu (2014) apply SDM to 27 Chinese regions from 1998 to 2007 for the empirical analysis, finding that productivity growth in China more tend to be the result of knowledge progress. More importantly, their results show that the knowledge spillovers not only exist in the region, also existed between different regions. Their finding highlights the importance of spatial effects of agglomeration externalities in China.

Based on standard approaches to investigate the effect of agglomeration economies used by previous researchers, such as Glaeser et al. (1992) and Marrocu et al. (2013), we extend on two perspectives. First, we provide an overall picture about changes in TFP growth in China and apply econometric methods to estimate elasticities of inputs for each sector without imposing a priori restriction on them. Second, we construct a spatial matrix to capture potential cross-regional dependence and apply the spatial econometric models to analyze the impact of local agglomeration on TFP growth under specific economic period in China.

In addition to the introduction, the paper is organized as follows. Section 2 introduces the estimations of TFP growth rate. Section 3 introduces the applied spatial econometric model and presents regression results and Section 4 concludes the main findings and discuss implications for policymakers.

2. Estimations of TFP growth

2.1. Measurements of TFP growth

The estimation methods of TFP can be divided into two types: the direct estimation method and the parametric method. The direct estimation method bases on the assumption of a specific production function, while the parametric method estimates the coefficients of elasticity of labor and capital input first. Yan and Yudong (2003) use a simple growth accounting exercise to estimate the capital stock and then estimate the China's TFP growth by residuals. Similarly, Burda and Severgnini (2014) construct production function and comprehensively used Denison-Hall-Jones decomposition method to estimate TFP. In this paper, considering the endogeneity of production functions, we use the two-stage-least-square (2SLS) method to measure the factor elasticity coefficients of capital and labor of 7 sectors in 101 cities in China from 2005 to 2013, respectively. Specifically, we estimate factor endowment elasticities for each of the 7 economic sectors within a traditional Cobb-Douglas production function model as follows.

$$\ln(GDP_{it}) = \alpha_1 + \alpha_2 \ln(K_{it}) + \alpha_3 \ln(L_{it}) + D_t + \epsilon_{it}, \quad (1)$$

where $i = 1,2,3,\dots,N = 101$ cities; $t = 2005, 2006, \dots, 2013$ (9 years); GDP is real gross domestic product, K is capital stock, and L are units of labor; D_t are time dummies (first eight year), and ϵ_{it} is the error term that follows i.i.d. standard normal distribution. Then, utilized K and L in the previous year as the instrumental variables, the first stage is summarized in equation (2) and equation (3):

$$ln(\widehat{K_{it}}) = \vartheta_0 + \vartheta_1\, ln(K_{it-1}) + \vartheta_2\, ln(L_{it-1}) + D_t + \tau_{it}, \quad (2)$$

$$ln(\widehat{L_{it}}) = \gamma_0 + \gamma_1\, ln(K_{it-1}) + \gamma_2\, ln(L_{it-1}) + D_t + v_{it}, \quad (3)$$

where $\widehat{K_{it}}$ and $\widehat{L_{it}}$ represent the estimated value of capital stock and labor invested in the city economists and year t for each sector. τ_{it} and v_{it} present error terms following

standard normal distribution. Then the second stage of estimating two parameters illustrates as follows.

$$\ln(GDP_{it}) = \rho_1 + \rho_2 \ln(\widehat{K_{it}}) + \rho_3 \ln(\widehat{L_{it}}) + D_t + \epsilon_{it}. \quad (4)$$

Then, using the two estimated coefficients of sector j (ρ_2 and ρ_3) in the original Cobb-Douglas production function, TFP in city i in year t is computed as equation (5).

$$TFP_{ijt} = \frac{GDP_{ijt}}{{K_{ijt}}^{\rho_2} * {L_{ijt}}^{\rho_3}}. \quad (5)$$

Thus, we can get TFP growth rate over the year period $t_1 - t_2$ ($t_2 > t_1$) as

$$TFPG_{ij,t_1-t_2} = \frac{TFP_{ijt_2} - TFP_{ijt_1}}{TFP_{ijt_1}}. \quad (6)$$

2.2. Data description and capital stock estimation

Considering the knowledge spillover and the mobility of technology highly related to the mobility of employees, this paper selects seven sectors with relatively high labor mobility, two of which are from the Secondary Industry (Manufacturing and Construction), and five of which are from the Third Industry (Transportation, Retail, Finance, Real Estate and Other Tertiary sectors).

To get the city-sectoral dataset, we use data from China City Statistical Yearbook and China Statistical Yearbook, assuming that GDP share of each sector in the province is the same as that of cities in the province. Among them, cities with different or larger deviation of GDP characteristics of sectors after calculation and cities with a small share in the province are screened out due to unavoidable bias. After removing those cities, this paper studies seven sectors of 101 cities.

Real city-sector GDP is deflated using the price index. Data of city-sectoral labor units is directly presented on China City Statistical Yearbook. For capital stock, utilizing the perpetual inventory method, we estimate capital K_{ijt} by equation (7)

$$K_{ijt} = (1 - \delta_j)K_{ijt-1} + I_{ijt}, \quad (7)$$

where: δ_j is the depreciation rate of the sector j and I_{ijt} refers to the incremental investment of the sector j in the city i in year t. Considering different sectors may have different depreciation rates. Tian (2016) uses China Input-Output Table to compute the depreciation rates of 3 main industries and 19 sectors by calculating the amount of depreciation of sub-items in each sector and comparing that with the fix asset investment in a few short periods. We apply the depreciation rates from his paper (1). Considering the part of fixed asset investment should be directly or indirectly used to produce, Incremental Fixed Asset Investment (IFAI), which represents by I_{ijt} in equation (7), is more proper to be put in the Cobb-Douglas production function (2).

The initial capital stock is widely estimated by many scholars while the different methods may have considerable variations with each other. Based on the limited dataset, we can

only use the value of IFAI after 2005 to deduce the initial capital stock in 2005 by assuming the growth of IFAI follows a certain pattern:

$$I_{2005+\Delta t} = I_{2005} e^{\theta \Delta t}, \tag{8}$$

where: I_{2005} refers to the IFAI of the specific sector in 2005, and $\Delta t = 1, 2, \ldots, 8$ years. Then, we rewrite equation (8) by doing logarithmic transformation in both sides and apply OLS estimation to estimate θ_j for each sector:

$$lnI_{ij,2005+\Delta t} = lnI_{ij,2005} + \theta_j \Delta t + u_{ij,2005+\Delta t}. \tag{9}$$

Then, if we assume the initial capital stock is the sum of all previous real incremental investment in fixed asset before year 2005, we estimate city-sectoral capital stock at year 2005 by using equation (10). Then, we get estimated city-sectoral capital stock series from 2005 to 2013 based on the capital accumulation equation (7).

$$K_{ij,2005} = \int_{-\infty}^{0} I_{ij,2005+\Delta t}\, d\Delta t$$

$$= I_{ij,2005} \int_{-\infty}^{0} e^{\theta_j \Delta t}\, d\Delta t$$

$$= \frac{I_{ij,2005}}{\theta_j}. \tag{10}$$

2.3. TFP growth rate estimation result and analysis

We calculate the elasticity coefficients of capital stock and labor output in the production function through equation (4), and the results are shown in Table 1. Despite computing TFP growth rate in city-sector level, we calculate the annual TFP growth rate of the aggregate secondary and tertiary industries from 2005 to 2012 (see Figure 1) and that in country-sector level (see Table 2) to describe the changes in TFP growth rate in a macro view.

Table 1. *City-industry level production function estimated elasticities of inputs*

	ρ_2	ρ_3
Manufacturing	0.631***	0.331***
Construction	0.438***	0.308***
Transportation and Storage	0.737***	0.277***
Wholesale and Retail Trades	0.526***	0.444***
Financial Intermediation	0.290***	1.003***
Real Estate	0.902***	0.125***
Other Tertiary sectors	0.730***	0.439***
Overall	0.728***	0.336***

Notes: For each sector estimates (despite Financial Intermediation) are obtained from a balanced city-level panel (N = 101), N × T = 909. The symbol of OLS inside a bracket suggests the sector fails to pass the Hausman Test at a 10 percent level and replaced by OLS regression result instead. *** p < 0.01, ** p < 0.05, * p < 0.1.

Figure 1. *The change of TFP growth rate in two sectors in China from 2005-2012*

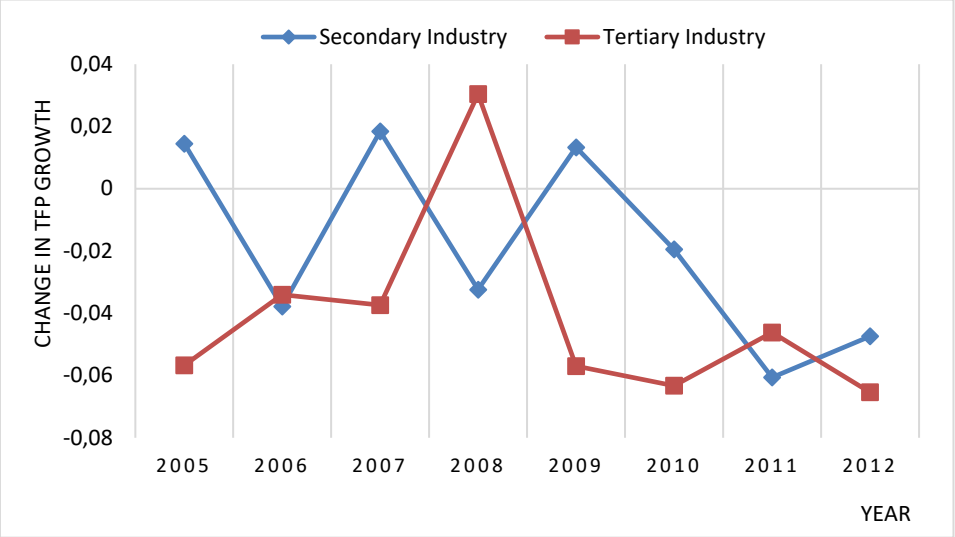

Table 2. *The TFP growth rate changes of seven sectors in China in 2005-2012*

Sector	2005	2006	2007	2008	2009	2010	2011	2012
Manufacturing	0.0421	0.0171	0.0373	-0.0523	0.0178	-0.0513	-0.0513	-0.1365
Construction	0.0599	0.0299	0.0866	0.1747	0.0457	-0.0932	-0.0233	-0.1386
Transportation and Storage	0.0776	0.0007	0.0092	0.0073	0.0234	-0.0141	0.0220	-0.1282
Wholesale and Retail Trades	0.0551	0.0164	0.0224	0.1319	0.0520	-0.0869	-0.0411	-0.1456
Financial Intermediation	0.1774	0.2657	0.0204	0.1389	0.0577	-0.0097	0.0758	0.0876
Real Estate	-0.022	-0.0280	-0.1379	0.1438	-0.0990	-0.1127	-0.0827	-0.0959
Other Tertiary sectors	0.0123	-0.0024	-0.0196	0.0013	-0.0437	0.0004	-0.0064	-0.0596

Figure 1 shows that country-level TFP growth rate for the secondary sector of the economy fluctuates from 2005 to 2009, and that continuously decreases from 2009 to 2013. The tertiary industry keeps decreasing from 2005 to 2013 despite an increase in 2008. Generally, the TFP in seven industries slightly increase in the first five years and then decrease in the last three years (Table 2).

In terms of changes in city-sector TFP growth, the disparities emerge among different regions and industries. Here we select ten cities with evident characteristics to illustrate our findings (Table 3). For instance, Guangzhou and Shenzhen have a positive TFP growth in the manufacturing, and financial intermediation industries. The differences in industries across cities are huge. From 2005 to 2013, the changes in all 101 cities' TFP growth of manufacturing industry are ranged between -70% to 50%. For construction industry, Yichang has a dramatic increase of 335% in TFP growth during the 9 years. Besides, most of 101 cities have an increase in productivity efficiency in this industry. As for the tertiary sector of the economy, the range of TFP changes in transportation and storage industry for 9 years is between -66% and 92%. For the wholesale and retail trades industry, Peking and

Shanghai have the highest two TFP growth rates from 2005 to 2013, which are 138%, and 203% respectively. For financial intermediation and real estate industries, several developing cities have a large increase in TFP growth since they are currently undeveloped in these two industries. According to the above estimation, Sanya, and Xuchang increase TFP of financial intermediation industries by 753%, and 485%. As shown in province-industry data, the productivity efficiency in real estate industry decreases widely. There are only 10 out of 101 cities have an increase of TFP in this industry including Nanjing, Changzhou, and Suzhou. For the other tertiary industries, the average TFP level goes down, and the range of nine-year TFP changes is between -57% and 15% among 101 cities. Besides, only 9 cities with a growth of TFP in the other tertiary industries suggests that the average TFP of tertiary industry goes down from 2005 to 2013.

Table 3. *Changes of TFP growth rate of 10 cities in China in 2005-2012*

City	Sector	2005	2007	2009	2012
Guangzhou	Manufacturing	0.054723	0.015967	0.018787	0.078508
	Construction	0.095914	0.081312	0.125975	0.079629
	Transportation and Storage	0.027146	-0.02948	0.010591	-0.08709
	Wholesale and Retail Trades	0.016942	0.041305	0.018074	-0.01773
	Financial Intermediation	0.321957	0.044448	0.005055	0.506937
	Real Estate	0.030061	-0.12306	-0.04752	0.001727
	Other Tertiary sectors	-0.03261	0.000545	-0.07407	0.003993
Shenzhen	Manufacturing	-0.00113	-0.00078	0.009465	-0.18498
	Construction	0.056507	0.08702	0.092438	-0.15118
	Transportation and Storage	0.026632	0.008643	-0.03199	0.002078
	Wholesale and Retail Trades	-0.0088	0.014568	-0.00347	-0.16023
	Financial Intermediation	0.287147	-0.08876	-0.13515	0.374476
	Real Estate	0.049416	-0.10333	-0.01956	0.020796
	Other Tertiary sectors	-0.02736	-0.00259	-0.08131	-0.06136
Yichang	Manufacturing	-0.00977	0.034056	-0.00337	-0.25326
	Construction	0.123655	0.286808	0.165458	-0.1243
	Transportation and Storage	0.042314	0.154816	-0.09136	-0.15808
	Wholesale and Retail Trades	0.0271	0.025095	-0.04832	-0.05144
	Financial Intermediation	0.224835	0.070754	0.415851	0.023012
	Real Estate	0.012351	-0.03734	-0.19421	0.007266
	Other Tertiary sectors	0.000307	0.001444	-0.09623	0.10648
Peking	Manufacturing	0.117614	-0.04417	-0.01143	-0.00029
	Construction	0.475939	0.149961	0.071386	0.065634
	Transportation and Storage	0.099173	-0.15981	0.106478	-0.00868
	Wholesale and Retail Trades	0.804648	0.045757	0.061911	-0.02697
	Financial Intermediation	-0.07319	-0.02923	-0.14906	-0.02935
	Real Estate	0.07419	-0.1938	-0.20315	-0.03703
	Other Tertiary sectors	0.179985	-0.02979	-0.00836	-0.03102
Shanghai	Manufacturing	0.070434	-0.05815	0.081782	0.001593
	Construction	0.239353	0.210093	-0.00117	0.131984
	Transportation and Storage	0.051058	-0.08266	0.181	-0.14445

City	Sector	2005	2007	2009	2012
	Wholesale and Retail Trades	0.536297	0.011686	0.006851	0.640943
	Financial Intermediation	0.06258	-0.10436	-0.12568	0.159176
	Real Estate	-0.08509	-0.20753	-0.29541	0.007979
	Other Tertiary sectors	0.100444	-0.01599	-0.02122	-0.17915
Sanya	Manufacturing	1.402192	-0.02989	0.064716	-0.25217
	Construction	0.877465	0.003924	0.00225	-0.12459
	Transportation and Storage	0.022531	-0.03687	-0.00431	-0.10125
	Wholesale and Retail Trades	0.1937	0.147408	0.126603	-0.06229
	Financial Intermediation	0.242215	0.55829	-0.06851	-0.17547
	Real Estate	-0.09321	-0.08911	0.135479	-0.10635
	Other Tertiary sectors	0.028355	-0.03679	-0.05983	-0.07178
Xuchang	Manufacturing	0.099995	0.100939	-0.02393	-0.22337
	Construction	0.045398	0.132849	0.073462	-0.01824
	Transportation and Storage	0.092318	0.147921	-0.12766	-0.07027
	Wholesale and Retail Trades	0.029939	0.024881	0.050752	-0.15085
	Financial Intermediation	0.434255	0.064067	0.222678	0.285947
	Real Estate	-0.05525	-0.11321	-0.0401	-0.11815
	Other Tertiary sectors	0.026425	-0.02293	-0.12946	-0.03489
Nanjing	Manufacturing	-0.03983	-0.06571	-0.00468	-0.0562
	Construction	0.052433	0.056308	0.103509	-0.22324
	Transportation and Storage	0.124593	0.047817	0.080609	-0.12235
	Wholesale and Retail Trades	-0.12725	-0.09354	-0.00023	-0.22651
	Financial Intermediation	0.276884	0.283131	-0.14118	0.141258
	Real Estate	0.027102	-0.10259	0.046785	-0.09546
	Other Tertiary sectors	0.036281	-0.00538	-0.00905	-0.11783
Changzhou	Manufacturing	0.036251	-0.0318	-0.00748	-0.14397
	Construction	0.056442	0.126304	0.089248	-0.23551
	Transportation and Storage	0.165167	0.044302	0.110779	-0.0208
	Wholesale and Retail Trades	0.025764	0.040955	0.057735	-0.06991
	Financial Intermediation	0.292751	0.055593	-0.01824	0.100011
	Real Estate	0.088546	-0.11579	0.057853	-0.09463
	Other Tertiary sectors	0.074987	0.009527	0.012983	-0.08798
Suzhou	Manufacturing	-0.01395	0.011629	-0.03714	-0.27755
	Construction	-0.15387	0.130969	-0.00447	-0.29196
	Transportation and Storage	0.226741	0.08735	0.101313	-0.21185
	Wholesale and Retail Trades	0.021061	0.085958	0.060176	-0.39912
	Financial Intermediation	0.265828	0.136267	0.037681	-0.26267
	Real Estate	0.107145	-0.0766	0.074469	-0.18134
	Other Tertiary sectors	0.120653	0.057668	0.032756	-0.21618

3. The spatial effects of agglomeration externalities in China

3.1. Agglomeration externalities measurements

It has been a hotly debated issue in economics whether an economic entity should be more specialized or diversified to gain more substantial productivity growth. The concept of specialization and diversification could be viewed from two different aspects. From the output-orientated view, economists use invested employment and labor in explaining the effect of industrial agglomeration.

According to Abdel-Rahman and Fujita (1993), a city is more specialized when it mainly produces one good rather than multiple goods, and the city is more diverse as its products both goods with fewer preferences. As for the input-orientated view, it suggests that how much we invested in the production process matters, especially for externalities input. Due to the accessible of input-orientated variables such as labor-input and capital-input, the input-orientated view is wildly used in measuring externalities by researchers (Combes, 2000; Marrocu, 2013).

This section introduces the measurements of specialization and diversification at the city-sectoral level, respectively.

Specialization externalities are usually measured by a location quotient (the proportion of total sectoral employment in a city relative to the national average share). For city i (out of 101 cities) and sectors j (within a set of 7 sectors), we define our specialization externalities index (SPE) based on employment as

$$SPE_{ijt} = \frac{L_{ijt}/\sum_j^7 L_{ijt}}{\sum_i^{101} L_{ijt}/\sum_i^{101}\sum_j^7 L_{ijt}}, \tag{11}$$

where: L_{ijt} is the labor units of sector j in city i in year t. A higher SPE index means the sector in the city is relatively more specialized than the average level.

Diversification externalities, also called Jacobs' externalities, may benefit firms in the sector with the knowledge spillover from other sectors inside the city. We apply the most common method, that is, inverse Herfindahl concentration index based on employment along with an influential modification from Combes (2000) who excludes the employment of the specific sector when calculating the sum of the squares of employment for a given city and sector. For city i and sector j with respect to the rest sectors j' ($j' \neq j$), we define our diversification externalities index (DIV) based on employment as

$$DIV_{ijt} = \frac{1}{\sum_{\substack{j'=1,\\ j'\neq j}}^{7} [L_{ij't}/(L_{it} - L_{ijt})]^2}. \tag{12}$$

A larger DIV index suggests other sectors in the city tend to be equally invested from the employment aspect.

3.2. Spatial model specification

Inspired by the previous literature, we specify the basic empirical model as follows

$$TFPG_{ij,t_1-t_2} = \beta_0 + \beta_1 SPE_{ijt_1} + \beta_2 DIV_{ijt_1} + \\ + \beta_3 lnTFP_{ijt_1} + \sum_{j=1}^{6} \gamma_j SD_j + \varepsilon_{ij}, \quad (13)$$

where: i refers to 101 cities in China and j refers to the 7 sectors, $TFPG_{ij,t_1-t_2}$ represents the TFP growth rate of sector j in city i over the period t_1 to t_2. SD_j is the sectoral dummy (first six sectors).

In this research, the spatial error model (SEM), spatial lag model (SAR), spatial Durbin model (SDM) and spatial Durbin error model (SDEM) are applied to describe the effect of dynamic externalities on city-industry level TFP growth with spatial dependence. A general form of the spatial econometric model is given by the following set of equations

$$y = \rho W y + X\beta + WX\gamma + u, \quad |\rho| < 1 \quad (14)$$

$$u = \lambda W u + \varepsilon, \quad |\lambda| < 1 \quad (15)$$

where: y is the matrix of dependent variables and X as a matrix of all non-stochastic explanatory variables. W is an exogenously given weight matrix, $\varepsilon|x \sim iidN(0, \sigma_\varepsilon^2 I_{nJ})$, $\sigma_\varepsilon^2, \beta, \rho, \lambda, \gamma$ are parameters to be estimated. In this paper, since we focus on the potential cross-regional dependence, we define a n by n weighted spatial matrix W^* by the inverse of distance in kilometers between two cities. Elements in the matrix W^* satisfy the following rule:

$$w_{ii'} = \begin{cases} \frac{1}{d}, & i \neq i' \\ 0, & i = i' \end{cases} \quad (16)$$

where: d is the distance between regions, which is calculated by utilizing the coordinate information (longitude and latitude). The longitude and latitude data are measured in degrees contain the coordinate of the centroids of the region, which is considered as the government location in each region. W^* is row normalized by dividing each element in a row by its row sum.

Thus, the econometric model in this paper can be represented as following matrix form:

$$TFPG_{ij,t_1-t_2} = \rho WTFPG_{ij,t_1-t_2} + 1_{NJ}\beta_0 + X\beta + WX\gamma + lnTFP_{t_1}\beta_{TFP} \\ + SD^*\theta + u, \quad |\rho| < 1 \quad (17)$$

$$u = \lambda W u + \varepsilon, \quad |\lambda| < 1 \quad (18)$$

where: $TFPG_{ij,t_1-t_2}$ is a $NJ \times 1$ matrix, $X = [SPE, DIV]$, $\beta = [\beta_{SPE}, \beta_{DIV}]'$. $SD^* = \iota_N \otimes SD$, where ι_N is a column vector of 1 with size N and SD is a $J \times 6$ matrix containing first six sector dummies. 1_{NJ} denotes an NJ by 1 column vector.

$\gamma = [\gamma_{SPE},\ \gamma_{DIV}]'$ and $W = W^* \otimes J_J$, u is a vector of errors. In this project, $= 101, J = 7$. When $\lambda = 0, \gamma = 0$ and $\rho \neq 0$, the model is the spatial lag model (SAR). When $\rho = 0, \gamma = 0$ and $\lambda \neq 0$, the form represents the spatial error model (SER). Except SAR and SEM, this project also considers the influence of cross-regional dependence on the effect of dynamic externalities on productivity growth. To achieve this goal, this research also applies SDM and spatial Durbin error model (SDEM). When $\rho \neq 0,\ \gamma \neq 0$ and $\lambda = 0$ the form presents SDM, while SDEM is applied when $\rho = 0, \gamma \neq 0$ and $\lambda \neq 0$. Maximum likelihood estimation is applied to obtain consistent estimators of all parameters.

According to Figure 1, TFP growth in both secondary sector and tertiary sector of the economy drops in year 2009. Besides, from Table 2, year 2008 or 2009 is the year of threshold due to the globally economic and financial meltdown. Suppose we define 2005 to 2009 as the first status of the economy, implying the case before recessions, and 2009 to 2013 as the second status of the economy, or post-recession period. In this research, we explore the effects of agglomeration on productivity growth during year 2005 to 2009 (first status) and year 2009 to 2013 (second status) separately to rule out the effect of dramatic change in overall economic status.

The results for choosing either 2008 or 2009 as threshold are similar, so only results for year 2009 as a threshold is reported in this paper. The results are shown in the next subsection (Table 4 and Table 5).

3.3. Regression results

Based on columns (1) to (4), diversification has significantly negative impact on the city-industry TFP growth in the first status. Besides, from columns (5) to (8), specialization externalities show a positive effect on growth in the second status, and the effect are significant for all spatial econometric models. Moreover, according to columns (3), (4), (7), (8), we can observe a positive and significant effect of firms in other cities on the local firm's performance, since all λ are positives regardless of current economic status. Specifically applying SAR and SDM models, the TFP growth in adjacent cities can bring significantly positive effect on the local TFP growth during both statuses (see columns (1), (2), (5), (6)). These facts support the theory of MAR externalities as mentioned above in section I. However, γ_{DIV} is significant and negative from columns (6) and (8).

If the adjacent cities are more diversified, it will not only reduce their firms' TFP growth, but also lower down the performance of firms in the targeted city. Hence, to sustain or to improve the city-industry TFP growth, it is beneficial for firms to specialize in its products and agglomerate in the same location. It seems if firms with the same type can agglomerate in the same region, and different cities develop their own competitive advantageous products/industries, it benefits the growth of production efficiency in each firm in all regions.

Table 4. *Results from Spatial Models from 2005 to 2009*

2005-2009	(1)	(2)	(3)	(4)
Variable	*SAR*	*SDM*	*SEM*	*SDEM*
β_{SPE}	0.0041 (0.9040)	0.0153 (0.6680)	0.0030 (0.9320)	0.0068 (0.8470)
β_{DIV}	-0.0627** (0.0190)	-0.0517* (0.0634)	-0.0540** (0.0499)	-0.0511* (0.0636)
β_{TFP}	-0.256*** (0)	-0.265*** (0)	-0.293*** (0)	-0.298*** (0)
ρ	0.776*** (0)	0.769*** (0)		
λ			0.783*** (0)	0.779*** (0)
γ_{SPE}		-0.212 (0.2960)		-0.359 (0.1590)
γ_{DIV}		-0.210 (0.2060)		-0.175 (0.3980)
DUMMY_IND	YES	YES	YES	YES
Constant	0.0929 (0.2690)	0.857** (0.0475)	-0.0141 (0.9420)	0.865 (0.1430)
Observations	707	707	707	707

Note: pval in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 5. *Results from Spatial Models from 2009 to2013*

2009-2013	(5)	(6)	(7)	(8)
Variable	SAR	SDM	SEM	SDEM
$\boldsymbol{\beta_{SPE}}$	0.0644*** (0.0001)	0.0701*** (0.0001)	0.0666*** (0.0001)	0.0662*** (0.0002)
$\boldsymbol{\beta_{DIV}}$	-0.0181 (0.1650)	-0.0090 (0.5040)	-0.0108 (0.4180)	-0.0100 (0.4530)
$\boldsymbol{\beta_3}$	-0.145*** (0)	-0.158*** (0)	-0.163*** (0)	-0.171*** (0)
$\boldsymbol{\rho}$	0.820*** (0)	0.821*** (0)		
$\boldsymbol{\lambda}$			0.835*** (0)	0.827*** (0)
$\boldsymbol{\gamma_{SPE}}$		-0.119 (0.2240)		-0.0607 (0.6250)
$\boldsymbol{\gamma_{DIV}}$		-0.202** (0.0120)		-0.220** (0.0314)
DUMMY_IND	YES	YES	YES	YES
Constant	-0.107** (0.0121)	0.536*** (0.0100)	-0.318** (0.0124)	0.368 (0.2270)
Observations	707	707	707	707

Note: pval in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

4. Conclusion

China's overall TFP has experienced a distinct decline over recent year. In this paper we provide an accurate measurement of the TFP for 101 cities and 7 sectors through utilizing 2SLS method to estimate the elasticity coefficient of capital stock and labor. We also estimate TFP from city and province level. Our result shows that from 2005 to 2009, the TFP of the secondary and tertiary industry in China grew rapidly, while from 2009 to 2013, the TFP of the tertiary industry in China decreased due to a large amount of underutilized

capital input. Considering that TFP is a core factor of urban development, and the agglomeration effect may help TFP growth, we study on the influence of cross-regional effect on externality on TFP growth. Based on the empirical research on the two economic stages of China from 2005 to 2009 and from 2009 to 2013, this paper uses four spatial econometric models respectively, and draws the following conclusions: There is a cross-regional effect of knowledge spillover on TFP, and the growth of TFP of city-sector will be affected by the growth of TFP of neighboring cities; In order to maintain or increase the growth rate of TFP of city-sector, it is beneficial for enterprises to concentrate production in the same area; more diversified neighboring cities will reduce the TFP growth of enterprises.

Notes

(1) For the sector "Other Tertiary sectors" in our study, we use the depreciation rate of the tertiary industry from Tian (2016).

(2) To get the real value, we apply FAIPI (Fixed Asset Investment Price Index), which reflects the price fluctuation of all kinds of investment and charging project that involved in the fixed asset investment.

(3) The government policy led the huge investment amount invested in several provinces in few years. For example, Financial sectoral investment of Tianjin increased 613 percent in 2011. The kind of investment did not work, therefore should not be put into the production function. Hence, we expurgate five abnormal invested cities including Tianjin, Liaoning, Anhui, Jiangsu, and Shanxi when we estimate the elasticities for the sector "Financial Intermediation".

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Time-varying volatility spillover of foreign exchange rate in three Asian markets: Based on DCC-GARCH approach

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Abstract. *This empirical analysis endeavors to examine the return volatility, co volatility and spillover impact of Australian dollar, Canadian dollar, Japanese yen, and Swiss franc in pertinent Asian economies such as India, Malaysia, and Singapore, by using the variance decomposition and GARCH-DCC techniques with the help of daily time series data from five years from 2012 to 2019. The result of GARCH-DCC analysis shows the evidence of ARCH and GARCH effect on all the tradable currencies, in the foreign exchange markets of above countries. The consequence of volatility spillover proves that, the Australian dollar is a net transmitter of volatility while the Canadian dollar is a net receiver of volatility in the Indian foreign exchange market. As per as Malaysian and Singapore's foreign exchange market is concerned it can be inferred that Japanese yen is dominant currency in Malaysian market while Swiss franc is relevant in Singapore's exchange market. These outcomes have vital ramifications that financial organizer should consider in recurrence volatility of tradable currencies of above foreign exchange market to forestall the financial risk.*

Keywords: foreign exchange, GARCH DCC, volatility and spillover.

JEL Classification: Q40, Q43.

1. Introduction

The persistent volatility in the financial market has drawn the attention of the gathering of financial analyst and monetary economist. Now the present dynamic and integrated global financial market, variability has become a relevant issue. Earlier 1980 all the econometrician that the variance of financial time series variables remains constant and due to this phenomenon, everybody endeavored to capture the conditional mean of that variable with the assumption of constant variance assumed it. There are various arguments about the volatility of the financial market in the current scenario. There are ample number of investigation done to reveal the nexus between the different exchange rates (Dornbusch and Fisher, 1980; Branson, 1983; Karolyi and Stulz, 1996; Subramanian and Kessler, 2012, Cockerell and Shoory, 2012), on the other hand much empirical investigation concentrated towards the calibration the level of dependence in the foreign exchange and stock market (see for example; Antonakakis, 2012; Apergis and Rezitis, 2001; Beer and Hebein, 2011; Ebrahim, 2000; Francis et al., 2006; Grobys, 2015; Kanas, 2000; Yang and Doong, 2004). There are much empirical analysis has scrutinized the co-movement of exchange rate return in terms of relevant tradable currencies. There is substantial literature can be accessed related to exchange rate return co-movement and its volatility in perspective of western developed economies (see: Erdemlioglu et al., 2012; Stancik, 2007; Annachhatre, 2013). In this paper, it has been tried to concentrate to explain the exchange rate return co-movements and their roles in transmitting shock from one to another. The Previous studies focused on capturing volatility of return co-movement and correlation interdependencies over time in the exchange rate with taking the world's top dominated currency like US dollar, British pound and the euro with concerned of the western financial market. This study intends to explore the return volatility co-movements and spillover effect of foreign exchange market by using GARCH DCC and VAR techniques in the context of Asian economies. One of the rationales behind the selection of Asian countries sample is that the literature does not provide enough evidence in the specific area. The Asian countries included in this study are; India, Malaysia, and Singapore. In this paper, it has been tried to explore the volatility return in exchange rate by taking the other dominated currencies such as Australian dollar (AUD), Canadian dollar (CAD), Japanese yen (JPY), and Swiss franc (FRANC) in the perspective of Asian Pacific financial market which has never been explored as before. This empirical investigation endeavor to contribute to the existing wisdom related to above theme. The current investigation makes a substantial addition to the literature. First, it advances the existing literature by considering top three Asian economies such as India, Malaysia, and Singapore together. Second, this study consider other dominated currency such as, the Canadian dollar, Japanese yen, Swiss franc and Australian dollar to understand the return volatility and spillover impact, while most of the literature on the above issue has given the importance to top dominating currencies such as, US dollar, GBP and euro for their analysis. The main logic for considering of daily data is to make the analysis more robust than with weekly and monthly data. Furthermore, the outcome of current study will provide scientific benchmark for the effective economic policymaking process to the economic think-tank groups, investors and multinational firms

of respective analyzed nations. The Investors will be benefited by the result of this investigation. For finding the conditional volatility in exchange rate return and correlation dependency and interdependency multivariate GARCH models with alternative assumptions have been applied. The current analysis applies the GARCH DCC (Dynamic conditional correlation) model which was recently advanced by the Engle and Sheppard in (2011). The Dynamic Conditional Correlations (DCC) model has become a dominant model in volatility transmission studies as it has power to preserve the parsimony of univariate GARCH models of individual assets volatility like time-varying correlations which makes it most sophisticated and robust method of volatility modeling. (Engle and Sheppard, 2001). It has clear computational advantages in that the number of parameters to be estimated in the correlation process is independent of the number of series to be correlated. Thus potentially very large correlation matrices can be estimated. To calibrate the spillover impact of four Major traded currencies in various exchange market, the Vector autoregressive (VAR) model have been employed. This paper is organized as follows. After the introduction, presentation of a review of the literature on the volatility of return on foreign exchange in the section 2, Section 3 illustrates the DCC-GARCH and Vector autoregressive (VAR) model. The empirical results are discussed in Section 4 and finally, Section 5 concludes.

2. Review of literature

The empirical evidence on currency dependence has been documented by numerous studies. There is an extensive amount of empirical analysis can be found about the foreign exchange, return volatility co-movement in consideration of world's leading and dominating currencies. Stancik (2007) propounded that greater the international linkages for trade lead to lower variability, the impact of exogenous variables such as market news vary nation to nation and key factor have a relevant effect on the exchange rate volatility. Nikkinen et al. (2006) found the evidence that currency options have volatility expectations and concluded that the Euro's volatility expectations have a relevant effect on the currencies of GBP and CHF. On the other hand, Annachhatre (2013) argued that volatility in exchange rates is an impulse by the excessive speculative activities, macroeconomic shocks or other global and domestic news. The empirical investigation done by the Kurasawa (2016) on the economic policy uncertainty (EPU) and US/Japan exchange rate volatility it revealed that, the dynamic conditional correlations between policy uncertainty and the exchange rate are not time-invariant. Saha and Chakrabarti (2011) found that the volatility spillover from stock to exchange rate market and vice versa do not have an asymmetric impact between these two financial market. Mirovic et al. (2016) revealed that portfolio balanced theory has predominance in the short run in all selected economies by the employing the GARCH DCC method. Kocenda and Valachy (2006) the outcome of analysis shows the evidence that, there is a high level of volatility persist in a floating exchange rate regime than under a fixed regime. Furthermore, the study of Subramanian and Kessler (2012) and Lien et al. (2013), advocated that the Chinese Yuan seems to be the

most dominating currency in perspective of East Asian economies. Furthermore, Fang et al. (2009) found that, the real exchange rate risk significantly affects the exports for all selected nations, negative or positive, in periods of depreciation or appreciation in context of Asian economies. The study of Mohammadi and Tan (2015) showed the evidence of unidirectional return spillovers from the US to the other three markets; but no spillover between Hong Kong and either of the two mainland China markets. On the other hand, Beine et al. (2006) investigated the credibility of central bank intervention on the volatility of yen versus euro with the application multivariate GARCH model. The result of empirical investigation revealed that. Patnaik (2013) found that the prevalence of very high level of volatility and volatility clustering in each of these exchange rates in India and also the volatility spillover interpreted from the DCCs amongst these rates is evident and asymmetric over a period of time. The study of Hashim et al. (2015) revealed that there is a negative relationship between stock prices index and exchange rate in Malaysia for Islamic as well as other stock indices. The stock index provides supports to the exchange rate for the long-term investment scenario by the application of MGARCH-DCC and wavelet approach. Wang and Lee (2016) found that Chinese stock market has a greater positive influence on other related Asian stock markets. Authors also concluded that the Chinese exchange rate movements have a positive impact on the foreign exchange rate markets of Singapore, South Korea, and Taiwan, but do not have any relevant impact on the other countries foreign exchange market by employing the GARCH family model. On the other hand the study done Mohammed et al. (2017) related to measuring contagion phenomenon between foreign exchange markets of twenty selected nations in different time scenario during Subprime crisis & Euro-Zone crisis advocates that, the contagion effects come from USA and euro area impact return series of all exchange rates for the period of 2007-2012. Furthermore Malik (2005) and Wan and Kao (2008) documented that the volatility in euro is much more than the British pound. On the other hand, Aloui (2007) investigated the stock as well as currency market of 5 dominant European countries together with US market with the help of EGARCH model. In the recent study, Chkili and Nguyen (2014) found that there is volatility spillover from stock market to exchange rate market with no feedback from exchange rate market of BRICS countries, i.e. Brazil, Russia, India, China and South Africa. Authors carried their study by applying the switching model. Das et al. (2016) endeavored to explore the return co-movements and volatility spillover in the most dominating foreign exchange markets as well as four emerging market by applying the GARCH DCC and VAR techniques.

3. Database and methodology

2.1. Data

For this empirical research, the daily data of exchange rate of different tradable currencies such as Australian dollar, Canadian dollar, Japanese yen, and Swiss franc has been gathered. Since the objective is to illustrate the usefulness of the empirical modeling strategy, the sample consists of three emerging markets such as Indian, Malaysian and

Singapore. Data for the study has been gathered from the Federal Reserve Bank of St. Louis database. The data of all the variables have been converted into the natural log return form. Daily data consist of seven years from June 2012 to May 2019 of all the variables and data of none trading days has been escaped as done by much previous empirical analysis for the making study convenient.

Table 1. *Descriptive statistics of currency return in the Indian market*

	INR/AUD	INR/CAD	INR/YEN	INR/FRANC
Mean	-028	-0.15	-0.23	0.009
Std Dev	0.67	0.60	0.81	0.80
Kurtosis	5.08	7.9	7.07	75.9
Skewness	-0.02	.29	0.16	4.45
Jarque-Bera	153.3***	33.15***	674***	9.9***
Q Stat	50.18	40.39	35.7	58.08**
Q^2stat	181.6***	725***	4989***	1536**

Note: *** is significant at 1% and ** at 5% critical value, INR represents Indian National Rupees.
Source: Federal Reserve Bank of St. Louis.

Table 2. *Descriptive statistics of currency return in the Malaysian market*

	MYR/AUD	MYR/CAD	MYR/YEN	MYR/FRANC
Mean	-0.015	0.001	-0.09	0.023
Std Dev	0.67	0.63	0.80	0.80
Kurtosis	5.14	6.89	7.59	61.71
Skewness	0.06	0.076	0.35	3.81
Jarque-Bera	25.31***	3161***	25.31***	1.58***
Q Stat	58.75**	38.93	32.77	42.17
Q^2stat	2458**	468**	189**	564**

Note: *** is significant at 1% and ** at 5% critical value, MYR represents is Malaysian Ringgit.
Source: Federal Reserve Bank of St. Louis.

Table 3. *Descriptive statistics of currency return in Singapore's market*

	SGD/AUD	SGD/CAD	SGD/YEN	SGD/FRANC
Mean	0.001	-0.012	-0.019	0.013
Std Deviation	0.87	0.40	0.58	0.63
Kurtosis	38.85	5.38	7.81	179.53
Skewness	-2.72	0.001	0.33	8.46
Jarque-Bera	3.8e+4***	11.74***	946.3***	1.2e+4***
Q Stat	38.97	30.10	30.58	62.81**
Q^2stat	754**	627**	129**	5614**

Note: *** is significant at 1% and ** at 5% critical value, SGD represents Singapore dollar.
Source: Federal Reserve Bank of St. Louis.

Tables 1, 2 and 3 documents the descriptive statistics of foreign exchange in perspective of India, Malaysia, and Singapore, it can be seen that there is heterogeneity in the result of descriptive statistics of foreign exchange rate market. The outcome of the Table 1 show that in Indian foreign exchange markets the average return of all the tradable currencies is negative except the return of Swiss franc. On the other hand, the result also provides evidence that all the currencies return is not normally distributed as well these variables has serial correlation because the result of Jarque-Bera and Q squire are significant. Lastly, according to the descriptive statistics outcome of Singapore market as depicted in Table 3 reveals that average return of Australian dollar and the Swiss franc is positive while other currencies are negative.

Table 4. *Unit root test of data*

Variables	ADF unit root test	PP unit root test
INR/AUD	-26.41***	-27.48***
INR/CAD	-16.35***	-16.89***
INR/JPY	-20.21***	-20.39***
INR/FRANC	-23.22***	-23.75***
MYR/AUD	-18.95***	-19.05***
MYR/CAD	-19.36***	-19.75***
MYR/JPY	-25.87***	-26.07***
MYR/FRANC	-18.58***	-19.08***
SGD/AUD	-17.96***	-18.31***
SGD/CAD	-20.85***	-20.87***
SGD/JPY	-22.55***	-22.67***
SGD/FRANC	-15.87***	-16.04***

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

3.2. Empirical estimation method

The relevant objective of current empirical investigation is to unearth the conditional volatility of exchange rate return, their correlation dependency and interdependency as well spillover effect in above mentioned countries foreign exchange rate markets. The econometric techniques used for this empirical analysis have two elements. First of all the multivariate GARCH models with alternative assumptions have been applied. The current analysis employs the GARCH DCC (Dynamic conditional correlation) model which was recently advanced by the Engle and Sheppard in (2011). The Dynamic Conditional Correlations (DCC) model has become a dominant mechanism in the volatility transmission studies as it has power to preserve the parsimony of uni-variate GARCH models of individual assets volatility like time-varying correlations which makes it most sophisticated and robust method of volatility modeling. (Engle and Sheppard, 2001).

3.2.1. The DCC-GARCH model

In the DCC model, the diagonal variable of H is modeled as GARCH models. The off-diagonal variables are modeled on nonlinear functions of the diagonal terms:

$$H_{ij,t} = \partial_{ij,t}\sqrt{H_{ii,t}H_{jj,t}}$$

Where $\partial_{ij,t}$ Follows a dynamic process, rather than being constrained is constant as in the CCC specification. Two additional coefficients, λ_1 and λ_2 are adjustment parameters that govern the evolution of the conditional correlations. They must positive and sum to less than one. A test for detecting, the sum of these parameters equaling zero tests the DCC model against the special case of the CCC model.

$$Y = \zeta x_t + e_t$$

$$e_t = \sqrt{H_t}\, v_t$$

$$H_t = \sqrt{D_t} R_t \sqrt{D_t}$$

$$R_t = diag\ (Q_t)^{-1/2}\ Q_t (diag(Q_t)^{-1/2})$$

$$Q_t = (1 - \lambda_1 - \lambda_2)R + \lambda_1 e_{t-1} + \lambda_2 Q_{t-1}$$

Where D_t a diagonal matrix of conditional variances is, R is a matrix of conditional quasi-correlations, and e_t is a vector of standardized residuals, ${D_t}^{-1/2}\ e_t$. R is a weighted average of the unconditional VCE of the standardized residuals and the unconditional mean of Q_t. All the flexible versions of the MGARCH models are estimated under a multivariate Gaussian t distribution as the normality assumption is rejected in most empirical applications.

3.2.2. The VAR model

$$y_t = \alpha + \sum_{i=1}^{n} \partial\, y_{t-i} + \sum_{i=1}^{n} \gamma_i V_{t-i} + \varepsilon_t$$

In the above VAR model, $y_t$is dependent variable which depends upon its i^{th} past lag as well as the i^{th} lag past lag of V independent variables. The term of α is a constant where ∂ and the γ_s are the coefficients of dependent and independent variables. The term of ε_t is white noise error term which is assumed to be identically independently distributed (i.i.d.). The variance decomposition can be found out after applying the above VAR model.

$$y_t = \alpha + \sum_{i=1}^{n} \partial\, y_{t-i} + \sum_{i=1}^{n} \gamma_i V_{t-i} + \varepsilon_t$$

Where t = 1, 2, 3… Z and ∂ *is* $N * N$ coefficient matrix and it follow a recursion of the form

$$\partial_i = \theta_1 \partial_{i-1} + \theta_2 \partial_{i-2} + \cdots + \theta_n \partial_{i-n}$$

and $\partial_0 = I_n$ and if $\partial_1 = 0$ for $i < 0$

(KPPS hereafter) H-step-ahead forecast error variance decomposition is computed as

$$\beta_{ij}^{g}(H) = \frac{\sigma_{ii}^{-1} \sum_{h=0}^{H-1} (e_i \beta_h \sum e_j}{\sum_{h=0}^{H-1} e_i \beta_h \ \ \sum \beta h\, e_i}, \quad i, j = 1, 2 \ldots . n$$

Where $\sum$ is variance matrix for the error vector, σ_{ii} is the standard deviation of the epsilon term of i^{th} variables and e is an $(n * 1)$ vector with one as the i^{th} element and 0 otherwise. To obtain a unit sum of each row of the variance decomposition, each entry of the variance decomposition matrix is normalized, so that construction the decomposition including own shocks in each market equal to one. According to the characteristics of generalized VAR, $\sum_{j=1}^{n} \beta_{ij}^{g}(H)$ is not equal to 1, and then normalize each entry of the variance decomposition matrix by the row, as follows

$$\beta_{ij}^{g}(H) = \frac{\beta_{ij}^{g}(H)}{\sum_{j=1}^{n} \beta_{ij}^{g}}$$

Using these results, the spillover index is constructed as follow:

Total spillover index.

$$s^{g}(H) = \frac{\sum_{i,j=1}^{n} \beta_{ij}^{g}(H)}{\sum_{i,j=1}^{n} \beta_{ij}^{g}(H)} * 100$$

Where i = return in one Market and j = return in other different Market. The index measure the contributions from the spillovers of volatility shocks across return of asset to the total forecast error variance

3.2.3. Directional spillovers

The directional spillovers help us recognize both magnitude and the direction of the spillover effect the result of variance composition do not hinge on the sequence of the variable. The directional spillovers received by variable i from all other variables j are defined as

$$S_{j\to i}^{g}(H) = \frac{\sum_{j=1}^{N} \beta_{ij}^{g}(H)}{\sum_{j=1}^{n} \beta_{ij}^{g}(H)}_{i\neq j} * 100$$

Where i = return of one Market and j = return of other Market. We can defined as return spillover effects, indicated the directional spillovers received by one country foreign exchange market from others countries Markets.

4. Empirical results

4.1. Return co-movement

First of the entire cross-correlation of different currency is calculated in different foreign exchange market by applying the GARCH DCC model.

Table 5. *Cross-correlation of return of Indian foreign exchange market*

	INR/AUD	INR/CAD	INR/JPY	INR/FRANC
INR/AUD	1***	0.62***	0.46***	0.34**
INR/CAD	0.62***	1***	0.50***	0.39***
INR/JPY	0.46***	0.50***	1***	0.48***
INR/FRANC	0.34**	0.39***	0.48**	1***

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

Table 6. *Cross-correlation of return of Malaysian foreign exchange market*

	MYR/AUD	MYR/CAD	MYR/JPY	MYR/FRANC
MYR/AUD	1***	0.67**	0.27**	0.42**
MYR/CAD	0.67**	1***	0.51	0.50***
MYR/JPY	0.27**	0.51*	1***	0.56**
MYR/FRANC	0.42**	0.50***	0.56**	1***

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

Table 7. *Cross-correlation of return of Singapore's foreign exchange market*

	SGD/AUD	SGD/CAD	SGD/JPY	SGD/FRANC
SGD/AUD	1***	0.085**	-0.05***	-0.566**
SGD/CAD	0.085**	1***	-0.019**	0.07**
SGD/JPY	-0.05***	-0.019**	1***	0.22**
SGD/FRANC	-0.566**	0.07**	0.22**	1***

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

Tables 5, 6, and 7 document the return cross-correlation of tradable currencies perspective of Indian, Malaysian and Singapore foreign exchange markets. The cross-correlation result of the Table 5 reveals that in Indian foreign exchange market, the return of all currency is positively related to each other. The correlation between the return of Australian and the Canadian dollar is the highest one while the association between the return of Australian dollar and the Swiss franc is the lowest one in comparison with other tradable currencies return in the Indian foreign exchange market. On the other hand in Malaysian foreign exchange market also, the return of all currency is positively related to each other. The correlation between the return of Australian and the Canadian dollar is highest one while the association between the return of Australian dollar and the Japanese yen is the lowest one in comparison with other tradable currencies return in the Malaysian foreign exchange market as shown by the Table 7.

Table 8. *DCC estimates in all three foreign exchange market*

	Indian foreign exchange market	Malaysian foreign exchange market	Singapore foreign exchange market
α	0.012***	0. 042***	0.049***
β	0.97****	0.723***	0.896***
$\alpha + \beta$	0.982***	0.765**	0.945***

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

The result of GARCH DCC's reveals that value of α and β are statistically significant, which indicates that the second moment of the return of selected tradable currencies is time varying in the Indian, Malaysian and Singapore's foreign exchange market. Furthermore, the sum of α and β is less than one which also indicates that the DCC model of estimation is perfect. On the other hand to understand the nature of volatility and their behavior of each currency the univariate GARCH estimation has also done for each variable.

4.2. ARCH and GARCH effect

Table 9. *Individual ARCH and GARCH in Indian foreign exchange market*

	ARCH($\boldsymbol{\alpha}$)	GARCH($\boldsymbol{\beta}$)	$\boldsymbol{\alpha + \beta}$	Status
AUD	0.049*	0.59*	0.639	Persist for long time
CAD	0.036*	0.62*	0.63	Persist for long time
JYP	0.057*	0.11*	0.16	Persist for long time
FRANC	0.011*	0.18*	0.191	Persist for long time

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

Table 10. *Individual ARCH and GARCH in Malaysian foreign exchange market*

	ARCH($\boldsymbol{\alpha}$)	GARCH($\boldsymbol{\beta}$)	$\boldsymbol{\alpha + \beta}$	Status
AUD	0.04*	0.91*	0.95	Persist for long time
CAD	0.082*	0.59*	0.672	Persist for long time
JYP	0.0127*	0.37*	0.38	Persist for long time
FRANC	0.004*	0.25*	0.254	Persist for long time

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

Table 11. *Individual ARCH and GARCH in Singapore's foreign exchange market*

	ARCH(α)	GARCH(β)	$\alpha + \beta$	Status
AUD	0.012*	0.20*	0.21	Persist for long time
CAD	0.12*	0.54*	0.66	Persist for long time
JYP	0.16*	0.49*	0.65	Persist for long time
FRANC	0.009*	0.220*	0.22	Persist for long time

Note: *** is significant at 1% and ** at 5% critical value.
Source: Federal Reserve Bank of St. Louis.

The ARCH and GARCH outcome of all three foreign exchange markets have been exhibited in Tables 9, 10, and 11 respectively. The outcome of the Table 9 shows the evidence of ARCH and GARCH effect in the foreign exchange market of India. The sum of ARCH and GARCH is less than one as well as significant is 5% or 1% critical value. As per as Malaysian foreign exchange market is concerned the outcome reveals that combined effect of ARCH and GARCH are less than one and significant, see Table 10. Lastly, the outcome of Singapore's foreign exchange market reveals that the ARCH and GARCH effect is significant as well as it is less than one as shown in Table 11.

4.3. Conditional variance

Figure 1. *Conditional variance of Indian foreign exchange market return*

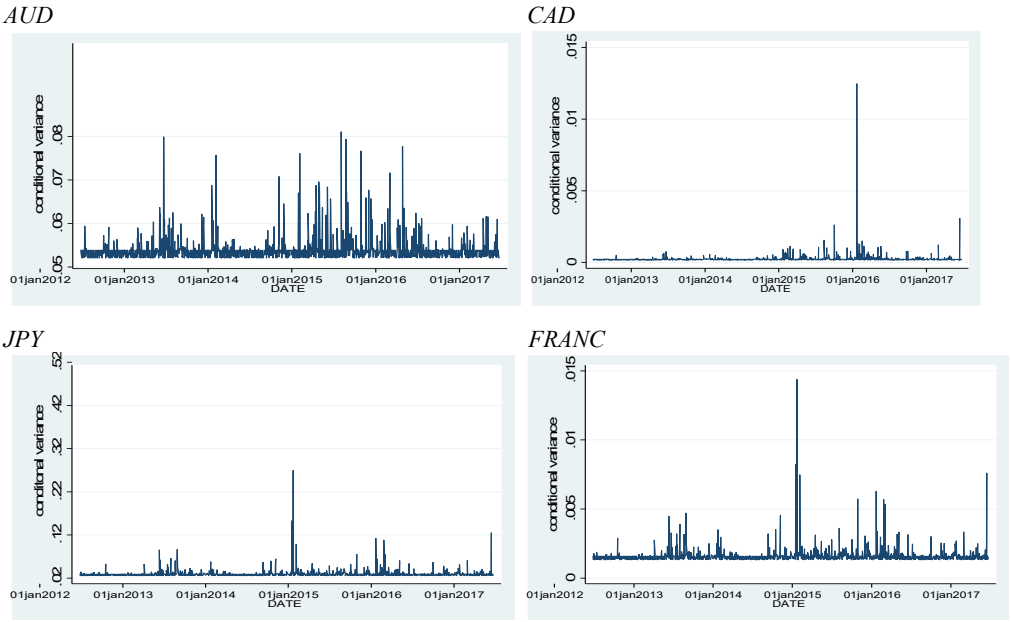

Figure 1 show the conditional return volatility of various currencies in the Indian foreign exchange market. The conditional variance of Australian dollar shows evidence of high volatility in comparison to other currencies in the Indian foreign exchange market. The persistence of high-level volatility in the return of Australian dollar can be seen between the periods of 2015 to 2016. Return of Canadian dollar shows stability till the period of 2015. But after that period it becomes slightly volatile. Japanese yen shows the continuing trend of increasing and decrease in volatility and it reaches to the pick level at January 2015.

Figure 2. *Conditional variances of Malaysian foreign exchange market return*

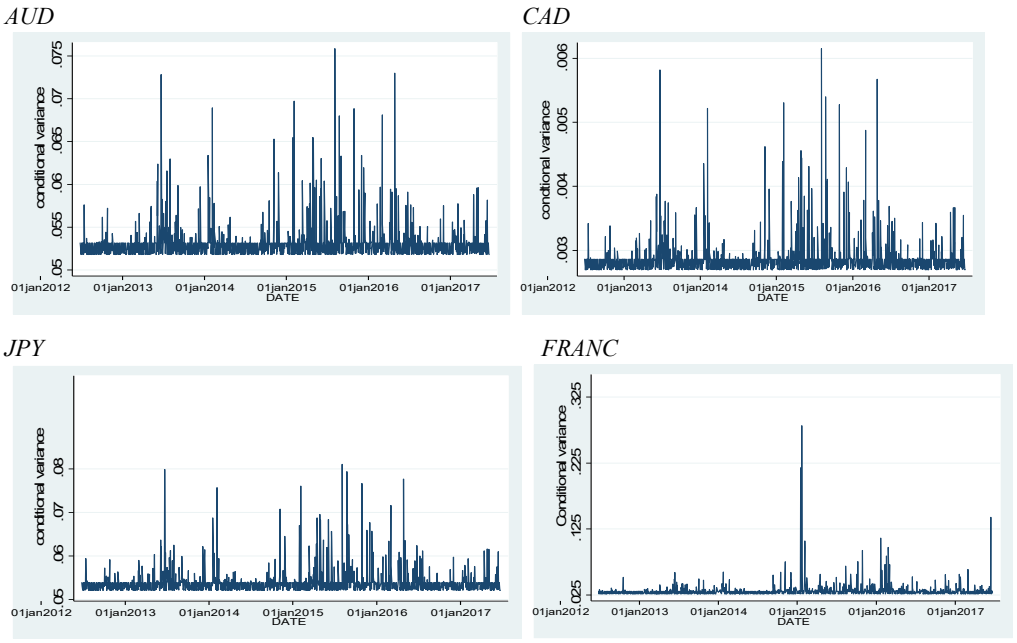

Figure 2 reveals the conditional return volatility of various currencies in the Malaysian foreign exchange market. The conditional variance of Swiss Franc shows evidence of high volatility in comparison to other currencies in the Indian foreign exchange market.

The persistence of high-level volatility in the return of Swiss Franc can be seen between the periods of 2015 to 2016. Return of Canadian dollar shows stability till the period of 2015. But after that period it becomes slightly volatile. Japanese yen shows the continuing trend of increasing and decrease in volatility and it reaches to the pick level at January 2015.

4.5. Volatility spillover

In this segment, it has been attempted to discover the net volatility spillover in Indian, Malaysian and Singapore's foreign exchange market. For this procedure, the vector autoregressive system (VAR) has been utilized and variance decomposition has been enumerated.

The raw diagonal of the following tables shows that the certain fraction of the total volatility of a variable has been explained by the other variable and the column of the table reveals the percentage of the volatility of other variables has been calibrated by it.

The last raw of the tables unearth the total net spillover impact of each variable and also reveals whether the variable is shocked transmitter or shock observer in the financial market.

Table 12. *Volatility spillovers in Indian foreign exchange market*

From					
	INR/AUD	INR/CAD	INR/JPY	INR/FRANC	Contribution from other
To					
INR/AUD	98.3	0.00	1.013	0.68	1.7
INR/CAD	6.2	90.9	0.2	2.7	9.1
INR/JPY	1.1	0.4	96.5	2.0	3.5
INR/FRANC	2.99	2.79	5.3	88.927	11.08
Contribution Including own	108.59	94.09	103.0.13	94.307	
Net spillover effect	8.59	-(5.91)	3.013	-(5.693)	

Note: The VAR lag length of order 1 was selected by the HIC Criterion. Values reported are the variance decomposition based on 5 - a step ahead forecasts.
Source: Federal Reserve Bank of St. Louis.

The outcome of the Table 12 reveals the volatility spillover of Indian foreign exchange market.

The result of volatility spillover reveals that in Indian foreign exchange market the Australian dollar is a net transmitter of volatility. It so, because the fraction of volatility of Australian dollar that is explained by the other currencies is only 1.7%, however at the same time 8.59% of the volatility of the other currencies has been explained by the Australian dollar. The net spillover effect is positive 8.59% which highest among the other currencies, which further document that Australian dollar, is the highest transmitter the volatility in Indian foreign market.

Table 13. *Volatility spillover in Malaysian foreign exchange market*

From					
	MYR /AUD	MYR /CAD	MYR /JPY	MYR /FRANC	Contribution from other
To					
MYR/AUD	95.3	2.10	1.92	0.68	4.7
MYR/CAD	0.2	95.9	3.2	0.7	4.1
MYR/JPY	0.43	0.07	99.5	0.0	0.5
MYR/FRANC	0.25	1.36	9.3	89.09	10.91
Contribution Including own	96.18	99.43	113.92	90.47	
Net spillover effect	-(3.82)	-(0.57)	13.92	-(9.53)	

Note: The VAR lag length of order 1 was selected by the HIC Criterion. Values reported are the variance decomposition based on 5 - a step ahead forecasts.
Source: Federal Reserve Bank of St. Louis.

The outcome of the Table 13 exposes the volatility spillover of Malaysian foreign exchange market. The result of volatility spillover reveals that in Malaysian foreign exchange market the Japanese yen seems the mostly strong currency in regards to other currencies.

The outcome of volatility spillover reveals that it is a net transmitter of volatility in Malaysian foreign exchange market. It so, because the fraction of volatility of Japanese yen that is explained by the other currencies is only 0.5%, however at the same time 13.92% of the volatility of the other currencies has been explained by the Japanese yen. The net spillover effect is positive 13.92% which highest among the other currencies, which further documents that, the Japanese yen is the highest transmitter of volatility and most dominated currency in Malaysian foreign market.

Table 14. Volatility spillovers in Singapore's foreign exchange market

From					
	SGD/AUD	SGD/CAD	SGD/JPY	SGD/FRANC	Contribution from other
To					
SGD/AUD	98.48	0.35	0.11	1.06	1.52
SGD/CAD	1.47	96.69	0.34	1.50	3.31
SGD/JPY	0.35	0.24	75.99	23.42	24.01
SGD/FRANC	0.93	0.32	0.21	98.54	1.46
Contribution Including own	101.23	97.6	76.65	124.52	
Net spillover effect	01.23	-(2.4)	-(23.35)	24.52	

Note: The VAR lag length of order 1 was selected by the HIC Criterion. Values reported are the variance decomposition based on 5 - a step ahead forecasts.
Source: Federal Reserve Bank of St. Louis.

The results of Table 14 manifest the volatility spillover Singapore's foreign exchange market. From the result of spillover effect, it can be inferred that in Singapore's foreign exchange market Swiss franc is most dominating currency among the other currency. It so, because the fraction of volatility of Swiss franc that is explained by the other currencies is only 1.46%, however at the same time 24.52% of the volatility of the other currencies has been explained by the Swiss franc.

5. Conclusions and policy implication

As effectively translated over that, there is an expanding measure of writing focused to take after the volatility of foreign exchange with the assumption of no potential results of co-movement of volatility. While observational examination that fixated on possible results of co-movement of the volatility of foreign exchange concentrated on catching volatility of return co-movement and relationship interdependencies after some time by taking the world's best overwhelming money, for example, US dollar, British pound and the euro in context of the western financial market. A large portion of the examination neglected to think about the other tradable currencies of the world for such investigation. Numerous examinations have taken thought of examination of return volatility of different monetary forms separated of US dollar, euro yet the greater part of concentrates centered to a specific nation's outside trade showcase, while numerous investigations are focused to western world which has considered to the investigation in different nations foreign exchange markets. There is a vast bit of broad correct examination concentrated on western economies while none of the examinations focused on the Asian point of view. This experimental examination making an extra commitment to previously mentioned writing by three ways. To begin with, it propels the current writing by considering top three Asian economies, for example, India, Malaysia, and Singapore together. Second, this examination considers other dominated currency, for example, the Canadian dollar, Japanese yen, Swiss franc and Australian dollar to comprehend the return volatility and overflow affect while past examination has given the significance top dominating currencies, for example, US dollar, euro for their investigation. Accordingly, this investigation is making an expansion by considering those monetary forms which have never been investigated by the before examines.

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Non-linear effect of public debt on economic growth: The case of Tunisia

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Abstract. *This study examines the non-linear effect of public debt on economic growth in Tunisia, making use of the autoregressive distributed lag (ARDL) approach and annual time series data covering the period 1986 to 2019. The results show that public debt has a double impact on economic growth in the long run, which confirms the existence of a non-linear relationship between the two variables in the long run. Thus, they indicate that public debt stimulates growth before contradicting it when it exceeds a certain critical threshold. Indeed, the estimated optimal public debt threshold is 64.4% of GDP. Although the impact of public debt on short-term economic growth is statistically insignificant, this implies that the debt-growth relationship in the short term does not follow a non-linear pattern.*

Keywords: non-linear, public debt, economic growth, ARDL.

JEL Classification: C52, O47, R15.

1. Introduction

The great economic recession that followed the international financial crisis, which started in 2007 and intensified in 2008, had a considerable negative impact on public finances in advanced economies, leading to a sharp deterioration in fiscal positions, with government deficits rising sharply in most countries. These large fiscal imbalances have led countries facing budget surplus problems to resort to debt flows to stabilise and boost economic activity. In addition, many of these countries have taken on debt, sometimes very heavily, making public debt a major problem for some of them, especially in the Euro area. As a result of the mis-investment of these debt flows, they took on more debt, which led to the emergence of the sovereign debt crisis in the Euro area. Although the debt problem caused by high levels of indebtedness in most developed countries is a concern for these countries, it is also a concern for developing countries, as over the past decades their public debt has risen to considerable levels due to poor economic performance and slowing growth.

In view of all the above, the debate in political and academic circles on the impact of public debt on economic growth has been transformed from a simple research of causal effects between debt and growth to a more profound research of the non-linear effects of debt on growth in order to identify the optimal threshold at which public debt could have a negative impact on economic growth. This thematic area has grown in importance mainly since the seminal work of Reinhart and Rogoff (2010) and has recently been widely studied in the economic literature.

In this respect, given the precarious situation of public finances in Tunisia characterised by budget deficits accumulated over the last few years, which then led the public authorities to resort to increased indebtedness, the present study focuses on the case of the Tunisian economy with the aim of examining the non-linear effect of public debt and economic growth as well as determining the optimal threshold of public debt, beyond which public debt has a negative impact on economic growth.

The remainder of the paper is organised as follows. A brief review of the literature on empirical studies is provided in section 2. Section 3 discusses the methodology, including model specification and data. Section 4 presents the empirical results and a brief discussion of the findings, while Section 6 provides a conclusion.

2. Literature review

The relationship between public debt and economic growth has been a long-standing topic of debate and controversy in the economic literature. On the theoretical level, Panizza and Presbitero (2013) point out that theoretical models give ambiguous results regarding the relationship between public debt and economic growth and that it is therefore primarily an empirical question. The empirical literature on the relationship between public debt and economic growth has undergone a new trend, attracting increasing attention, both in the political arena and in academia, since the seminal work of Reinhart and Rogoff (2010) and renewed interest since the sovereign debt crisis in the Euro area in 2010. It focused mainly on the non-linear relationship between debt and growth introduced by the two authors in

their famous study "Growth in a Time of Debt". Indeed, the two authors compiled data for 44 developed and developing countries spanning approximately two centuries, from 1790 to 2009, and they distinguish four regimes, using histograms, namely low debt economies (less than 30% of GDP), with medium-low public debt (between 30% and 60% of GDP), and with a GDP), medium-high public debt (between 60% and 90% of GDP) and public debt high (more than 90% of GDP). Their results show that the public debt does not affect severely real long-term growth when the ratio of public debt to GDP is below a threshold of 90% of GDP, once the debt ratio exceeds this 90% of GDP threshold, the median growth rate declines by 1% and the average growth rate declines substantially more. However, the controversial results of this study have led several researchers to question whether there is a universal fixed point at which the ratio of public debt to GDP hinders economic growth. Thus, Reinhart and Rogoff's (2010) study also provided a new perspective on the empirical literature on the link debt-growth correlation, focusing in particular on assessing the main findings of their paper. In this respect, several recent empirical studies have strongly criticised the findings of Reinhart and Rogoff (2010). For example, Herndon, Ash and Pollin, in a 2013 study, were the first to shed light on Reinhart and Rogoff's (2010) pioneering paper. Using their data directly, the authors point to problems with database coding errors, selective exclusion of available data and incorrect summary statistics weighting errors. After correcting these errors, Herndon and his co-authors point out that the average growth rate beyond the 90% public debt to GDP ratio is actually 2.2% and not -0.1%.

In addition, other studies have shown that the optimal threshold of public debt, estimated at around 90% of GDP by Reinhart and Rogoff (2010), should not be considered as a fixed threshold reflecting the reality of all countries. For example, Caner et al. (2010) analysed the threshold effects of the average public debt-to-GDP ratio on long-term real GDP growth by estimating a threshold least squares regression in a representative sample of 101 countries, both developed and developing, over the period 1980-2008. The results of their estimation show the existence of a threshold effect in the debt-growth relationship for the whole sample studied, where the estimated debt threshold was 77%. Indeed, from this threshold, each additional percentage point of debt leads to a decrease of 0.017 percentage points in real GDP growth. However, their analysis of the sub-sample of 75 developing countries shows that the optimal debt threshold is about 64%. In a more recent study conducted on a sample of 135 countries (24 developed, 111 developing) over the period 1970-2012, Karadam (2018) examines threshold effects in the relationship between debt and growth using a PSTR (Panel Smooth Threshold Regression) model developed by Gonzales et al. (2005) which is an extension of the PTR (Panel Threshold Regression) model initiated by Hansen (1999). Their results reveal that the long-term effect of debt on growth shifts from positive to negative, when the debt threshold exceeds 106% GDP, although the threshold is lower for developing countries, and is equal to 88% of GDP.

Also, there are other studies that, on the one hand, have not been able to identify a robust non-linear relationship between public debt and growth and, on the other hand, reject the idea of a common and even well-defined debt threshold for all countries. For example, Panizza and Presbitero (2014), using the instrumental variables method, analysed the causal relationship between public debt as represented by the ratio of public debt to GDP and real

GDP per capita growth in a sample of 18 OECD countries. The results show a negative correlation between the two variables, but do not validate the causal effect of public debt on growth. Indeed, the relationship between debt and growth could simply be explained by the fact that low economic growth leads to high levels of public debt and not vice versa. For their part, Eberhardt and Presbitero (2015) examined the relationship between public debt and long-term economic growth in 18 countries including 118 developed, emerging and developing countries over the period 1960-2012 by adopting two linear and non-linear specifications with a dynamic panel model. They concluded that there is a negative relationship between public debt and long-term growth in the countries considered, but no evidence of systematic non-linearity, and they also rejected the idea of a common threshold for all countries. In the same vein, focusing on dynamic models of heterogeneous panel data with cross-sectional dependent errors, Chudik et al. (2017) analyse the relationship between public debt and economic growth in a sample of 40 developed and developing countries over the period 1965-2010. Their results confirm those of Eberhardt and Presbitero (2015), according to which public debt has negative long-term effects on economic growth and there is no evidence of a universally applicable threshold effect in the relationship between these two variables.

In an IMF publication, Pescatori et al. (2014) use a new methodology that differs from Reinhart and Rogoff (2010), allowing them to take the impact of economic growth on public debt and not the other way around, with a particular focus on the medium- and long-term relationship between the debt-to-GDP ratio and subsequent GDP growth, not just the short-term link. Their study covers data from 188 IMF member countries between 1875 and 2011. According to their analysis, the co-authors reject the idea that there is a well-defined threshold of public debt beyond which growth prospects are seriously compromised. On the contrary, the medium-term association between public debt and economic growth declines for higher levels of debt. Similarly, they find that the relationship between debt level and growth is influenced by the debt trajectory, which means that the debt trajectory can also be the debt level to understand future growth prospects.

Despite criticism of Reinhart and Rogoff's (2010) work, several empirical studies largely support their conclusions, finding evidence of a non-linear relationship between debt and growth and a negative effect when the debt threshold is around 90% of GDP. For example, Kumar and Woo (2010) examine the impact of high public debt on long-term economic growth for a panel of 38 advanced and emerging economies over the period 1970-2007. The results of their examination using a dynamic panel regression model suggest an inverse relationship between initial public debt and subsequent GDP growth. Indeed, a 10 percentage point increase in the public debt/GDP ratio is associated with a 0.2 percentage point decrease in annual real GDP per capita growth. Thus, this negative effect is amplified when public debt exceeds the 90% of GDP threshold. Moreover, only high levels of debt, above 90% of GDP, have a significant negative effect on growth. Cecchetti, Mohanty and Zampolli (2011) analysed the relationship between debt and economic growth based on a panel threshold regression (PTR) model originally proposed by Hansen (1999) for a sample of 18 OECD countries (all from advanced economies) over the period 1980-2010 and found that, although there is a critical threshold of around 85% of GDP, above this threshold public debt negatively affects GDP growth. Indeed, a 10 percentage point increase in the

public debt-to-GDP ratio leads to a decline in real GDP per capita growth of more than one-tenth of a percentage point. Furthermore, Checherita-Westphal and Rother (2012) explore the average impact of central government debt on GDP per capita growth in 12 Eurozone countries over four consecutive decades starting in 1970. The results of their estimations using both the fixed-effects panel method and the instrumental variables method in a growth model based on a conditional convergence equation including a quadratic term for the ratio of gross government debt to GDP show that the relationship between government debt and GDP per capita growth is non-linear in the form of an inverted "U" curve. Indeed, debt has a negative impact on growth when it exceeds the threshold around 90-100%. In other words, high debt growth rates, on average, are associated with lower long-term growth rates at debt levels above 90-100% of GDP. However, the negative effects of high debt to growth can arise as soon as it reaches 70% of GDP. In the same geographical space, Baum et al. (2013) used a dynamic threshold panel model originally developed by Caner and Hansen (2004) to examine the non-linear impact of public debt on GDP growth over the period 1990-2010. Their results show that the short-run impact of public debt on GDP growth is positive and highly statistically significant, but that its impact becomes insignificant, especially when public debt reaches the threshold of 67% of GDP. However, above a threshold of 95% of GDP, the impact of additional debt on economic growth becomes negative. Minea and Parent (2012) have tested the pertinence of the 90% threshold of the public debt/GDP ratio found by Rogoff and Reinhart (2010) for the sample of 20 developed countries over the period 1946-2009 using a panel threshold model with smooth transition known as PSTR. Their simulations show that government debt has a negative impact on average real GDP growth when the debt-to-GDP ratio is between 90 and 115%. Nevertheless, the authors deduce that the correlation between public debt and average GDP growth becomes positive when the level of public debt reaches 115% of GDP, and more precisely when there is no evidence of a statistically significant relationship when the debt/GDP ratio is between 60 and 90%.

Yet, the recent study by Balázs Égert (2015) entitled "Government debt, economic growth and non-linear effects: Myth or Reality" has changed the perception of the results and the direction of analysis of the debt-growth relationship in the empirical literature. Using non-linear threshold models on panel data for 41 countries and emerging economies (based on Reinhart and Rogoff (2010)) and over the period 1946-2009, Balázs Égert (2015) claims that a non-linear negative relationship between debt and economic growth can be detected, but that it is only observed at much lower levels of public debt (between 20 and 60% of GDP). It also suggests that the threshold beyond which debt has a negative effect on economic growth depends strongly on the coverage of the data (in terms of country coverage and time dimension), the specification of the model and the measure of public debt. Thus, the thresholds determined should not be considered as optimal. They should only be seen as a guide to instruments to make fiscal policies more effective and improve the efficiency of countries' fiscal discipline. Meanwhile, Agbékponou and Kebalo (2019) used Hansen's (1999) non-linear endogenous threshold approach in a panel regression model to analyse the impact of central government debt on economic growth and more specifically to determine the level of public debt that should not be exceeded to sustain economic growth in 15 countries of the Economic Community of West African States

(ECOWAS) during the period 2007-2016. The results obtained from their estimates show the existence of a debt threshold equal to 30.71% of GDP. Thus, beyond this threshold, any additional unit of central government debt has a negative impact on the growth of ECOWAS countries.

Recent work focusing on the case of some countries in the Middle East and North Africa (MENA) region, notably that of Samia Omrane Belguith et al. (2017) and Wissem (2019), supports the conclusions of Balázs Égert (2015) according to which the non-linear negative effect of debt on growth occurs at debt levels approaching 40% of GDP. In a panel of four MENA countries (Egypt, Morocco, Tunisia and Turkey), Samia Omrane Belguith et al. (2017) studied the non-linear impact of public debt on economic growth over the period 1970-2010 using a Panel Smooth Threshold Regression (*PSTR*) *Model*. Their results show that the relationship between debt and growth in these countries is non-linear, in the form of an inverted "U" curve between these two variables, and that the optimal threshold of public debt is around 40% of GDP, beyond which an eventual increase in public debt starts to slow down economic growth. Furthermore, considering panel data for 4 North African countries (Tunisia, Algeria, Morocco and Egypt) covering the period 2003-2012, Wissem (2019) examines the non-linear relationship between public debt and economic growth using the panel threshold regression (PTR) model proposed by Hansen (1999). His results confirm the non-linear relationship between public debt and growth, indicating that the optimal threshold for public debt is around 42.8% of GDP.

More recent studies offer a different way of establishing the impact of debt on growth, taking into account both the short and long-term impact, rather than examining the impact of a single aspect, using a different methodological approach from previous ones, namely the Auto Regressive Distributed Lag (ARDL) approach. For example, Sanusi et al. (2019) analyse the non-linear effects of public debt on economic growth in the 16 countries that make up the Southern African Development Community (SADC) for the period 1998-2016. The authors apply ARDL approach on a quadratic equation. Their results show that public debt has a double impact on economic growth in the long run. This finding confirms the existence of a non-linear relationship between the two variables in the long run, indicating that public debt stimulates growth before counteracting it when it exceeds the critical threshold. Indeed, the estimated optimal debt threshold is 57% of GDP. Although the impact of public debt on short-term economic growth is statistically insignificant, this means that the debt-growth relationship in the short run does not follow a non-linear pattern.

Moreover, the empirical literature includes studies about one country using time series data in their econometric analysis. To our knowledge, few studies have been undertaken on the issue of the threshold effect in the relationship between public debt and economic growth. In a study that focuses on Greece, Pegkas (2019) addressed the issue of the threshold effect in the relationship between the debt of the central government and the country's economic growth over the period 1970-2016 by following the methodology of Bai and Perron (1998, 2003) in the framework of linear models with multiple structural changes. The results show that there is evidence of a negative association between public debt and growth and that the magnitude of this negative relationship between debt and economic growth depends on

debt regimes. Indeed, at debt levels below 23.5% of GDP, any increase in the public debt/GDP ratio is associated with an economic growth effect than at very high debt levels of 109.4% of GDP. Yosra Baaziz and colleagues (2015) examined the dynamic relationship between the high public debt ratio and real GDP growth in South Africa for the period 1980-2014 using a non-linear Smooth Transition Regression (STR) model. The results of their examination reveal that the relationship between public debt and real GDP growth depends on the country's level of indebtedness. Thus, it appears that the negative non-linear effect detected occurs at a debt threshold of 31.37% of GDP.

As regards the case of Tunisia, to our knowledge, few studies have been undertaken on the threshold effect in the relationship between public debt and economic growth. Using a quadratic approach, Walid (2013) analyses the link between public debt and growth for the Tunisian case over the period 1986-2012 and specifically addresses the issue of determining the optimal public debt threshold. According to their analysis, they suggest the existence of a non-linear relationship in the form of an inverted "U" between public debt and economic growth in Tunisia, whose optimal public debt threshold is around 48.5% of GDP. In the same vein, Slimani et al. (2015) investigate the effects of external debt on economic growth over the period 1970-2012. Based on a quadratic specification, the authors come to the conclusion that external debt has a double impact on economic growth in Tunisia, a positive impact up to a threshold of 51%, beyond this threshold, external debt has a negative impact on growth. In addition, Riadh Brini and co-authors (2016), analyse the impact of public debt on economic growth in Tunisia over the period from 1990 to 2013. Adopting the ARDL approach, the authors show that there is a negative long-run relationship between public debt and economic growth by stating that the increase in public debt reduces long-term economic growth in Tunisia. Indeed, a 1% increase in public debt reduces long-term economic growth by about the same percentage, i.e. 0.99%. Thus, the co-authors used the Granger causality test and found that in the short and long run, there is a unidirectional causality between public debt and economic growth in Tunisia.

3. Methodology, data and empirical results

3.1. Econometric methodology

Empirical studies generally adopt a non-linear approach to analyse the relationship between public debt and economic growth. In this context, the study uses a quadratic model, as adopted by Pattillo et al. (2002), to examine the non-linear effect of public debt on economic growth in Tunisia which can be given as:

$$Y_t = \alpha + \beta_1 PD_t + \beta_2 PD_t^2 + \beta_x X_t + \varepsilon_t \quad (1)$$

where: Y_t is the dependent variable which corresponds to the growth rate of real GDP per capita: (GDPC); α is the constant; ε_t represents the error term; PD_t denotes the ratio of public debt to GDP; X_t groups the set of control variables, in particular, three control variables are used, namely Investment, Exports of goods and services (% of GDP) and Inflation rate.

Equation (1) can be rewritten in the following form:

$$GDPC_t = \alpha + \beta_1 PD_t + \beta_2 PD_t^2 + \beta_3 INV_t + \beta_4 INFL_t + \beta_5 EXPR_t + \varepsilon_t \quad (2)$$

The specification of the quadratic model consists in introducing the public debt/GDP ratio variable with its square in the group of explanatory variables. Indeed, the addition of the quadratic term is justified by the possibility that the relationship between public debt and economic growth is non-linear. The non-linearity and the type of relationship between the two variables depend, moreover, on the size and magnitude of the interest coefficients β_1 and β_2 of the model, which reflect the effect of debt on growth. In this context, if both β_1 and β_2 are statistically significant, three conditions are involved: in the case where β_1 is positive and β_2 is negative, then the debt-growth relationship is non-linear in the form of an inverted "U" curve, in the case where β_1 is negative and β_2 is positive, then the debt-growth relationship is non-linear in the form of a "U" curve, and in the case where β_1 and β_2 have the same sign, then the debt-growth relationship is linear.

3.2. Sources and data

The dataset includes annual macroeconomic data for Tunisia covering the period 1986-2019 and is extracted from the Ministry of Finance of Tunisia and the World Development Indicators (WDI) Database.

Table 1. *Description of the variables and data sources*

Symbol	Variables	Description	Source
GDPC	GDP growth rate	Growth rate of real GDP per capita.	World Development Indicators
PD	Public debt	Public debt in percentage of GDP.	Ministry of Finance of Tunisia
PD ^{2}	(Public debt)^2	Squared term of the public debt variable	Own calculations
INV	Investment	Gross fixed capital formation in percentage of GDP.	World Development Indicators
INFL	Inflation rate	Inflation is measured by consumer price index.	World Development Indicators
EXPR	Exports of goods and services	Exports of goods and services as percent of GDP	World Development Indicators

3.3. Empirical results

It is essential to check the stationarity of the variables under consideration as a preliminary step before applying the estimation procedure. We tested the stationarity of the variables concerned with the classical unit root tests Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) not only to determine the degree of integration of each variable but also to avoid spurious regressions. The results of these tests are reported in Table 2 below.

Table 2. *Results of unit root tests*

Variables	Level		First Difference	
	ADF	PP	ADF	PP
GDPC	-5.95*** (0.00)	-5.95*** (0.00)	---	---
PD	-2.59 (0.10)	0.42 (0.80)	-3.94***(0.00)	-4.02*** (0.00)
PD ^{2}	0.27 (0.75)	0.37 (0.78)	-4.01***(0.00)	-3.98***(0.00)
INV	-3.23*(0.09)	-0.97(0.28)	-4.81***(0.00)	-4.81***(0.00)
INFL	-0.30 (0.98)	-0.31 (0.56)	-6.47 (0.00)	-17.87 (0.00)
EXPR	-4.87***(0.00)	-3.13**(0.03)	---	---

Notes: (.) – p.values; ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

The results show that all variables are stationary in first difference as the null hypothesis of the unit root test is not rejected, except for the growth rate of real GDP per capita (GDPC) and exports of goods and services as a percentage of GDP (EXPR) which are stationary in

levels. This means that (GDPC) and (EXPR) are the only variables integrated of order zero (0), while all other variables are integrated of order one (1) and no variable is integrated of order two (I(2)). This result makes the ARDL (Autoregressive Distributed Lag) approach to co-integration developed by Pesaran et al. (2001) most appropriate to estimate our model. This approach is employed as it has several advantages. Firstly, it is more appropriate than in particular Johansen's (1988) technique, which requires all variables to be integrated in the same order, because of its specificity, which is applicable regardless of whether the variables are purely zero-order integrated (I(0)), first-order integrated (I(1)) or mutually co-integrated. Secondly, it is able to overcome correlation and endogeneity problems in the variables under study. Thirdly, the ARDL approach is able to estimate the parameters using a single equation rather than a vector approach where a system of equations is required and it is also more efficient and robust for small samples compared to other techniques. Next, we proceed to examine the co-integration or the existence of a long-run equilibrium relationship between the variables studied using the bounds test of Pesaran et al. (2001) based on the ARDL approach. The results of this test are given in Table 3.

Table 3. *Results of bounds test for co-integration*

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	9.99	10%	2.08	3
		5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Notes: I(0) denotes the lower bound; I(1) denotes the upper bound.

The results of the bounds test show that the value of the F-statistic (9.99) is significantly greater than the upper bound critical values, which implies the rejection of the null hypothesis of no co-integration and confirms the existence of a co-integration relationship between the dependant variable (GDPC) and the explanatory variables concerned.

Table 4. *Results of short-run ARDL estimates*

ARDL (1, 2, 1, 1, 2, 2) selected based on AIC				
Variables	Coefficient	Std. error	t-Statistic	Prob.
D(PD)	0.947540	0.957095	0.990018	0.3360
D(PD) ^{2}	-0.008232	0.007273	-1.131736	0.2735
D(INV)	1.010344	0.342016	2.954084	0.0089***
D(INFL)	0.235516	0.323697	0.727582	0.4768
D(EXPR)	0.147833	0.129588	1.140788	0.2698
ECT(-1)	-1.192573	0.122586	-9.728497	0.0000***

Notes: AIC – Akaike Information Criterion; ***, **, and * represent significance at the 1%, 5% and 10% levels respectively.

The above results show that the ECT error correction term (-1) is statistically significant, its coefficient is negative, which guarantees an error correction mechanism and also confirms the existence of a long-run equilibrium relationship (cointegration) between the growth rate of real GDP per capita (GDPC) and the explanatory variables. This estimated coefficient is equal to (-1.19), which indicates that about 1% of the previous years' imbalance in the (GDPC) from the explanatory variables is corrected at a speed of 119% with respect to its long-run target, which translates into a relatively fast adjustment towards the long-run equilibrium.

Moreover, the coefficients of the variable public debt to GDP (PD) and that of the same variable in terms of squared (PD^2) are both insignificant, implying that in the short run, public debt has no impact on economic growth for Tunisia. This result implies that, the relationship between public debt and economic growth in Tunisia does not follow a non-linear pattern in the short run.

Furthermore, exports of goods and services as a percentage of GDP (EXPR) and the inflation rate (INFL) are not significant and do not seem to have an impact on economic growth in the short run for Tunisia according to our model. This result is not really surprising, although it is in contradiction with the economic literature.

Although, investment (INV) is statistically significant and has a positive effect on economic growth in the short term. Indeed, an increase of 1% in investment would increase GDP per capita growth by 1.01% ceteris paribus. In fact, this result is in line with the economic literature according to which investment is a real engine of growth and reflects the preponderant role of investment in improving productive capacities and developing socio-economic infrastructures while strengthening economic activity.

Table 5. *Results of long-run ARDL estimates*

ARDL (1, 2, 1, 1, 2, 2) selected based on AIC				
Variables	Coefficient	Std. error	t-Statistic	Prob.
PD	1.695225	0.616443	2.750012	0.0137**
PD^2	-0.013160	0.005128	-2.566345	0.0200**
INV	-0.046244	0.130770	-0.353630	0.7280
INFL	-0.634097	0.187421	-3.383277	0.0035***
EXPR	0.329820	0.151253	2.180583	0.0436**
C	-60.23588	24.30708	-2.478121	0.0240**

Notes: AIC – Akaike Information Criterion; ***, **, and * represent significance at the 1%, 5% and 10% levels respectively.

Contrary to the short term, investment (INV) has no impact on economic growth in the long term, as its significance is not assured. Indeed, the non-significance of investment in the Tunisian context is explained by the absence of favourable climatic conditions as well as by the political instability that characterises the macroeconomic environment. For exports of goods and services as a percentage of GDP (EXPR) and the inflation rate (INFL) respectively, they are statistically significant. The effect of inflation on long-term economic growth is negative (-0.63). Indeed, an increase of one (1) percentage point in the inflation rate reduces GDP per capita growth by 0.63. This result is consistent with the economic literature, where there is a negative correlation between inflation and economic growth. As for (EXPR), its coefficient is positive (0.32) which confirms that the growth-export correlation is positive and supports that it is an engine of growth and development in the long run.

Furthermore, the results obtained for the public debt variables (PD) and (PD^2) indicate that the coefficients associated with these variables of interest are both significant and of opposite sign, the coefficient for the public debt to GDP variable is positive and for the same variable squared (PD2) is negative. This implies that public debt has a double impact on economic growth in the long run. Indeed, at the beginning, a positive impact in accordance with the Keynesian economic vision which stipulates that public debt stimulates economic growth provided that it is used to finance productive investments,

thereafter, it will have a negative impact which is explained by the fact that an uncontrolled accumulation of the level of public debt will absorb the export revenues and the budgetary expenditure for investment and will consequently slow down the economic expansion. These last results justify the thesis of the debt overhang theory according to which a reasonable evolution of the debt should be beneficial to growth and that an accumulation of heavy debt risks slowing down the economic expansion of the country and validate the theoretical statement of a typically non-linear relationship in an inverted "U" shape between public debt and economic growth in the long term for the Tunisian case.

On the one hand, our results about the non-linearity in the debt-growth relationship largely corroborate with the results of the pioneering work of Reinhart and Rogoff (2010) and also with other recent studies such as those conducted by Samia Omrane Belguith et al. (2017) on some MENA countries and Wissem (2019) on some North African countries, who have argued that high debt levels are detrimental to economic growth and that the existing relationship between debt and growth is non-linear. On the other hand, they contradict the findings of other previous studies such as Riadh Brini et al. (2016) who found that, for the case of Tunisia, public debt has a negative impact on economic growth in the long run, and that the negative effect of debt on growth does not seem to be associated with a certain threshold of high debt.

Overall, in the short and long run, our results are in line with some previous work such as Sanusi et al. (2019) on the Southern African Development Community (SADC) countries where public debt in the short run has no impact on economic growth while in the long run it has a double impact and where the relationship between public debt and economic growth follows a non-linear pattern.

Given the non-linear relationship between public debt and economic growth and therefore the existence of a threshold effect of debt on growth, we proceed to determine the optimal threshold of public debt that maximises growth for Tunisia from the results of the estimation of the long-term relationship. Indeed, the optimal level of public debt is determined by maximising the equation linking public debt and growth by deriving the growth rate of real GDP per capita in relation to the public debt to GDP ratio.

$$\mathrm{GDPC} = 1.695225\mathrm{xPD} - 0.013160\mathrm{xPD}^2$$

$$\mathrm{GDPC} = \frac{\partial \mathrm{GDPC}}{\partial \mathrm{PD}} = 0$$

$$\rightarrow = 1.695225 - 2\mathrm{x}0.013160.\,\mathrm{PD} = 0$$

$$\rightarrow P\mathrm{D}^{*} = \frac{1.695225}{0.02632}$$

= 64.4%.

The optimal public debt threshold that maximises economic growth in Tunisia is 64.4% of GDP. Thus, beyond this level of public debt, any additional debt becomes harmful to growth and consequently the Tunisian economy enters a prohibited zone characterised by a considerable drop in growth.

Table 6. *Results of the diagnostic tests*

Tests	Null Hypothesis	Value (Probability)
Jarque-Bera	Normal Distribution	0.25 (0.88)
Breusch-Godfrey Serial Correlation LM	No Serial Correlation	1.67 (0.22)
Breusch-Pagan-Godfrey	Homoskedasticity	0.62 (0.81)
Ramsey RESET	Correctly Specified	0.52 (0.47)

For the tests reported in Table 6 that are relevant for the diagnostic of the estimated ARDL model, we note that the null hypothesis is not rejected for all tests performed and we conclude that the errors are normally distributed, are homoscedastic and are not auto-correlated and finally the model is correctly specified. Furthermore, Figures 1 and 2 show the CUSUM and CUSUM of squares test curves for the estimated ARDL model. As shown in Figures 1 and 2, the plot of the CUSUM and CUSUM of squares test statistics remains within the critical limits of the 5% confidence interval, which implies the non-rejection of the null hypothesis of stability that indicate the stability of the estimated parameters.

Figure 1. *Plot of the CUSUM test*

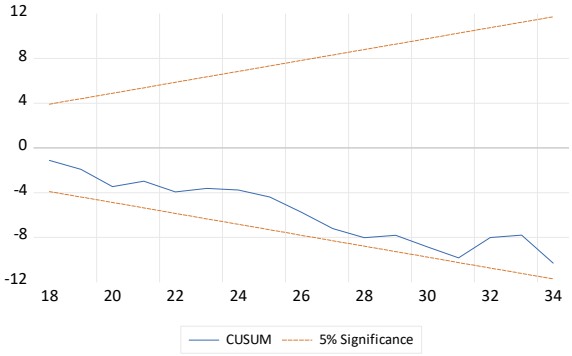
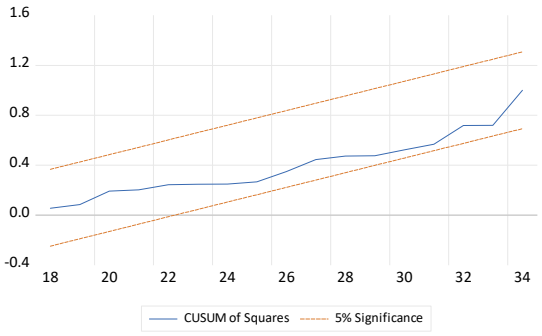


Figure 2. *Plot of the CUSUM of Squares test*



4. Conclusion

The debate on the relationship between public debt and economic growth has recently focused on the non-linear impacts of public debt on economic growth. This paper contributes to this debate by addressing the non-linear effect of public debt and economic growth in the case of Tunisia during the period 1986-2019. The results of our estimation

using the ARDL approach reveal that there is a double impact of public debt on economic growth in the case of Tunisia, which confirms the existence of a non-linear relationship between public debt and economic growth in the long run. This indicates the existence of a threshold level of public debt, estimated at 64.4% of GDP, above which any additional public debt has a negative effect on economic growth in Tunisia. In the short term, the relationship between public debt and economic growth does not follow a non-linear pattern, which implies that public debt has no impact on economic growth in the Tunisian case.

The findings in this study reflect Tunisia's current economic situation, which is characterised by weak economic performance and a considerable level of public debt, and are a strong warning to the Tunisian government to put public debt to productive use while keeping it under control so that it remains within an optimal range to continue to stimulate economic growth.

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Application of single Sharpe index on the optimal portfolio construction using Indian blue-chip stocks

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Abstract. *Portfolio plays an important role for an investor as it reduces the risk and maximize the return on investment. But portfolio construction is a complicated process. To ease the process of portfolio construction many academicians developed optimal portfolio construction model, the Sharpe Single Index model is one of them. The present study has used the Sharpe Single Index model to construct an optimal portfolio in the Indian Capital Market using blue chip companies listed with NSE from 1st January 2011 to 21st January 2021. For the present study total 27 blue chip stocks were found and their weekly and monthly closing price data collected. After analysis of the data the study found that for the weekly data out of 27 securities only 1 security is found to be eligible for the optimal portfolio whereas 18 securities are found for the monthly data. The reason for finding this contrary result may be due to data variation. So, from this finding we can say that for the particular model it is better to use monthly data rather than using daily or weekly data which are too volatile to predict the returns of the securities and construct a portfolio. The result of the study would be useful to long-term investors who can either copy this portfolio or pick and choose from among these stocks.*

Keywords: NSE, Sharpe model, optimal portfolio, risk and risk-premium, blue-chip, securities.

JEL Classification: G1, G11, G12.

Introduction

Investment in stock market is always subject to market risk and this risk can have a significant effect on the wealth of the investors. An investor can minimize or mitigate the risk to a certain extent by constructing a portfolio. A portfolio can be constituted of stocks, bonds or other financial assets or real assets owned for profit by investors. Initially the concept of diversification was found out by Markowitz (1952) who quoted as "do not put all your eggs in one basket" and started the selection of portfolio on the basis of quantitative techniques. He advocated the portfolio construction by diversification of the securities to reduce the portfolio risk. He found out that with the help of statistical tool investors can choose a portfolio where variance of portfolio return will be low but it'll give specific or utmost expected return, having a specified level of variance. For an investor, the number of stocks or other financial assets he wishes to hold in a single portfolio is not restricted. In a single portfolio, depending on the investor's choice, there might be two or more stocks or other financial assets.

Portfolio is usually considered as helpful in reducing the risk of an investor. In a portfolio as and when one or two out of the total stocks perform negatively the other remaining stocks may perform positively, giving a positive return to the investors. There could be again different styles of portfolio such as, high-risk portfolio having assets of higher expected return and highly risky too; or medium-risk portfolio having assets of moderate expected return with moderate risk; or low-risk portfolio having financial assets like Treasury Bills and the majority of the investment on low risk assets i.e. government securities. It is very important for investors either individual or institutional investors, to create a well-diversified optimum portfolio for making profit out of it.

In a financial market, different types of financial assets are available which carry different level of risk. Stock market is considered as a risky market where companies of different sizes and nature are being listed. Accordingly, stocks can be categorised into different sub-groups. Blue-chip stocks are one of the subgroups under stock market.

A stock to be considered as a blue-chip need to be financially sound, healthy operation for years, large market capitalization and most importantly should provide good returns to its shareholders. The blue-chip stocks generally and mostly pay dividend regularly to its shareholders. Another important aspect of a blue-chip stock is that they are the market leader among the companies in the sector they operate in terms of market capitalization. Stability and timely payment of dividends, strong financial backup, goodwill and brands are some of the factors which makes blue-chip securities popular among investor. An investor in India can either directly or by mutual funds invest in blue-chip securities.

The purpose of this paper is to use the Sharpe Single Index model to construct an optimal portfolio of blue chip stocks in the Indian stock market.

Significance and scope of the study

India's economy is among the fastest growing in the world. A significant number of individuals and institutional investors, consisting of national and foreign investors, are actively engaged in the stock market. All market participants are investing cash in the stock market, expecting a decent return from it. The investors are by and large affected by the confusion about the return on investment and high stock market volatility. A portfolio is often useful for an investor at a certain degree of risk to gain the return from the investment. It is often more dangerous to hold a single asset than to hold several assets. While selecting securities for a portfolio, every investor is confronted with a dilemma in deciding on the proportion of investment in any security and usually gets confused. The Sharpe Single Index model is one model which can help investors to build an optimum portfolio in order to help them avoid these unpredictable circumstances. The Sharpe index model helps investors find the most suitable portfolio for their needs. The current study aims to use the Sharpe Single Index model to create an optimal portfolio in the Indian stock market. The study will be helpful for investors to create their own ideal portfolio or serve as a guide for them. The results of the study would show the usefulness of the portfolio construction model. The study covers 27 Indian blue chip stocks which are selected out of the stocks listed under NSE and BSE. These blue chip stocks are selected on the basis of their performance over the last five years. Those stocks having a net debt to equity ratio of less than one and an average return on equity of at least 15% over the last five years are considered for the study. The study uses NSE Nifty 50 index as a market proxy and 91 Days T-Bill as risk-free rates. The 10 years of data between 1st January 2011 and 23rd January 2021 are used for the study.

The paper is structured as follows: Section 2 provides features of blue chip securities; the literature review related to the empirical studies on construction of portfolios are presented in the Section 3; section 4 covers the research design and methodology of the study; section 5 discusses the results of the analysis and finally conclusions are drawn.

Features of blue-chip securities

Blue-chip stocks in India are seen as an investment option that is desirable to achieve long-run financial objectives. Some of the reasons for investing in blue-chip shares include higher quarterly returns; enables the building of corpus; enables diversification of the portfolio; and addresses the recession impact, inflation and economic stagnation. Blue-chip shares may, however, be unsuitable for small investors because of their higher price. Some of the features of blue-chip securities are given below:

- *Assured risk premium.* A blue-chip security provides risk-premium quarterly in the form of dividends. The blue-chip securities are considered as safe investment for investors due to the fact that they are well-established in nature. The certainty of earning steady but guaranteed returns comes with these securities.

- *Credit-Worthiness.* Blue-chip firms have ample resources to quickly clear up their financial dues and commitments. This, in essence, makes creditworthiness high in the shares issued by such firms.
- *Risk factor.* Since large companies are issuing stocks with stable financial performance, the risk factor of blue chip companies is comparatively smaller. By diversifying their investment portfolio, investors will further reduce the burden of risk associated with blue-chip shares.
- *Investment period.* The investment term generally exceeds seven years. Blue chip, thanks to its long investment horizon, is ideal to achieve long term financial goals.
- *Growth odds.* Blue-chip companies are the biggest companies with the maximum potential for growth. This affects blue-chip shares, which over time have a slow but consistent growth.
- *Taxation.* Investors in blue-chip securities get tax benefits in India under Section 80 C of the Income Tax Act. Generally the short term tax on profit more than 1 lakh is 15 percent whereas for the same profit long term capital gain tax is 10 percent.

Major advantages of investing in blue-chip stocks

Blue-chip securities have a strong financial standing, excellent market assessment and a high credit value for their investors and offer them multiple benefits. Investors in blue-chip stocks would benefit from these benefits –

- *Consistent and stable dividends.* Regardless of market conditions, blue-chip investors are relying on their investments for stable returns. These returns are generated in the form of a quarterly split.
- *Achieving financial goals.* It's a long-term investment option with a 7-year investment horizon. Investors are given ample time to build a healthy corpus for their respective financial objectives over the years.
- *Profit of diversification of portfolios.* Blue chip companies are well-known companies which do not generate single channel revenue. It allows them not only to reduce their losses from operational retroactivities but also to spread out the risks associated with blue-stock shares to its investors.
- *Liquidity.* Companies with a high degree of creditworthiness enjoy market goodwill. It directly improves the market value of blue chip securities and turns them into an attractive investor option. This makes it possible to buy and sell these stocks that create liquidity in the market directly.

Literature review

Several studies have been conducted in order to build an optimal portfolio using stocks from the Indian equity market. Using the daily data of 14 stocks of manufacturing sector listed in the NSE Nifty index, Debasish and Khan (2012) had developed an optimal portfolio in accordance with the Sharpe index model.

The study found that only three stocks were qualified for the optimal portfolio of the 14 stocks, namely Hero Motors Corp., Tata Motors and Asian paints. Hero Motors Corp was found to have the highest weightage in the portfolio, accounting for 58.22% of the total.

Sarker (2013) used the Sharpe single index model to create an optimal portfolio on the Dhaka Stock Exchange (DSE). The study looked at the regular closing prices of 164 DSE stocks for a five-year period from July 2007 to June 2012. They found 33 stocks as being ideal for the optimal portfolio with an average return of 6.17 percent. According to the analysis the optimal portfolio's beta is smaller than the market beta, and the portfolio's return is very high as compared to the portfolio volatility.

Desai and Surti (2013) developed an optimal portfolio based on the NSE Nifty 50 companies taking a three-year study cycle. From the 50 firms, only 10 were chosen for the best portfolio using the Sharpe single index model. The study looked at the stocks' volatility as well as their results. They assume that assessing a stock's success allows for the discovery of ideal stocks, which will assist investors in making the best decision possible.

Gopalakrishnan (2014) built an ideal portfolio in the Indian stock market. The analysis used 13 actively traded IT stocks and the S&P CNX Nifty of the National Stock Exchange as a market proxy. The study which used monthly data from 2004 to 2008, discovered that the IT Index returns were extremely volatile in relation to the market index. The study also discovered that there is a substantial relationship between the IT index and the CNX Nifty index, but the IT index outperformed the market index in terms of excess return. The stocks' betas were usually less than one, with the exception of four stocks with betas greater than one.

Using the BSE Sensex's fifteen stocks, Nalini (2014) investigated the Sharpe single index model for constructing an optimal portfolio. The research used six years of annual data from 2009 to 2014. A total of four stocks were found to be suitable for the ideal portfolio.

In the Indian capital market, Mehta (2015) built an ideal portfolio using the Sharpe single index model. The daily closing price of NSE Nifty 50 index companies from July 2012 to July 2014 were used. It looked at the financial results of eight out of fifty firms. After deciding the C* cut-off point, 7 stocks were listed as being eligible for the creation of an ideal portfolio, but funds were eventually allocated to only two stocks using the Sharpe Single index model.

Shah (2015) used the CAPM and Sharpe single index models to create an optimal portfolio using the top 15 BSE stocks by market capitalization. The study used data from January 2000 to March 2015, spanning 16 years. According to the findings, the Sharpe single index model works better for building an optimal portfolio because it provides the exact number of stocks and investment weightage for each stock.

With the aid of the Sharpe single index model, Sathyapriya (2016) built a sectoral optimal portfolio, which included stocks from the Infrastructure and Pharmaceutical sectors. The study used the daily stock data of 20 stocks from the Infrastructure and Pharmaceutical

sectors for four years from 2008 to 2012. He used a single index formula to measure the returns of mutual funds and portfolio strategies. The securities are compared to a cut-off point in order to achieve an acceptable asset mix for investment decisions. These securities were evaluated and rated on the basis of excess returns on beta.

Vinoth and Jayashree (2017) used the Sharpe Single Index model on the select cement companies listed in the BSE. The study used the daily stock price from January 1, 2012, to May 31, 2017 of 21 stocks in the cement industry. Just three stocks were found to be eligible for the optimal portfolio after using the single index model.

Mohith et al. (2017) built an optimal portfolio of energy and FMCG stocks from the NSE 50 index using the Sharpe Single Index model. They used the daily stock price data for five years from January 1, 2011, to December 31, 2015. The analysis included a total of nineteen firms, but only eight of them were eligible for the portfolio.

Raju and Jambotkar (2018) used 20 blue chip stocks listed on the NSE and BSE to build an optimal portfolio in the Indian capital markets. They used daily data for ten years, from January 1, 2007, to October 31, 2017. The study looked at both market risk and stock specific risk of the selected blue-chip stocks, both of which have an effect on the risk premium of the stocks. Nine stocks were found to be eligible for the construction of an optimal portfolio out of a total of twenty, and funds were distributed among them accordingly.

From literature review it has been observed that most of the studies have been conducted sector wise to a limited number of companies included in the NSE Nifty 50 and BSE Sensex. Most of these studies were conducted using daily data taking limited number of stocks and sector. So from the above literature it is clear that the number of securities or stocks inclusion is limited and almost all the studies have been conducted on daily data which is very noisy or fluctuates very frequently.

Another important observation from the literature is that no recent studies on the particular model could be found. During the recent time the market went through some very bad scenario such as covid-19 pandemic which makes it very risky to invest in the market. Thus, in this paper an attempt is made to construct an optimum portfolio using the weekly and monthly data of 27 Blue-chip stocks listed in the NSE with the help of Sharpe index model.

Objectives of the study

1. To construct an optimal portfolio with the help of Blue-chip stocks listed under NSE as on 22nd February, 2021.
2. To analyze the selected Blue-chip securities risk and returns.
3. To examine the market risk and stock specific risk of the selected securities.
4. To decide about the fund allocation to each selected security for the optimal portfolio.

Methodology

A. Data source

The present study is based on secondary data. The data is collected from the NSE official website, RBI official website, Yahoo finance, etc. The other required information relating to the study has been collected from the official websites of the companies, annual reports, books, journals, newspaper and other printed media, etc.

B. Period of the study

The data covers weekly closing stocks price of 10 years from 1st January 2011 to 23rd January 2021.

C. Sample

The blue chip stocks are identified on the basis of their performance over the last five years. Those stocks having a net debt to equity ratio of less than one and an average return on equity of at least 15% over the last five years are considered for the study. For the present study total 28 blue chip stocks were found out but due to unavailability of data for past 10 years one stock was excluded. Finally 27 blue chip stocks have been considered as the final sample for the study and these Blue Chip stocks are listed on the NSE as on 22nd February 2021.

The NSE Nifty 50 index is taken as the market proxy which represent about 66.8 percent of the total free float market capitalization of the stocks listed on the National Stock Exchange as on 29th March, 2019. The NSE Nifty 50 is a well-diversified index in 13 sectors of the economy which consists of 50 stocks. The Nifty 50 index is used for multiple purposes like benchmarking fund portfolios, index funds and index based derivatives.

D. Tools of analysis

The present study used financial techniques and statistical tools for analysing the data. The data were analysed using MS-Excel 2019 and then interpretation of the results are made. The study adopted the following steps for building the optimal portfolio in the Indian capital market.

a) Return of stocks

The return of stocks are calculated as below:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} * 100 \quad (1)$$

Where:

R_{it}= Return of the i^{th} stock.

P_{it}= Current month's closing price of stock.

P_{it-1}= Previous month's closing price of stock.

Return of market

The return of the market proxy is calculated as below:

$$R_{mt} = \frac{P_{mt}-P_{mt-1}}{P_{mt-1}} * 100 \quad (2)$$

Where:
R_{mt}= Return of the market proxy (NSE Nifty 50).
P_{mt}= Today's closing price of market portfolio.
P_{mt-1}= Yesterday's closing price of market portfolio.

Beta or systematic risk

The sensitivity of security prices in relation to market is called beta or systematic risk. Beta measures the volatility systematic risk of a stock or a portfolio in comparison to the market. The systematic risk cannot be diversified which is market specific. The only risk which can be eliminated is unsystematic risk that is stock specific. A well-diversified portfolio can eliminate the unsystematic risk to zero but the systematic risk will be there which is measured by Beta.

$$\beta_i = \frac{COV_{im}}{\sigma_m^2} \quad (3)$$

Where:
β_i– Systematic Risk of a security or portfolio.
COV_{im}– the covariance between security return and market return.
σ_m^2– the variance market return.

b) Excess return to beta ratio

It is the ratio which represent the earning or risk premium (reward earned over and above the risk-free return) to the asymmetry of earning or risk as measured by Beta (β). So it is a return per unit of systematic risk or beta value.

$$Excess\ Return\ to\ Beta\ Ratio = \frac{R_i-R_f}{\beta_i} \quad (4)$$

Where,
R_i= the return of stock *i.*
R_f= risk free rate of return.
β_i= Beta of stock *i.*

Ranking of securities

The potential risk and return relationship of a stock is represented by the excess return to beta ratio. All the selected stocks are ranked according to their performance in comparison of the benchmark market index. The highest excess return to beta ratio stock is ranked top and lowest at the bottom in the descending order.

Calculation of cut-off rate (Ci)

The Ci value is calculated for each securities. The security who has secured the highest Ci value is considered as the cut-off point C*. All the securities arranged above C* have high excess return to beta than the cut-off Ci and all the securities below C* has low excess returns to beta. For calculating the Ci values the following formula is used.

$$C_i = \frac{\sigma_m^2 \sum_{i=1}^{N} \frac{R_i - R_f}{\sigma_{ei}^2} * \beta_i}{1 + \sigma_m^2 \sum_{i=1}^{N} \frac{\beta_i^2}{\sigma_{ei}^2}} \quad (5)$$

Securities are added to build an optimal portfolio which excess return to β ratio' exceeds C_i.

$$\frac{R_i - R_f}{\beta_i} > C_i \quad (6)$$

Building an optimal portfolio

Once the stocks are selected, an investor should determine about the fund allocation to each securities which will generate the maximum return at a given level of risk. The fund allocation formula is given below:

$$X_i = \frac{Z_i}{\sum_{i=1}^{N} Z_i} \quad (7)$$

$$Z_i = \frac{\beta_i}{\sigma_{ei}^2} \left(\frac{R_i - R_f}{\beta_i} - C^* \right)$$

The equation (7) represents the weights on each stock and their sum is equal to one. The next formula shows the relative investment in each stock. The unsystematic risk or the residual variance has a role in determining the amount of fund to be allocate in each stock.

Data analysis and interpretation of weekly data

Table 1 represent the 27 Blue-chip securities which are ranked according to the framework of Sharpe model. The above table show us that the Bajaj Finance Ltd. generated the highest weekly return of 0.95 percent whereas Coal India Ltd. generated lowest weekly negative return of -0.09 percent. The beta value of stocks represent the degree of volatility in securities returns in association with the overall market returns. Beta value more than one means stocks are more volatile than the market whereas beta value less than one represents stocks are less volatile compared to market. In the present study all of the stocks found to have less than one beta value which means all the stocks less volatile than the market. HDFC Bank Ltd. (0.58) have the highest beta value whereas Yes Bank Ltd. (0.06) have the lowest value. As HDFC Bank Ltd. have the highest beta value the stock also exposed to highest systematic risk or market risk and Yes Bank Ltd. lowest. On the other hand Yes Bank Ltd. is exposed to highest unsystematic risk or security specific risk and HDFC Bank Ltd. have the lowest. The stocks in the table are ranked on the basis of excess returns to beta ratio. After following Sharpe framework for ranking the stocks it has found that Bajaj Finance Ltd. is ranked top and BPCL Ranked last.

Table 1. *Ranking of stocks on the basis of excess returns to beta ratio*

Companies	R_i	β_i	$\beta^2\sigma_m^2$	σ_{ei}^2	$R_i - R_f$	$(R_i - R_f)/\beta_i$	Ranking
Bajaj Finance	0.95	0.26	0.36	5.14	0.82	3.21	1
Eicher	0.71	0.21	0.25	5.26	0.58	2.76	2
AuroPhar	0.54	0.15	0.13	5.38	0.41	2.66	3
TECHM	0.41	0.22	0.27	5.24	0.28	1.25	4
HCL Tech	0.46	0.28	0.43	5.08	0.33	1.20	5
HINDUNILVR	0.43	0.26	0.37	5.13	0.30	1.15	6
Asian Paint	0.47	0.30	0.50	5.01	0.34	1.13	7
IndusInd Bank	0.42	0.28	0.43	5.08	0.29	1.05	8
TCS	0.38	0.28	0.43	5.07	0.25	0.91	9
Maruti	0.41	0.34	0.65	4.86	0.28	0.81	10
DrReddy	0.27	0.18	0.18	5.33	0.14	0.78	11
Lupin	0.23	0.14	0.10	5.40	0.10	0.74	12
Axis Bank	0.31	0.33	0.58	4.93	0.18	0.56	13
INFY	0.28	0.27	0.40	5.11	0.15	0.55	14
HDFC	0.31	0.34	0.63	4.87	0.18	0.54	15
ZEEL	0.23	0.19	0.21	5.30	0.10	0.50	16
HDFC Bank	0.39	0.58	1.87	3.63	0.26	0.45	17
Yes Bank	0.15	0.06	0.02	5.49	0.02	0.43	18
Bajaj Auto	0.27	0.38	0.81	4.70	0.14	0.38	19
Wipro	0.23	0.26	0.37	5.14	0.10	0.38	20
Bosch Ltd	0.24	0.30	0.51	5.00	0.11	0.37	21
M&M	0.23	0.33	0.59	4.92	0.10	0.30	22
HeroMotor Corp	0.19	0.29	0.47	5.04	0.06	0.20	23
L&T	0.18	0.39	0.86	4.65	0.05	0.13	24
ITC	0.17	0.29	0.46	5.05	0.04	0.12	25
Coal India	-0.09	0.25	0.35	5.16	-0.22	-0.87	26
BPCL	0.37	0.23	0.30	5.20	-0.46	-1.97	27

Source: author's computation using NSE, RBI data.

Table 2 depicts the C_i values of all the 27 Blue-ship securities. In the table highest C_i values is 0.21 of Bajaj Finance Ltd., which is taken as a cut-off point. Only those will be selected whose excess return to beta ratio is more than the cut-off points i.e. Bajaj Finance Ltd. From the analysis it can be observed that none of the securities ranked above the Bajaj Finance Ltd. that means their excess return to beta ratio is less than the cut off which suggest only one security is qualified for the optimal portfolio. For the present study only Bajaj Finance Ltd. considered for the construction of an optimal portfolio.

Table 2. *Cut-off values of stocks*

Companies	$A = \sigma_m^2 \sum_{i=1}^{N} \left(\frac{R_i - R_f}{\sigma_{ei}^2}\right) * \beta_i$	$B = 1 + \sigma_m^2 \sum_{i=1}^{N} \beta_i^2/\sigma_{ei}^2$	$C_i = \frac{A}{B}$
Bajaj Finance	0.226	1.071	0.21**
Eicher	0.129	1.047	0.12
Aurobindo Pharma	0.064	1.024	0.06
TECHM	0.065	1.052	0.06
HCL Tech	0.101	1.084	0.09
HINDUNILVR	0.083	1.073	0.08
Asian Paint	0.111	1.099	0.10
IndusInd Bank	0.088	1.084	0.08

Companies	$A = \sigma_m^2 \sum_{i=1}^{N} \left(\frac{R_i - R_f}{\sigma_{ei}^2}\right) * \beta_i$	$B = 1 + \sigma_m^2 \sum_{i=1}^{N} \beta_i^2/\sigma_{ei}^2$	$C_i = \frac{A}{B}$
TCS	0.077	1.085	0.07
Maruti	0.109	1.134	0.10
DrReddy	0.026	1.034	0.03
Lupin	0.014	1.019	0.01
Axis Bank	0.066	1.118	0.06
INFY	0.043	1.078	0.04
HDFC	0.070	1.130	0.06
ZEEL	0.020	1.039	0.02
HDFC Bank	0.233	1.517	0.15
Yes Bank	0.001	1.003	0.00
Bajaj Auto	0.065	1.172	0.06
Wipro	0.027	1.072	0.03
Bosch Ltd	0.038	1.102	0.03
M&M	0.037	1.120	0.03
Hero MotorCorp	0.019	1.092	0.02
LT	0.024	1.184	0.02
ITC	0.011	1.091	0.01
Coal India	-0.059	1.068	-0.06
BPCL	-0.115	1.058	-0.11

Source: Author's computation using NSE, RBI data.

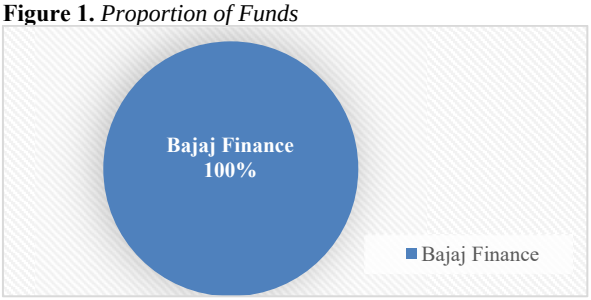
Table 3 and Figure 1 represent the optimal portfolio selected security i.e. Bajaj Finance Ltd. from the NSE blue-chip securities i.e. 27. Due to selection of one security only, the whole money is allocated to that particular security.

Table 3. *Optimal portfolio stocks fund allocation share*

Companies	β_i	σ_{ei}^2	$(R_i - R_f)/\beta_i$	β_i/σ_{ei}^2	C_i	$((R_i - R_f)/\beta_i) - C^{**}$	Z_i	$X_i = \frac{Z_i}{\sum Z_i} * 100$
Bajaj Finance	0.26	5.10	3.21	0.05	0.21	3.00	0.15	100
Total Sum							0.15	100

Source: Author's computation using NSE, RBI data.

Figure 1. *Proportion of Funds*



Data analysis and interpretation of monthly data

Table 4. *Stocks are ranking on the basis of excess returns to beta ratio*

Companies	R_i	β_i	$\beta^2\sigma_m^2$	σ_{ei}^2	$R_i - R_f$	$(R_i - R_f)/\beta_i$	Ranking
Bajaj Finance	4.46	0.29	2.21	137.74	3.89	13.40	1
Eicher	3.23	0.25	1.58	92.15	2.66	10.81	2
Aurobindo Pharma	2.50	0.19	0.97	165.85	1.93	10.02	3
HINDUNLVR	1.95	0.19	0.93	33.42	1.38	7.30	4
TECHM	1.84	0.25	1.58	69.01	1.27	5.16	5
DrReddy	1.16	0.12	0.36	57.07	0.59	4.97	6
Asian Paint	2.14	0.32	2.66	50.67	1.57	4.91	7
InduSind	2.03	0.34	3.01	150.16	1.46	4.31	8
TCS	1.61	0.25	1.63	40.88	1.04	4.18	9
Lupin	1.08	0.13	0.45	72.46	0.51	3.85	10
Maruti	1.94	0.39	4.04	90.12	1.37	3.48	11
BPCL	1.59	0.33	2.86	95.09	1.02	3.09	12
Wipro	1.06	0.16	0.67	56.08	0.49	3.03	13
INFY	1.27	0.24	1.49	60.59	0.71	2.95	14
ZEEL	1.11	0.22	1.27	107.60	0.54	2.47	15
HDFC	1.41	0.36	3.36	60.40	0.84	2.35	16
Axis	1.43	0.39	3.94	113.26	0.86	2.23	17
HDFC Bank	1.82	0.66	11.29	30.79	1.25	1.91	18
Bajaj Auto	1.27	0.42	4.66	55.10	0.70	1.67	19
Bosch	1.12	0.34	2.98	68.22	0.56	1.64	20
MM	1.04	0.38	3.72	78.12	0.47	1.25	21
Hero MotoCorp	0.92	0.33	2.77	66.82	0.35	1.06	22
LT	0.94	0.42	4.60	84.04	0.37	0.89	23
ITC	0.71	0.46	5.61	30.57	0.14	0.29	24
Yes Bank	0.51	0.16	0.70	284.95	-0.06	-0.39	25
Coal India	-0.45	0.33	2.79	54.02	-1.02	-3.12	26
HCL	3.47	-0.01	0.00	572.54	2.90	-506.79	27

Source: Author's computation using NSE, RBI data.

Table 4 represents the monthly return data of 27 Blue-chip securities which are ranked according to the framework of Sharpe index model. The above Table 4 show us that the Bajaj Finance Ltd. generated the highest monthly average return of 4.46 percent whereas Coal India Ltd. generated lowest monthly average negative return of -0.45 percent. The beta values of all the securities have less than one beta value which means all the stocks are less volatile than the market. HDFC Bank Ltd. (0.66) have the highest beta value whereas HCL (-0.01) have the lowest value. The securities in the above table are ranked on the basis of excess returns to beta ratio. After following Sharpe framework for ranking the stocks it has found that Bajaj Finance Ltd. is ranked top and HCL Ranked last which is contrary to weekly data. In weekly data HCL is ranked 5th and BPCL ranked last. It has been also observed that in the ranking of the securities for both weekly and monthly haven change except few securities.

Table 5. *Cut-off values of stocks*

Companies	$A = \sigma_m^2 \sum_{i=1}^{N} \left(\frac{R_i - R_f}{\sigma_{ei}^2}\right) * \beta_i$	$B = 1 + \sigma_m^2 \sum_{i=1}^{N} \beta_i^2 / \sigma_{ei}^2$	$C_i = \frac{A}{B}$
Bajaj Finance	0.215	1.016	0.211
Eicher	0.186	1.017	0.183
Aurobindo Pharma	0.059	1.006	0.058
HINDUNLVR	0.203	1.028	0.198
TECHM	0.118	1.023	0.116
DrReddy	0.032	1.006	0.032
Asian Paint	0.258	1.053	0.245
IndusInd	0.086	1.020	0.085
TCS	0.167	1.040	0.160
Lupin	0.024	1.006	0.024
Maruti	0.156	1.045	0.149
BPCL	0.093	1.030	0.090
Wipro	0.036	1.012	0.036
INFY	0.073	1.025	0.071
ZEEL	0.029	1.012	0.029
HDFC	0.131	1.056	0.124
Axis	0.077	1.035	0.075
HDFC Bank	0.699	1.367	0.512**
Bajaj Auto	0.141	1.085	0.130
Bosch	0.072	1.044	0.069
MM	0.060	1.048	0.057
Hero MotoCorp	0.044	1.041	0.042
LT	0.049	1.055	0.046
ITC	0.054	1.183	0.046
Yes Bank	-0.001	1.002	-0.001
Coal India	-0.162	1.052	-0.154
HCL	-0.001	1.000	-0.001

Source: Author's computation using NSE, RBI data.

Table 6 depicts the C_i values of all the 27 Blue-ship securities. In the Table 6 it can be seen that the highest C_i value is 0.512 of HDFC Bank Ltd., which is taken as a cut-off point. Only those securities will be selected whose excess return to beta ratio is more than the cut-off points i.e. HDFC Bank Ltd. From the analysis it can be observed that all the stocks ranked above the HDFC Bank Ltd. are having higher excess return to beta ratio and all these securities are considered for the construction of an optimum portfolio. Total 18 securities including HDFC Bank Ltd. are above the cut-off point compared to 1 security in weekly data.

Table 6. *Optimal portfolio stocks fund allocation share*

Companies	β_i	σ_{ei}^2	$R_i - R_f/\beta_i$	β_i/σ_{ei}^2	C_i	$(R_i - R_f/\beta_i) - C^{**}$	Z_i	$X_i = \frac{Z_i}{\sum Z_i} * 100$
Bajaj Finance	0.29	137.74	13.40	0.00	0.21	13.19	0.03	9.07
Eicher	0.25	92.15	10.81	0.00	0.18	10.63	0.03	9.25
Aurobindo Pharma	0.19	165.85	10.02	0.00	0.06	9.96	0.01	3.78
HINDUNLVR	0.19	33.42	7.30	0.01	0.20	7.11	0.04	13.07
TECHM	0.25	69.01	5.16	0.00	0.12	5.04	0.02	5.86
DrReddy	0.12	57.07	4.97	0.00	0.03	4.94	0.01	3.33
Asian Paint	0.32	50.67	4.91	0.01	0.24	4.66	0.03	9.57
InduSind	0.34	150.16	4.31	0.00	0.08	4.22	0.01	3.11
TCS	0.25	40.88	4.18	0.01	0.16	4.02	0.02	8.01
Lupin	0.13	72.46	3.85	0.00	0.02	3.82	0.01	2.27
Maruti	0.39	90.12	3.48	0.00	0.15	3.33	0.01	4.74
BPCL	0.33	95.09	3.09	0.00	0.09	3.00	0.01	3.40
Wipro	0.16	56.08	3.03	0.00	0.04	3.00	0.01	2.79
INFY	0.24	60.59	2.95	0.00	0.07	2.88	0.01	3.70
ZEEL	0.22	107.60	2.47	0.00	0.03	2.44	0.00	1.63
HDFC	0.36	60.40	2.35	0.01	0.12	2.23	0.01	4.31
Axis	0.39	113.26	2.23	0.00	0.07	2.15	0.01	2.41
HDFC Bank	0.66	30.79	1.91	0.02	0.51	1.39	0.03	9.71
Total Sum							0.31	100

Source: Author's computation using NSE, RBI data.

Figure 2. *Proportion of Funds*

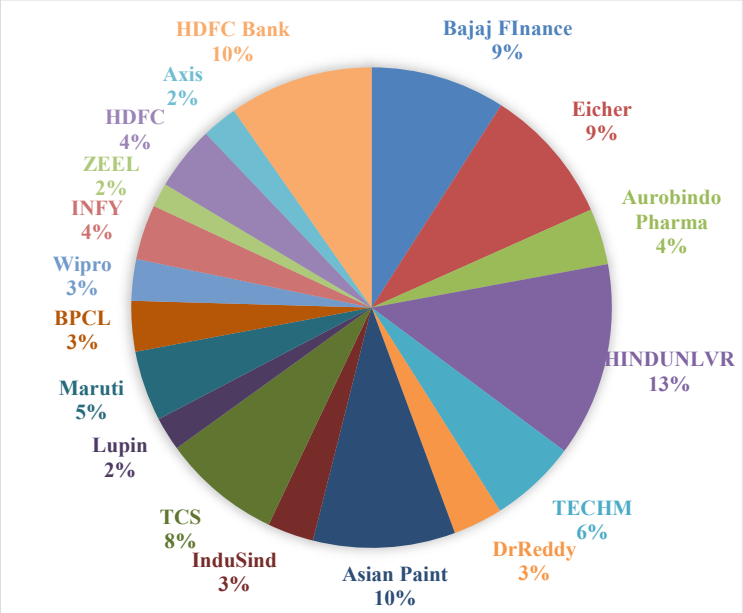


Table 6 and Figure 2 represent the optimal portfolio which consists of 18 securities from the NSE blue-chip securities i.e. 27 and their contribution to the portfolio. The major portion of fund in the portfolio should be invested in the Hindustan Unilever Ltd. (13%), Asian Paint Ltd. (10%), HDFC Bank (10%), Bajaj Finance Ltd. (9%), Eicher Motor Ltd. (9%). All these investment are done to get reasonable return at a reasonable market risk and company risk.

Conclusion

The present study is based on Sharpe Single Index model. The model has been used to construct an optimal portfolio using Blue-chip securities of the Indian stock market after analyzing return performance, beta values, market risk and company risk. For the study both weekly and monthly securities return data has been used and the same is collected from Yahoo finance official website. The selected the NSE blue-chip securities which consists of 27 securities. The study found that for the weekly data out of 27 securities only 1 security is found to be eligible for the optimal portfolio whereas 18 securities are found for the monthly data. The reason for finding this contrary result may be due to data variation. So from this finding we can say that for the particular model it is better to use monthly data rather than using daily or weekly data which are too volatile to predict the returns of the securities and construct a portfolio. Apart from this there maybe another reason i.e. blue-chip security are meant for long term investment that is why it is better to use monthly return data. Constructing an optimal portfolio using Blue-chip securities is much easier than any other securities, this is due to the fact that blue-chip securities are considered to be safe investment because they give regular dividend to their investors, they are either market leader or among the top 3 in the respective sectors by their market capitalization. Their capacity to meet the liability is much higher or most of them have almost zero debt. They are considered to be financially sound and considered to be reputed trustworthy.

However, the investment decision should be taken only after considering all factors affecting securities. Those may be general economic conditions or other macroeconomic factors regulating the movement of these stocks and their behavior on the market. Many such microstudies must be carried out with various sample forms in mind. The findings of the present study and micro-level studies have more utility value for emerging-economy fund managers like India where the capital markets continue to be established and many international institutional investors are involved in investing in leading stocks traded in those countries stock exchanges.

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Budget policy, economic cycle and debt in the West African Economic and Monetary Union (WAEMU) countries: Empirical evidence based on a regime change model

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Abstract. *In this paper, we study the non-linear effect of the economic cycle and debt on the basic budget balance (BBB) in WAEMU countries over the period 1982-2018. Using a panel model with threshold effects and smooth transition, the hypothesis of non-linearity between the BBB, the economic cycle and debt was verified. The results show that an increase in the debt ratio above a threshold of 66% has a negative effect on the BBB's elasticity relative to the economic cycle in the following period. Moreover, the results show that the dynamics of the BBB adjust the increase in external debt during high economic growth periods. This measure could be strengthen the reach of the stability and growth pact through its BBB as the economic integration lever initiated by WAEMU countries since several decades.*

Keywords: budget, economic cycle, debt.

JEL Classification: E3, E6, C24.

1. Introduction

The role of fiscal policy in economic activity has been studied since Musgrave's work (1959). This pioneering literature assigns a key role to the fiscal tool as an instrument for smoothing the economic cycle through steady growth (Sloman and Wride, 2011). However, its role in stabilizing the economic cycle is sometimes controversial (Bouthevillain et al., 2013). In fact, while Barro (1979) indicates that an optimal budget policy is one that is independent of the cycle, the Keynesian model confers a counter-cyclical role. This latter view has been widely supported in a context of the perverse effects of the economic and financial crisis of 2007 (Blanchard et al. 2010; Brand, 2012). Beyond these divisions, there is a consensus in the literature that the fiscal authorities' behaviour should be either counter-cyclical, acyclical or neutral (Creel et al., 2011). Evidently, this debate on the effectiveness of fiscal policy dates back to the old debate between Keynesians, who support state intervention to stabilize the economy, and those who can be described as liberal, who promote debt reduction (Bouthevillain et al., 2013).

Based on this evidence, the effectiveness of budgetary advocacy in the context of the adoption of the mechanisms of the Stability and Growth Pact, as it is the case in several economies, has generated a fervour in the literature with results that are both convergent and contradictory (Benassy et al., 2010; Sagna, 2017). Under this mechanism, members of a monetary union are invited to mediate between counter-cyclical action and respect for the main budgetary balances. In the West African Economic and Monetary Union (WAEMU) zone, apart from Coulibaly (2013) 's study which indicates fiscal acyclism, most show that fiscal policies have been pro-cyclical (AryTanimoune et al., 2008; Guillaumont and Tapsoba, 2009; Wade, 2015) since the adoption of the Convergence, Stability, Growth and Solidarity Pact (CSGSP) mechanism. However, the Sagna (2017)’s study shows that fiscal policies (via the CSGSP) have differentiated effects on activity; but also the latter (CSGSP) seems to limit the margins for fiscal policy maneuver within WAEMU.

This pro-cyclicality highlighted by most studies is attributed to the willingness of the WAEMU’s authorities to ensure fiscal discipline (AryTanimoune and Plane, 2005). It is therefore established that within the Union, the authorities seem to have opted for fiscal discipline that is supposed to allow public finances to be restored while preserving debt sustainability (Coulibaly, 2013). However, whatever the choice made by the authorities, the budgetary instrument must provide a concomitant response to the concerns of cyclical stabilization and debt control.

However, the analysis of the stylized facts regarding the evolution of the primary balance and external debt ratios in relation to the cyclical position of the economy leads to an ambiguity in fiscal activism. In fact, the primary balance increased in terms of budget surplus from 0.84% over the period 1994-1999 to 0.88% over the period 2000-2008, while the debt ratio declined considerably, from 113% to 55%. During those respective periods, the economy experienced a period of strong economic growth. As a result, the output gap/GDP increased from an average of 3.2% (expansion) to 12.2% (expansion time). This implies that a reduction in the debt ratio coupled with an increase in the primary balance surplus has resulted in an improvement in the economic situation (counter-cyclical). In contrast, compared to the previous period, when the Union experienced a shortfall in its

primary balance level (-0.14%) and a reduction in the debt ratio (26%), it experienced a period of economic weakness (-3.4%) over the period from 2009 to 2018. This implies that a deterioration in the primary balance and a decrease in the debt ratio have led the economy into a recessive (pro-cyclical) phase. Thus, this fiscal balance seems to offset the positive evolution of the debt ratio, but makes fiscal policies pro-cyclical. These stylized facts reinforce the idea that the relationship between the budgetary balance, debt and the economic cycle appears to be non-linear, especially after the adoption of the CSGSP of 1999.

Moreover, from a theoretical point of view, the Stability Pact, while advocating fiscal discipline, encourages countries to pursue counter-cyclical policies (Guillaumont and Tapsoba, 2009). In practice, these CSGSP measures result in heavy constraints on countries. In fact, the fiscal rule is the same for all countries, while economies differ both in their initial situation and in their long-term prospects and debt capacities (Benassy et al., 2010).

This finding has important implications on predicting the effects of economic conditions on fiscal policies. This implies that modeling via a regime change model (non-linear effect) should be preferred in order to accurately measure the impact of economic conditions and debt on the effectiveness of fiscal policies via the budget balance. In addition, there is the idea that, since private agents' consumption decisions are based on inter-temporal arbitration, the empirical literature (Giavazzi et al., 2000; Afonso, 2001) supports the ambiguity of the effects of fiscal stimulus on economic activity. From that moment on, the influence of fiscal policy on economic activity would depend on the level of debt or the level of the public deficit (Sagna, 2017; Largent, 2017).

Although such a concern has been the subject of extensive studies in African franc zone countries (AFZC), the few studies that have examined the non-linear effect of fiscal policies on economic activity in the WAEMU are those of AryTanimoune et al. (2008); Wade (2015); Bini et al. (2016); Sagna (2017) and Ghazi (2018).

These studies showed that the effect of WAEMU's fiscal policies on economic activity would be constrained by the level of public debt at 83%; 49.8% (for Wade, 2015) and 48% (Bini et al., 2016) respectively. More specifically, based on a smooth transmission auto-regressive vector model, Sagna (2017)'s contribution shows the differentiated effects of fiscal policy on activity and the limitation of fiscal policy flexibilities within the WAEMU by the CSGSP. As a result, these studies did not seek to shed light on the inverse relationship, including the effect of the economic cycle and debt on the effectiveness of fiscal policies via the basic budget balance (BBB). They ignore several aspects in the analysis. Does a reduction in the volatility of economic activity make the BBB effective? Also, is there not a debt threshold above which the BBB is less effective in its cyclical stabilization function?

These questions are justified insofar as excessive fluctuations in the economic cycle, an unsustainable debt ratio and the nature of the transmission mechanisms from one regime to another (gross or smooth) undermine the effectiveness of economic policy in a heterogeneous monetary union. The related empirical literature did not integrate these

aspects into the analysis. These questions converge towards the main question of this paper: is there a non-linear effect of the economic cycle and debt on the budget balance (BBB)? In this respect, this paper intends to assess the non-linear effect of the economic cycle and debt on the BBB in the WAEMU countries based on the modeling of threshold effects with smooth transition as described in the Gonzales et al. (2005)'s panel.

Our empirical investigations add to the available literature on the effects of fiscal policy. While addressing the issue in the opposite direction to that of the authors (AryTanimoune et al., 2008; Wade, 2015; Bini et al., 2016), this study makes an empirical contribution to the debate on the effectiveness of the BBB, as a key criterion of the CSGSP; but also as an instrument for economic stabilization in the WAEMU.

The study shows that any measure to reduce the BBB deficit in WAEMU countries must take into account the indebtedness ratio achieved (less than 66%) by economies, particularly during expansion periods. This measure could be strengthen the reach of the stability and growth pact through its BBB as the economic integration lever initiated by WAEMU countries since several decades.

In the following; section 2 of the paper is dedicated to the literature review, the stylized facts of WAEMU are discussed in section 3, section 4 to the methodology, section 5 presents and analyses the results of the estimates and section 6 to the conclusion.

2. Literature review

2.1. Economic cycle and fiscal policy: overview of theoretical debates

The economic literature highlighting the functions of fiscal policy dates back to Musgrave (1959)'s work. For this author, any fiscal policy has three essential functions: the optimal allocation of resources, the redistribution and then the short-term stabilization of the economy. Having become the theoretical reference framework regulating State intervention in economic life since the 1960s, it seems increasingly irrelevant to the advent of the integration process in which almost all countries in the world have engaged. Thus, fiscal policy issues are handled within the framework of the monitoring mechanisms known as the Stability and Growth Pact. In this context, the analysis focuses on the importance of the budgetary externalities generated by a monetary union. Theoretical solutions (fiscal federalism or fiscal discipline rules) have been identified to mitigate the negative externalities that may emerge in currency unions. However, this fiscal issue in monetary union is characterized by two controversies that exclude the scope of economic policy.

The first controversy concerns the role that fiscal policy should play in the economic cycle (Bénassy et al., 2010). While Barro (1979) advocates a fiscal policy independent of the economic cycle (avoiding inter-temporal distortions by keeping primary expenditure and tax rates unchanged), another literature argues that the focus should be on deficit control and medium-term debt reduction. In contrast, the Keynesian model assumes that fiscal policy should be countercyclical. This latter view has been supported in recent literature (OECD, 2010; Baum et al., 2012). Basically, because the time lags in the implementation of fiscal policy are often considered long, they undermine the effectiveness of fiscal

policies in times of recession (Ramey, 2011). Although Brand (2012) suggests that one of the conditions for greater fiscal efficiency is the rapid implementation of the stimulus policy, this issue is still under discussion. Thus, in the recent literature developed by Ganem (2014), the author indicates that the effectiveness of fiscal policy depends on three conditions: being timely, temporary and targeted. In a context of increasing interdependence between economies, fiscal policy is less effective because of the existence of "leaks" on the fiscal multiplier.

The second controversy concerns the responsibility of States, in particular the role of the Stability and Growth Pact, which is responsible for a constrained fiscal policy (Benassy et al., 2010). As Artus (2011) notes, the theoretical framework for limiting the public deficit is based on the assumption that it generates a negative externality. This could be transmitted through interest rates that would rise if some countries had large public deficits, or through inflation expectations linked to the monetization of excessive public debt on the other countries of a monetary union. Thus, the main argument in favour of such budgetary discipline is based on the risk that an unsustainable fiscal policy in a country could threaten the monetary stability of the union. This fiscal discipline is supposed to make relations between the fiscal and monetary authorities more transparent and to prevent conflicts of objectives that can lead to an increase in public deficits and then in interest rates. Otherwise, unsustainable fiscal policy increases the risk of pressure on monetary policy for higher inflation or a very low interest rate.

Beyond the relevance of these analyses, the constrained measures of the Stability and Growth Pact cannot guarantee the sustainability of public finances. It is to this conclusion that the literature (Jobert and Tuncer, 2009; Wickens, 2010) comes to the conclusion that the Stability and Growth Pact itself is neither a necessary nor a sufficient condition for ensuring and guaranteeing the sustainability of public finances. The public finance crisis in the Eurozone (2009-2010) revealed the failure of the Stability and Growth Pact to impose fiscal discipline in some countries such as Greece. Likewise, it is interesting to note that the debate on the modalities of the Stability and Growth Pact to ensure budgetary discipline has revealed strong limitations (Benassy et al., 2010). It is asymmetrical and carries a pro-cyclical bias because it encourages governments to reduce their deficits at the bottom of the cycle and not at the top of the cycle. It is noticeable that the theoretical literature remains unclear in explaining the scope of the Stability and Growth Pact through fiscal policies to stabilize the economic cycle. These different and often conflicting assumptions form the basis of an important empirical literature that has been developed since then.

2.2. Economic cycle and fiscal policy: Synthesis of the empirical literature

The empirical literature on fiscal policy cyclicality or fiscal activism has been extensive in recent years. The first empirical studies on the cyclicality of fiscal policy can be traced back to the work by Gavin and Perotti (1997). These authors show that fiscal policy in Latin America was pro-cyclical. From this baseline study, some authors (Kaminski et al., 2004; Manasse, 2005) show that this revealed fiscal pro-cyclicality is not only a Latin American phenomenon, but is common to many developing countries. In fact, studies within African Franc Area (AFZC) show that monetary and fiscal instruments are highly pro-cyclical. This result indicates the ineffectiveness of these instruments in their stabilization function

(Demirel, 2010). These studies are generally based on two methodological approaches. This includes panel regressions on macroeconomic variables with which the authors associate estimators (DMC and GMM) with or without cross effects and threshold effects modeling with gross or smooth transition. Among the studies that are included in the first methodological approach, we have those of: Talvi and Végh (2005); Dramani (2007) and Adedeji and Williams (2007); Diallo (2009), Guillaumont and Tapsoba (2011), Coulibaly (2013) and Wade (2015).

In fact, Talvi and Végh (2005), in their study covering a sample of 56 countries, show that fiscal policies in the G7 countries have been non-cyclical, while they are pro-cyclical in developing countries. This pro-cyclicality was highlighted by Dramani (2007) and Diallo (2009) in their studies on AFZC and sub-Saharan African countries respectively. In addition to the pro-cyclicality of fiscal policies in relation to GDP as revealed by Dramani (2007), the study highlights the existence of a contra-cyclicality of these policies with respect to inflation. The major contribution of Diallo's (2009) work is to have highlighted the importance of strong institutions as a mechanism for inverting the pro-cyclicality of fiscal policies. On the other hand, the empirical literature through Talvi and Végh (2005)'s study explains this pro-cyclicality by the fact that fluctuations in the fiscal base prevent the achievement of large budget surpluses during periods of expansion when confronted with pressures from different social groups and lobbies for an increase in public spending.

Like previous studies, Wade (2015)'s study shows that pro-cyclicality results from a reduction in States' margin of intervention in the use of the budgetary instrument when fiscal policies are constrained by rules. Adedeji and Williams (2007), on the other hand, already explained that this pro-cyclicality depends on the fact that the fiscal adjustment is not instantaneous. The study reveals the current fiscal performance is dependent on the previous year's performance. These results seem to support the prevailing opinion that the provisions of the CSGSP should be reviewed in this era of major challenges that are emerging on the horizon. In addition to these categories of studies, which advocate a review of the convergence criteria, we can associate those by Guillaumont and Tapsoba (2011), Coulibaly (2013) on the WAEMU zone.

Earlier, Guillaumont and Tapsoba (2009), using the "modified" Talvi and Vegh's model, showed that the pro-cyclicality of fiscal policies became more prominent in the WAEMU during a recession. Moreover, in another study, Guillaumont and Tapsoba (2011) show that in recession phases, the WAEMU fiscal authorities reduce public spending and increase their tax burden rate.

Although these results are conclusive, they do not state the relevance of the BBB as a fiscal stabilization driver. It is in this framework that Coulibaly (2013)'s contribution shows that WAEMU's fiscal policies have been non-cyclical and do not allow for an adjustment of the evolution of the external public debt. The study supports the idea that the primary fiscal balance could substitute the overall balance as a standard of sound public finance management, as it offers more flexibility. Huart (2011) also supported the non-cyclical fiscal policy within the European Union countries in 2009. Hence, these studies questions the effectiveness of the BBB in performing its role as a cyclical stabilizer for economies.

In short, the results of these studies lead, without any objection, to the conclusion that the role played by fiscal policies in smoothing the economic cycle within the WAEMU is very mixed. These findings contradict an optimal fiscal policy as defined in the literature. However, the main limitation of all these studies is that they assume a linear relationship in budget responses over the economic cycle. But there could be a non-linear relationship.

Studies within AFZCs that take this limit into account adopt threshold effect models with gross or smooth transition. In the first group adopting threshold effect modeling where the transition is gross (Hansen, 1999), there is a study by AryTanimoune et al. (2008) on WAEMU over the period 1986-2002; then that of Bikai (2010) on the economies of EMCCAS (Economic and Monetary Community of Central African States). These studies reveal that fiscal policies in these countries have had a Keynesian influence on GDP when the debt ratio is below 83% (for WAEMU) and 79% (for EMCCAS) respectively.

Although the results of this approach are relevant, they are nevertheless limited in methodological content. In fact, the Hansen (1999) approach assumes that the transmission mechanism from one regime to another is supposed to be gross and there is no guarantee of accuracy. Similarly, the elasticity of GDP in terms of fiscal policy is assumed to be constant from one country to another. This assumption is not straightforward according to the principle of economic dynamics. Moreover, these studies did not clearly incorporate the economic variables that are the source of such a non-linear relationship between GDP and the budgetary balance. Smooth transition threshold effect modeling is one of the methodological alternatives used in the empirical literature to address these limitations. The work by Wade (2015) and Bini et al. (2016) is part of this approach and focuses on WAEMU's countries. Thus, these studies reveal a debt threshold of 49.8% and 48% as a percentage of GDP respectively. In contrast to the high debt threshold (79-83%) found in previous studies, these studies justify this moderate threshold (around 50%) by considering the effects of debt reduction from which most economies have benefited through the PPTE initiative.

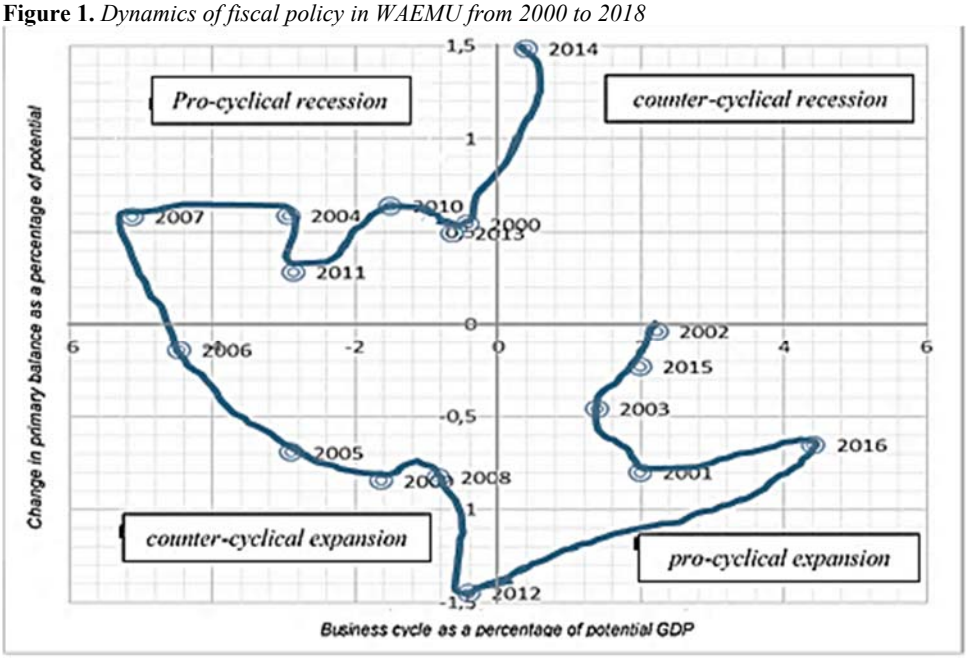
In total, almost all the empirical literature seeks to highlight the effect of fiscal policies on economic activity. The inverse relationship is rarely examined. This paper attempts to do this by explaining the threshold effects of the cycle and debt, in relation to the BBB. However, before this stage, it seems necessary to us to explain through stylized facts the budgetary response according to the cycle in the WAEMU zone.

2.3. Stylised facts in WAEMU

For the objectives of this section, the primary structural balance excluding grants (PSB) is used to capture the fiscal policy stance. Compared to other balances, it remains more credible in demonstrating the orientation of discretionary fiscal policy (Bini et al., 2016). It is assessed using the following relationship: $PSBhd_t = +aX_t + e_t$, where: $PSBhd_t$: the primary balance excluding actual grants; X is the difference between actual and potential GDP; $a.X_t$ is the short-term primary balance; as the elasticity of the primary balance to the economic cycle, the parameter $a.$ measures changes in the primary balance due to a 1% increase in real GDP; e_t is the residual of the model. It (e_t) represents the structural primary

balance. The figure below summarizes the main trends observed in the fiscal response over the economic cycle in WAEMU countries from 2000 to 2018.

Figure 1. *Dynamics of fiscal policy in WAEMU from 2000 to 2018*



Source: Author' construction.

The above figure suggests that WAEMU is increasingly pursuing pro- and counter-cyclical fiscal policies in the expansion phase. In fact, from 2001 to 2003, following any economic expansion, fiscal policies were pro-cyclical in nature. On the other hand, following the recession generated by the financial crisis of 2007, they were counter-cyclical during 2008 and 2009. This shows that the fiscal policy pursued during this period was expansionist in order to offset the negative effects of the crisis. However, its effect was temporary and, apart from 2012, from 2010 to 2013, there was a pro-cyclical nature of the budgetary instrument in a recessive context. This fiscal behaviour was previously observed in 2000, 2004 and 2007. In addition, as shown by Figure 1, except for 2014, which was an exceptional case of contra-cyclicality in a recession, fiscal behaviour during an expansion period is ambivalent among WAEMU countries. Fiscal policies switch between contra-cyclicality (as in 2005, 2006, 2008, 2009 and 2012) and pro-cyclicality (2001, 2002, 2003, 2015 and 2016). In the light of the conclusions by Creel et al. (2011) about optimum fiscal activism (counter-cyclical or non-cyclical), the stylized facts show that the WAEMU's authorities behaved optimally in the years 2005, 2006, 2008, 2009, 2009, 2012 and 2014. For the other years, the cyclicality of fiscal policies seems sub-optimal. In fact, out of a total of 18 periods (2000 to 2017), fiscal behavior was pro-cyclical over 12 periods compared with six (06) periods of contra-cyclicality. Thus, the dominance of a pro-cyclical fiscal policy has been highlighted in the WAEMU zone. This result confirms the empirical contributions within WAEMU (AryTanimoune et al., 2008; Wade, 2015).

Therefore, this empirical literature supports the idea that the multilateral surveillance adopted by WAEMU creates a pro-cyclical bias in public spending during recessions that is stronger than in other African countries. This result suggests a change in the rule of multilateral surveillance (introducing as a criterion, for example, the achievement of budget surpluses during periods of expansion) in order to ensure greater efficiency of fiscal policy in the Union. In the same vein, this study seeks to determine the conditions for the effectiveness of the primary budget balance as an instrument for cyclical stabilization through a modeling of threshold effects with smooth transition in a panel.

3. Methodology

This section aims to test possible threshold effects with smooth transition in panel as developed by Gonzales et al. (2005) between the cycle and debt on WAEMU fiscal policies. Several variables are used in the literature to capture fiscal policy. This paper uses the basic budgetary balance to capture fiscal policy. This choice is justified because it constitutes the key criterion of the WAEMU CSGSP and also to comply with the requirements of this mechanism.

3.1. Specification of Panel Smooth Transition Regression (PSTR)

Referring to the work by Pommier (2004) and Coulibaly (2013), the budget balance (basic or primary) is explained by its level in the previous year (S_{t-1}), the debt delayed by a period (D_{t-1}) and then the output gap of the current year (X_t). Based on this work, we specify the equation below as follows to highlight a possible non-linear effect of the economic cycle (X) and debt (D) on the basic budget balance (S) in the case of the presence of two regimes (a threshold).

$$S_{it} = \alpha_i + \beta_0 X_{it} + \beta_1 X_{it} \Gamma(g_{it}, \theta, \lambda) + Z_{it}.\delta + e_{it} \quad (1)$$

where: α_i a vector of individual fixed effects; e_{it} is the error term that is independent and identically distributed i.i.d. (0, σ_e^2).

X_{it}, is the variable of interest (the output gap or the debt). The output gap is defined as the relative deviation of observed GDP from its trend level. Depending on whether this gap is positive or negative, it represents a phase of high economic activity (expansion) or low economic activity (recession) respectively. Z_{it} is a vector of the variables of control (ratio of FDI/GDP; opening rate and terms of trade) that we use in our specification in accordance with the work by Adedeji and Williams (2007).

$\Gamma(g_{it}, \theta, \lambda)$ is a continuous transition function to model the smooth transition (constrained between 0 and 1. This is associated with a transition variable (denotes dg_{it} which can be the ratio of the previous debt or the ratio of output gap/GDP). λ is a threshold parameter and θ the transition speed or smoothing parameter which measures the slope of the transition.

The parameters (θ and λ) will be estimated. In such a specification, the two parameters ($\lambda..et..\theta$) depend on the number of regimes r (with j = 1, r).

In equation No. 1, $\Gamma(g_{it},\theta,\lambda).$ represents the logistical transition function proposed by Gonzales et al. (2005). It takes the following form:

$$\Gamma(g_{it},\theta,\lambda) = \left[1+\exp(-\theta(g_{it}-\lambda))\right]^{-1}. \quad (2)$$

If the transition variable (g_{it}) is different from the threshold variable (X_{it}), the elasticity of the FB with respect to X_{it} (output gap) in function of the transition variable (debt) for the i^{ieme} country at date t is written:

$$a_{it} = \frac{\partial SBB_{it}}{\partial X_{it}} = \beta_0 + \beta_1 * \Gamma(g_{it},\theta,\lambda) = \beta_0 + \beta_1 * \left[1+\exp(-\theta(g_{it}-\lambda))\right]^{-1} \quad (3)$$

According to the definition of the transition function we have:

$$\left.\begin{matrix}\beta_0 \leq a_{it} \prec \beta_0+\beta_1 \quad if\,\beta_1 \succ 0\\ \beta_0+\beta_1 \leq a_{it} \prec \beta_0 \quad if\,\beta_1 \prec 0\end{matrix}\right\} \text{ since } 0 \leq \Gamma(g_{it,}\theta,\lambda) \leq 1$$

The marginal effect (a_{it}) reverts to the value of (β_0) and ($\beta_0+\beta_1$) as soon as the transition function $\Gamma(g_{it},\theta,\lambda)$ tends respectively towards 0 and then towards 1. With regard to the smoothing parameter, the PSTR corresponds to a PTR with three regimes (two thresholds) as soon as its value (θ) tends towards infinity ($\rightarrow \infty$).

In contrast, when θ tends towards zero ($\rightarrow 0$); the transition function $\Gamma(g_{it},\theta,\lambda)$ becomes a constant and the PSTR model merges with a panel of individual fixed effects. Basically, as in the Logit and Probit models, it is preferable to interpret the sign of the estimated parameters that indicate a decrease or increase in elasticity. In this context, these parameters simply indicate whether the effect of the economic cycle (debt) on the BBB has increased or decreased. We will refer to a non-linear effect, since β_0 and β_1 change in sign (+/-). If the two coefficients (β_0 and β_1) are of the same sign, we refer to a strengthening effect on the relationship between the economic cycle (or debt) and the BBB from the threshold thus determined. It is worth noting that the methodology of the PSTR is sequence-based. It is a question of: (i) the non-linearity test; (ii) the residual non-linearity or "no remaining linearity" test which aims to test the number of transition regimes or functions necessary to capture all the heterogeneity and non-linearity in the data; (iii) the model estimation by non-linear least squares in the data.

3.2. Description and data sources

The data used in this study come from two databases: WDI (World Development Indicators) and the WASCB (West Africa Sates Central Bank) database. The study period is from 1982 to 2018, covering all UEMOA countries except Guinea Bissau. The estimates were made using panel data. The advantage of working with panel data for a regime change model is that they simultaneously solve heterogeneity, autocorrelation and temporal instability issues in the relationship over time (Fouquau, 2008). More specifically, the data we use include:

- (i) The basic budget balance ratio (BBB) to GDP: it is calculated as follows: BBB = total revenue excluding grants - current expenditure (including loans minus repayments) - capital expenditure from own resources. These data are from the WASCB database.
- (ii) The economic cycle (output gap noted X) is defined as the ratio to GDP of the gap between observed GDP and its potential level assessed via the Hodrick-Prescott filter.
- (iii) The debt-to-GDP ratio was calculated from WASCB data.
- (iv) Terms of trade: this variable was calculated by relating the export price index to the import price index from the WDI database.
- (vi) Trade openness was assessed through the sum of exports and imports as a percentage of GDP. These data are from the WDI database.
- (vii) The FDI ratio to GDP was calculated from WDI data.

Table 1. *Descriptive statistics*

Variables	Number of Observations	Mean	Standard deviation	Min	Max
Basic budget balance (BBB)	252	-7.3	4.5	-31.1	2,8
Economic Cycle (% of GDP)	252	-9.9	51	398	49
Debt (D)	252	62.2	30.7	13	167
FDI/GDP	252	1.54	2.4	-1.13	17
Term of exchange (TE)	252	92	23	8	169
Openness rate (OR)	252	58	19	28	11

Source: Author' estimates.

From this table, it appears that the BBB remains slightly correlated with the explanatory variables. Regarding the explanatory variables, they remain slightly correlated with each other (low correlation compared to 0.5). Thus, these results suggest that the risk of multi-colinearity in the model is almost negligible (Table 2).

Table 2. *Correlation coefficients among the different explanatory variables*

Variables	BBB	Cycle	FDI	Debt	TE	OR
BBB	1					
Cycle	-0.1	1				
FDI	-0.1	-0.34**	1			
Debt	0.1	-0.08	0.02	1		
TE	0.32**	0.29**	-0.18	0.07	1	
OR	0.22	0.11	-0.09	0.11	0.18**	1

Source: Author' estimates: **significant at the 5% threshold.

In addition, it is worth noting that the unit root test on panel data (Pesaran, 2004) indicates that most variables of interest are stationary at the level (Table 3). This result allows us to display the estimation results.

Table 3. *Stationarity results*

Variables	IPS Test (1997) (1st Generation)	Pesaran Test (2004) (2 nd Generation)
Terms of exchange	-2.86(0.29)	-3.29(0.11)
Basic budget balance	-2.73(0.01)	-1.30(0.02)
Previous debt (D)	-4.71 (0.33)	-1.25 (0.02)
Openness (OR)	-4.16 (0.22)	-6.95 (0.01)
Economic Cycle(X)	-3.05 (0.01)	-3.42 (0.02)
FDI/GDP	-3.09(0.43)	-1.48(0.24)

Source: Author' estimates: (...) are the p-values associated with each statistic.

3.3. Linearity test

It aims to check whether the PSTR structure is appropriate. The point is to examine whether there is no linear relationship between the endogenous variable (BBB) and the exogenous variables (the economic cycle and debt). The Table 4 shows the results of the non-linearity test.

Table 4. *Result of the non-linearity test*

Specifications	Model No. 1	Model No. 2	Model No. 3	Model No. 4
Threshold	Economic cycle	Economic cycle	Previous debt	Previous debt
Transition variable	Cycle	Debt	Debt	Cycle
m (Centralization parameters)	m=1	m=1	m=1	m=1
H0 : r = 0 vs H1 : r = 1	0.007 (0.93)	7.12 (0.008)**	3.89 (0.09)	7.12 (0.008)**
H0 : r =1 vs H1 : r = 2	0.09 (0.65)	1.32 (0.98)	3.5 (0.45)	1.2 (0.67)

Note: the values in brackets are p-values. We just present in the above table the Fisher statistics of the Lagrange Multiplier (LMF) proposed by Gonzales et al. (2005). The other two statistics (LM and Pseudo LRT) yield the same results ** significant at the 5% threshold. The linear model (r = 0) is tested versus a threshold model (r = 1). If the null hypothesis is rejected, the single-threshold model is tested versus a two-threshold model (r = 2). This procedure continues until the assumption of an additional threshold is not rejected.
Source: Author' estimates.

In the different models, it is a question of investigating the non-linearity between: (i) BBB and the economic cycle using the cycle in the transition function (Model 1); (ii) BBB and the economic cycle, using debt in the transition function (Model 2); (iii) BBB and previous debt using debt in the transition function (Model 3); (iv) BBB and debt using the cycle in the transition function (Model 4).

The results of the test show that the hypothesis of non-linearity is confirmed for models 2 and 4 while it has been invalidated for models 1 and 3. Since then, we have been interested in these models for which the non-linearity hypothesis has been accepted in the rest of the analysis. Moreover, it appears from these models that a single transition function is sufficient to clean out non-linearity, because the alternative hypothesis H1: r = 2 is rejected (p-value > 5%) in any case. In this respect, for reasons of simplification, we have assumed for those models in which the non-linearity relationship has been identified, that a single transition function to a threshold is more than sufficient. Using this methodology was less about highlighting the exact number of regimes generated than about highlighting the non-linearity between the economic cycle and BBB debt.

3.4. Empirical results

The preliminary test results being conclusive, we present in Table 5 the final estimate of the PSTR model in order to highlight the relationship between the BBB and: (i) the economic cycle subject to the level of previous debt (Model 2); (ii) the previous debt subject to the level of the economic cycle (Model 4).

The first and foremost comment arising from this table is the value of the smoothing parameter (θ) which indicates the relevance of the PTR (abrupt transition) or PTSR (smooth transition) model. In fact, as Eggoh (2009) points out, when θ is high (low), PTR modeling (PSTR) is appropriate in highlighting the non-linearity relationship between two variables; only that the adjustment that will occur at the slope level is very high (gradual). In the case of a PSTR, this suggests that the transition from one regime to another is smooth.

In the light of the estimation results (via the slope), the structure of the PSTRs is suitable to highlight the non-linearity in models No. 2 and 4. Thus, we are able to support the idea that the transition between the two extreme regimes is rather smooth for these models (No. 2 and 4).

Table 5. *Final results of the PSTR model*

Specifications	Endogenous variable: Basic Fiscal Balance			
	Model No. 2		Model No. 4	
Threshold	Economic cycle		Previous debt	
Transition variable	Previous debt		Economic cycle	
(m* ; r*)	(1 ; 1)		(1 ; 1)	
Threshold (λ)	66		2.1	
Slope value $\boldsymbol{\theta}$	8.9		1.4	
	Coefficients	*p-value*	*Coefficients*	*p-value*
Parameter $\boldsymbol{\beta_0}$	0.18	0.001**	0.10	0.005**
Parameter $\boldsymbol{\beta_1}$	-0.01	0.000**	-0.18	0.006**
Control variables				
Termes of l'exchange	-0.02	0.008**	-0.02	0.001**
FDI/GDP	0.15	0.23	-0.23	0.07*
Openness	-0.02	0.37	-0.02	0.38

Source: Author' estimates: ** Significant at 5% threshold.

The results presented in Table 4 show that the coefficients (β_0) are positive while those of (β_1) are negative for models in which non-linearity has been validated. Thus, for these different models, we can say that the non-linearity between the BBB and the cycle and debt respectively has been confirmed for given levels of certain macroeconomic variables. In this respect, it could be considered to highlight the marginal effects of models (2 and 4) for which the transition is smooth (smoothing parameter estimated at 8.9 and 1.4).

Since the estimated parameters are not directly interpretable, it is possible to assess the impact of debt on the relationship between the BBB and the economic cycle via the signs of coefficients (marginal effects or elasticity). From equation No. 3, the marginal effect of the BBB in relation to the economic cycle (A.SBB/X) as a function of external debt is given by the relationship (4); whereas that of the BBB in relation to previous debt (A.SBB/D) as a function of the economic cycle, by the expression (5).

$$A_{SBB/X} = 0{,}18 - 0{,}01 * \left[1 + \exp(-8{,}9(Dette - 66))\right]^{-1} \quad (4)$$

$$A_{SBB/D} = 0{,}10 - 0{,}18 * \left[1 + \exp(-1{,}4(Cycle - 2{,}1))\right]^{-1} \quad (5)$$

Analysis of the relationship between the basic *budget* balance (BBB) and the economic cycle subject to the previous Debt (transition: Debt-to-GDP ratio).

Considering model 2 (Equation 4), we can see that the coefficient β_0 is positive (β_0 = 0.18) while the coefficient β_1 is negative (-0.01). β_0 being of positive sign, this implies that a counter-cyclical fiscal policy has a positive effect on the elasticity of the BBB with respect to the cycle when the debt ratio is below 66%. Thus, although the cycle is positively

associated with the BBB, the latter would be more sensitive to fluctuations in economic activity in countries with high debt ratios. On the other hand, the negative sign of the parameter β_1 indicates that the increase in the previous debt ratio above a threshold of 66% has a negative effect on the elasticity of the BBB with respect to the economic cycle. This result means that a policy of excessive debt makes fiscal activism inefficient. Thus, any policy of controlling the BBB according to the cyclical position of the economy is effective for a debt ratio below 66%.

As already shown, the low value of the slope (8.9) suggests that the structure of the PSTR is suitable for model No. 2. This smooth transition is illustrated by Figure 2.a, which describes the evolution of the BBB's elasticity over the economic cycle as a function of the debt ratio.

Moreover, regarding the influence of variables of control on the BBB, the results indicate that an improvement in the terms of trade contributes to reducing the BBB's deficit. This implies that an appreciation of the BBB (deficit reduction) would require policies that would not only improve the terms of trade, but also control the debt ratio (at 66%).

Analysis of the relationship between the BBB and previous debt subject to conditions at the economic cycle level (transition: economic cycle)

In the same vein as model 2, it emerges from the parameters (β_0 = 0.1 and β_1= -0.18) of model 4 (equation 5) that an expansive fiscal policy positively affects the BBB's elasticity with respect to debt if and only if it is in a context of procyclical fiscal policies (high economic cycle). Moreover, this positive coefficient (β_0 = 0.1) indicates that the dynamics of the BBB adjusts the debt growth when the economy is in a phase of high growth. Thus, an increase in the level of public debt is associated with an appreciation of the BBB when the economy is expanding. This is the result found in Coulibaly (2013)'s study which shows that "the Primary Base Balance has an advantage over the BBB excluding grants to adjust the positive evolution of the public debt...". Contrary to the result of this study, ours indicates that the BBB could reduce the evolution of the debt ratio only if the economy is in an expansion phase. This implies that a reduction policy of the BBB based on previous debt could be viable when the economy is in a boom.

These results have significant implications on how fiscal policy is funded depending on whether the economy is expanding or contracting. If it is less affected by debt, the results are certainly modified. In this respect, a reorientation of the funding method of fiscal policy other than debt is necessary, particularly in periods of economic recession. In fact, in periods of economic downturn, WAEMU's economies will struggle to meet the BBB budget standard set by the CSGSP.

Similarly, based on our variables of control, the results show that an increase in FDI and an improvement in the terms of trade contribute to a reduction in the BBB deficit. In addition, due to the low value associated with its slope (Model no. 4), the structure of the PSTR is appropriate in this model. Figure 2.b describes the evolution of the BBB's elasticity with respect to debt as a function of the economic cycle.

Overall, these results have implications in terms of economic policies that aim to reduce the BBB's deficit without compromising the achievement of fiscal discipline, which is a guarantee of the stability of the WAEMU's financial and monetary system. These are measures that aim to control the debt ratio while encouraging the emergence of economic expansion phases. Thus, the strengthening of political stability combined with a strategy of attracting FDI and a policy of internal processing of raw materials in order to reduce the extent of the deterioration in the terms of trade are necessary for this purpose.

Figure 2. *Effect of debt and the economic cycle on the elasticity of the BBB*

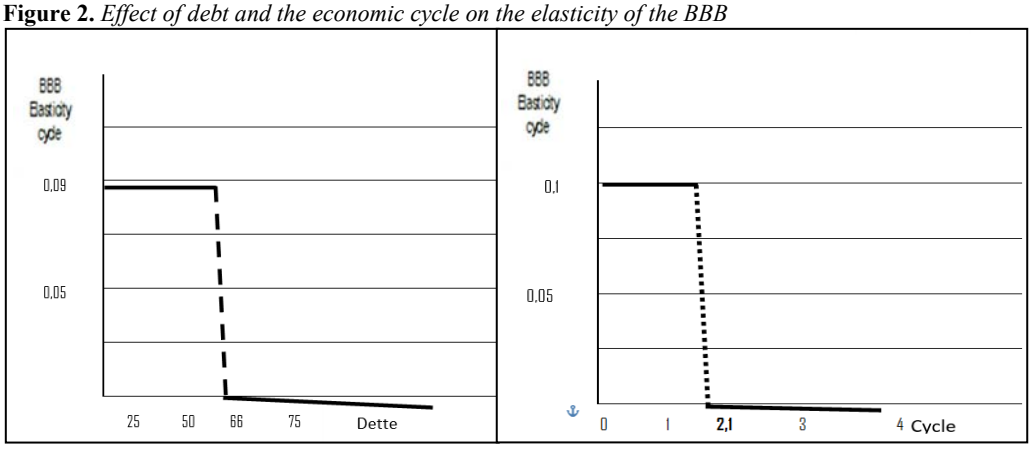


Figure 2.a. *Effect of debt on BBB/Cycle's elasticity* Figure 2.b. *Effect of cycle on BBB/Cycle's elasticity*

Source: Author' construction.

4. Conclusion

This study attempted to assess the non-linear effect of the economic cycle and debt on the BBB within WAEMU's countries. Based on a threshold effects model with smooth transition in panel (PSTR) developed by Gonzales et al. (2005), the hypothesis of non-linearity between the BBB and the economic cycle (debt) has been confirmed. The results show that the dynamics of the BBB adjusts the increase in external debt when the economy is in a period of economic upturn. Similarly, the study shows that to be effective, any measure to reduce the BBB deficit in WAEMU's countries must take into account the debt ratio achieved (less than 66%) by the economies, particularly during periods of expansion. Such a result concerning the conditions for the effectiveness of the BBB's reduction in accordance with the cyclical position of the economies or the level of debt would probably not be unanimously accepted and would lend themselves to methodological improvements. In this study, the transition variables used in the transition functions lower the sensitivity of the BBB to the economic cycle. Thus, we can consider investigating the transition variables that condition non-linearity and that increase in sensitivity of the relationship as a result of their growth. Similarly, one could also consider assessing the relationship between the BBB and the economic cycle by using the MS-VAR (Markov-Switching Vector Autoregressive) model in which, unlike the PSTR, the variable of the transition between the regimes follows a Markovian process that is unobservable; but also, the different regimes are discrete and stochastic in nature.

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The impact of government spending on the economic growth of a sample of developing countries using panel data

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Abstract. *The following study aims to study the impact of government spending on economic growth for the period (2005-2019) using panel data on a sample of (15) developing countries. The Pooled Mean Group Estimator (PMG) method was used to estimate the study model. The results of which showed in the short and long run the existence of a significant and direct relationship between government spending and economic growth in the countries under study. This is consistent with most of the previous studies and the Keynesian theory, which indicate that government spending is one of the components of effective aggregate demand, which is positively reflected on the gross domestic product through its ability to create new individual incomes, and thus a rise in the productivity and consumption of economic agents.*

Keywords: government spending, economic growth, panel data, (PMG).

JEL Classification: H5, O47, C23.

1. Introduction

The subject of the economic impacts of government spending is of great interest to researchers, especially the impact on economic growth. Economic schools differ in highlighting this effect through the role that the government plays in economic activity. Some of them adhered to economic freedom, and some resorted to its intervention. In general, there is no clear agreement among economists about this impact, whether positive or negative. On the contrary, John Maynard Keynes sees government spending as an element of effective aggregate demand, and therefore its impact is reflected on the national product. Hence, it is possible to deduce the problematic of the study and find out the direction of the relationship of government spending with economic growth, which is an important economic result for the developing countries' governments, especially since the public sector (government spending) in these countries represents a relatively large share of the society's economic resources. Therefore, in this study, we will try to study the following problematic: What is the impact of government spending on economic growth in the developing countries under study for the period (2005-2019)? This is done by building a standard model to measure this effect for a sample of 15 Asian and African countries estimated by Panel data. In addition, the (PMG) method is relied upon to study this effect in the short and long run, after answering the problematic of the study, and using two statistical programs represented in (Eviews12) and (Stata15), in line with the modern trends of econometric models methods.

2. Literature analysis

After reviewing several previous studies dealing with government spending and its impact on economic growth, we found a difference in determining the nature of the relationship, which is due to its complexity and lack of clarity in its features. We found a number of academic studies, including the study of Chipaumire et al. (2014) entitled The Impact of Government Spending on Economic Growth: Case of South Africa (1990-2010). In it, the researcher addresses the causal relationship between public spending and economic growth in South Africa by testing the Keynesian and classical theory based on quarterly data for the period (1990-2010). The study found a negative causal relationship from government spending to economic growth, which is not consistent with the Keynesian theory, which shows that there is a positive impact of spending on GDP. He attributes this to the inefficiency of the government's agreement programs in South Africa (Chipaumire et al., 2014). As for Lahirusham Gumasekara (2015) entitled The Impact Government Expenditure on Economic Growth: A Study of Asian Countries, the researcher studied the long-run equilibrium relationship between government spending and economic growth in some Asian countries (Singapore, Malaysia, Thailand, South Korea, Japan China, Sri Lanka, India and Greece) based on Granger causality test and panel fixed effect. The results show a positive and significant impact of government spending on GDP in the Asian region. It has also been proven that there is a long-run relationship between economic growth and government spending in these countries, and there is a two-way causality from economic growth to government spending and from government spending to economic growth. Thus, it was confirmed that the study is consistent with Keynes' theory and

Wagner's Law, meaning that the government plays a key role in achieving growth (Gumasekara, 2015). Moreover, we also found Sheilla Nyasha's study (2019): The impact of public expenditure on economic growth. Here, the researcher presents the idea that determining whether or not an increase in public spending is beneficial to economic growth is difficult and tries to focus on reviewing the literature that evaluates the impact of government spending on economic growth. This study collected various studies on the impact of public spending on the economy, and on the basis of their results, three groups emerged, the positive impact, the negative impact, and the absence of an impact. This was followed by a review of each relevant study and an evaluation of each one. The researcher concluded that the effect of government spending on economic growth is unclear, and tends towards a positive effect based on the comprehensive review of previous empirical studies in various countries since the 1980s (Nyasha, 2019). In addition, Jung Chan et al. (2019) Study of the Relationship between Government Expenditures and Economic Growth for China and Korea drew our attention. His study aims to analyze government spending on the economic growth of China and Korea, using a quantitative regression (QR) model. The researcher chose Korea as a comparison country to China, which is dominated by the socialist system and the Baro theory was relied upon to test the relationship between the two variables. The study found that Korea adopted the strategy of trade openness and worked to reduce government intervention in the market and increase the flexibility of the labor market in accordance with the recommendations of the International Monetary Fund, which allowed more flexibility for the impact of economic growth on government spending. On the other hand, China still maintained a socialist system, and the government was influential in the market through state-owned enterprises. There was an effect of government spending on economic growth, but to a lesser extent than in Korea, which supports Baro's theory. Government expenditures stimulate economic growth by increasing the efficiency of the private sector at an early stage of economic growth (Chan et al., 2019). In the study of Cristian et al. (2021) entitled Government Spending and Economic Growth: A Cointegration Analysis on Romania, the researchers try to identify the nature of the relationship between government spending and economic growth. This is in order to test Wagner's and Keynes' theories in Romania during the period (1995-2018) using semi-annual data and through long-run dynamic analysis of the two time series, co-integration methodology and Engle-Granger causality test. Moreover, they concluded that there is no long-run co-integration relationship, while the double causal relationship appeared in the short run, which are results that prove the validity of the Keynesian theory, which refers to the intervention of countries in the economy through the government expenditure multiplier government (Popescu and Diaconu, 2021). As for the study of (Nembot Ndeffo et al., 2021) entitled Effects of Public Expenditure on Economic Growth in the CEMAC Subregion: A Comparative Analysis between the Fragile and Non-fragile States, its study aims to conduct a comparative analysis of the effects of public expenditure on economic growth between two groups of African countries. The first is represented by countries with fragile economies, Chad, the Central African Republic and the Congo, while the second represents the non-fragile economy, namely Chad, the Central African Republic and the Congo. This is by highlighting the differential effects of investment spending and consumer spending during the period (1975-2016) using the approach of ARDL. The results revealed a positive and stable long-run relationship between public spending and the rate of economic growth

in the region of countries that are characterized by a non-fragile economy. The researcher also recommended directing public spending towards productive development projects (Luc et al., 2021).

3. Data and study model

In order to answer the study problematic, we will use cross-sectional time-series data analysis methods by relying on individuals from a sample that includes 15 developing countries, including African and Asian, represented in: Vietnam, the Philippines, Senegal, Uganda, Pakistan, Republic of the Congo, Mali, Morocco, Cameroon, Algeria, Jordan, Nigeria, Malaysia, India, Thailand i.e. N = 15. As for the time limits, it extends between 2005 to 2019 i.e. T = 15, which means that the sample size is estimated at (N × T = 225) and the only criterion for choosing the time period, as well as the countries, is the availability of data obtained from the World Bank database (wdi). The study model will be as follows after entering the logarithm:

$lngdp = \beta_0 + \beta_1 lngov + \beta_2 lninv + \beta_3 lninvl + \varepsilon_t$

Lngdp – GDP (constant 2010 US$).

Lngov – Gross national expenditure (constant 2010 US$).

Lninv – Direct foreign investment, net inflows (BoP, current US$).

Lninvl – Domestic investment expressed as gross capital formation (constant 2010 US$).

ε_t – Represents the limit of random error.

(β_0, β_1, β_2, β_3) – The model parameters.

4. Dynamic panel presentation

4.1. The Unit Root test panel data

In contrast to the time-series tests, the stability tests related to various Panel data have appeared since 1994, especially when there are a large number of observations and individuals. Among them, we mention the tests of Maddala and Wu (1999), Choi (2002) and Harris and Tzaralis (1999) (Hsiao, 2003, p. 298), but the most important of them are (Dickey and Fuller (1979). This is in addition to Im, Pesaran, and Shin (2003) who took precedence in suggesting a unit root test using panel data to relieve the limitations of the Levin, Lin, and Chu test (2002), which is based on two main assumptions: homogeneity of the autoregressive root under the assumption of independence of individuals (Im et al., 2003, p. 53). There is also another test called Hadri (2002) that is distinguished from the rest of the tests in that it's null and alternative hypothesis is unlike the rest of the previous tests, and it also takes into account the quality of the heterogeneity of the autoregressive root (Hadri, 2002, pp. 148-161).

4.2. Presentation of the estimation methods (PMG) and (MG)

Pesaran, Shin and Smith (1999) presented two methods for dealing with the bias caused by heterogeneous trends in dynamic panel models, namely, the Mean Group Estimator (MG) and the Pooled Mean Group Estimator (PMG), (Pesaran et al., 2004, p. 7). We estimate the study model and a dynamic panel represented in the impact of government spending on economic growth in the countries under study with (PMG) and (MG). For this purpose, we first formulate the model in the framework of the ARDL model (*p, m,…, mk*) with *p* the number of regressions of the dependent variable and *m* the number of regression of the independent variables as follows:

$$lngdp_{ti} = a_{0Y} + \sum_{j=1}^{p} \lambda_{ij} \, . \, lngdp_{i,t-j} + \sum_{i=0}^{m} \delta_{ij} \, X_{i,t-j} + Y_t + \mu_i + \varepsilon_{it}. \qquad (1)$$

where:

$lngdp_{ti}$ – represents the country's gross domestic product (i) during the time period (t).

$X_{i,t-j}$ – The matrix of independent variables represented in (*lngov*, *lninv, lninvl).*

λ_{ij} – Parameters of the time-delayed dependent variable.

δ_{ij} – Parameters of the explanatory variable

ε_{it} – The limit of the random error, which is assumed to be symmetrically and naturally distributed across countries and time periods, that is:

$\rightarrow N(0, \sigma_{\varepsilon}^2)\ \varepsilon_{it}$

(*m, p*) – represent the distributed slowdown periods that differ from one country to another.

The fixed effects μ_i can be taken into account to contain the differences between the countries under study, and the time effects Y_t can also be taken into account.

Model (1) can be reformulated in the context of error correction as follows:

$$\Delta lngdp_{ti} = \Theta_i(ln\ gdp_{i,t-j} - \beta_i' X_{i,t-j}) + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \, \Delta ln\ gdp_{i,t-j} +$$

$$+ \sum_{i=1}^{m-1} \delta_{ij}^{*} \, \Delta X_{i,t-j} + Y_t + \mu_i \ + \varepsilon_{it}. \qquad (2)$$

With an imbalance correction parameter, or the speed of variable adjustment $lngdp_{ti}$ to the equilibrium relationship, long-run parameters and short-run dynamic relationship parameters, and to obtain MG estimates, a model is estimated for each country separately. Then the average of the estimated parameters is taken, which are the long and short run parameters and the lower-bound error correction parameter, and this is as follows:

$$\widehat{\Theta}_{MG} = \frac{\sum_{j=i}^{N} \widehat{\Theta}_i}{N}, \qquad \hat{\beta}_{MG} = \frac{\sum_{j=i}^{N} \hat{\beta}_i}{N},$$

$$\hat{\lambda}_{MG} = \frac{\sum_{j=i}^{N} \hat{\lambda}_{ij}}{N}, \qquad \hat{\delta}_{MG} = \frac{\sum_{j=i}^{N} \hat{\delta}_{ij}}{N},$$

where:

N – the number of countries under study.

j = 1, …, q-1.

It is an estimation method (MG) that does not take into account that some parameters of the model can be equal (homogeneous) across countries, therefore, we relied in estimating our study model also on the panel data for the estimates of the (PMG). It allows to involve the homogeneity constraints of the long run acceleration coefficients in calculating the average within the group and to obtain the averages of estimating the error correction coefficients and other coefficients for the short-run acceleration in the model. By applying this constraint to the model, the generated model becomes as follows:

$$\Delta lngdp_{ti} = \Theta_i(ln\, gdp_{i,t-j} - \beta_i' X_{i,t-j}) + \sum_{j=1}^{p-1} \lambda_{ij}^{*}\, \Delta ln\, gdp_{i,t-j} +$$

$$+ \sum_{i=1}^{m-1} \delta_{ij}^{*}\, \Delta X_{i,t-j} + Y_t + \mu_i + \varepsilon_{it}. \qquad (3)$$

The long-run parameters β_i' become equal across the group of states. In order to obtain the estimators of the combined group mean (PMG), the model (3) is estimated, and we get:

$$\widehat{\Theta}_{PMG} = \frac{\sum_{j=i}^{N} \widehat{\Theta}_i}{N}, \quad \hat{\beta}_{PMG} = \frac{\sum_{j=i}^{N} \hat{\beta}_i}{N}, \quad \hat{\lambda}_{PMG} = \frac{\sum_{j=i}^{N} \hat{\lambda}_{ij}}{N}, \qquad \hat{\delta}_{PMG} = \frac{\sum_{j=i}^{N} \hat{\delta}_{ij}}{N}$$

$$j = 1, \ldots, q-1$$

5. Study results

5.1. The results of testing the stability of the study variables

For the purpose of testing the stability of the study variables, we relied on the tests of Levin, Lin, and Chu (2002), Im Pesaran and Shin test IPS (2003) and ADF – Fisher Chi (1981). We applied these tests to the study variables and reached the results shown in Table 1, where the equations of the tests include the constant and trend, and then we chose the appropriate deceleration periods in an automated manner according to the AIC standard.

Table 1. *Results of unit root tests for study variables*

Test	At the level					
Variable	LLC test		LPS test		ADF test	
	Test value	P-value	Test value	P-value	Test value	P-value
Lngdp	-0.65760	0.2554	3.45367	0.9997	22.7987	0.8234
lngov	-2.01364	0.0220	1.42142	0.9224	30.5882	0.4358
lninv	-2.19571	0.0141*	-1.94966	0.0256	50.3391	0.0114*

Test	At the level					
Variable	LLC test		LPS test		ADF test	
	Test value	P-value	Test value	P-value	Test value	P-value
lninvl	-3.30097	0.0005*	0.00299	0.5012	30.9564	0.4176
Variable	In the first difference					
	Test value	P-value	Test value	P-value	Test value	P-value
Lngdp	-4.14007	0.0000*	-2.44075	0.0073*	50.9013	0.0100*
lngov	-5.97783	0.0000*	-4.18135	0.0000*	68.7094	0.0001*
lninv	-	-	-	-	-	-
lninvl	-7.48293	0.0000*	-5.93544	0.0000*	91.5596	0.0000*

* The probabilities are significant at 5%.
Source: Prepared by the researcher based on Eviwes12.

The results of the stability test show that the foreign direct investment variable *Lninv* is stable at the level, where the probability value of the variable is less than 5% based on the tests, LLC ADF, IPS, from which we reject the null hypothesis for the existence of unit roots. As for the variables *lngov, lngdp, lninvl,* the results of the IPS: ADF tests showed that they are unstable at the level as the corresponding probabilistic values are greater than the level of significant values 5%, and after making the differences, they became stable at the first difference.

5.2. Studying the co-integration between the study variables

Co-integration tests for panel data differ from their counterparts in time-series. Pedroni (2004) proposed a co-integration test for panel data that assumes heterogeneity, which is a test similar to the tests of (McCoskey and Kao, 1998). Cointegration relations are defined by (Kao, 1999) and (Pedroni, 2004) as the test of the unit root hypothesis for equation remainders where the null hypothesis H_0 acknowledges that there is no co-integration relationship between the studied variables versus the alternative hypothesis H_1 (Blatagi, 2005, p. 254).

The results of the stability test show that the study variables are a mixture of stable variables at the level and integrated variables of the first degree. In order to ensure the existence of a long-run relationship between the two variables, that is, the existence of a long equilibrium relationship, the Kao test was used in our study as shown in Table 2.

Table 2. *A table showing the results of the Kao cointegration test*

Kao test	Statistical	P-value
ADF	-5.812425	0.0000
Residual variance	0.001282	
HAC variance	0.000970	

* The probabilities are significant at 5%.
Source: Prepared by the researcher based on Eviwes12.

From the above table, we notice that there is a long-run co-integration relationship, where the statistical ADF appeared significant at the level of significance of 5%. Thus, we reject the null hypothesis that there is no cointegration and accept the alternative hypothesis.

5.3. Estimating the error correction model according to the (PMG) and (MG) methods

After making sure that there is a co-integration, we estimated the study model according to the (PMG) and (MG) methods, as shown in Table 3. In order to compare between the (PMG) and the (MG) estimation results, the *Hausman-Test* was used.

Table 3. *The study model estimation results according to the PMG and MG methods*

Estimation method	PMG		MG	
Variables	Long-run estimations			
	Coefficient	P-value	Coefficient	P-value
Lngov	0.8463	0.000*	1.1541	0.000
Lninv	0.0158	0.007*	-0.0397	0.084**
Lninvl	0.0183	0.528	-0.2426	0.069
	Short-run estimations			
CointEq(-1)	-0.2001	*0.002	-0.4980	0.000
Lngov	0.2484	*0.016	0.0664	0.615
Lninv	-0.0002	0.936	0.0066	0.083**
Lninvl	-0.0445	0.149	-0.0229	0.634
cons	0.6226	*0.001	0.9511	0.099**

Hausman-Test	H-stat	P-value
	6.98	0.0725

* The probabilities are significant at 5%.
** The probabilities are significant at 10%.
Source: Prepared by the researcher based on Stata15.

The results of the Hausman-test indicate that the p-value of the test is estimated at p-value = 0.0725, which is greater than 5%. This leads us to reject the alternative hypothesis and accept the null hypothesis that the PMG method is the best method for estimating our study model.

From the results of Table 3 of the (PMG) estimations, it is clear that the error correction coefficient CointEq(-1) is negative (-), and it is significant at the 5% level according to the probability statistic, and this confirms the results of the joint integration according to Kao test. As for the estimated value of the error correction coefficient CointEq(-1), it was estimated at -0.2001, which means that 20.01% of the imbalance of the variable GDP (lngdp) for the previous period (year) is getting corrected in the current period.

The results of the (PMG) estimations in the long run show that there is a positive and significant relationship at the 5% level between the government spending index (lngov) and economic growth (lngdp) in the developing countries under study. When government spending rises by one unit, assuming other factors remain constant, this leads to an increase in GDP by 0.8463%. This is consistent with most of the previous studies and with the Keynesian theory, which indicates that government spending represents one of the elements of effective aggregate demand, which is positively reflected on the gross domestic product through its ability to create new individual incomes, and thus a rise in the productivity and consumption of economic agents. Accordingly, the theory of effective demand and the idea of the multiplier that Keynes came up with confirms the positive impact of public spending on economic growth. The same results were supported by the error correction model for the short-run relationship, where the positive impact of the government spending variable had a flexibility estimated at 0.2484%.

The parameter of foreign direct investment (lninv) appears significant and has a direct relationship with the economic growth variable in the long run. When foreign investment rises by one unit, with the stability of other factors, it leads to a rise in GDP by 0.0158%. The interpretation of this stems from the fact that the flow of foreign direct investment represents the most important elements of external financing for development in

developing countries. This is supported by the neoclassical interpretation, which highlighted that the impact of foreign direct investment (lninv) on economic growth (lngdp) is positive despite its limitations, and this confirms the weakness of flexibility, which is estimated at 0.0158%. As for the short run, according to the error correction model, the foreign direct investment parameter (lninv) appeared insignificant, and this can be explained by the delayed response of economic growth (lngdp) in the short run to the influx of foreign direct investment. As for the coefficient of the gross capital formation variable expressing domestic investment (lninvl), it appeared insignificant, whether in the long run or in the error correction model for the countries under study. As for the coefficient of the gross capital formation variable that expresses domestic investment (lninvl), it appears insignificant, whether in the long run or in the error correction model for the countries under study.

6. Conclusion

Various studies and research analyze the relationship between government spending and economic growth. The Keynesian theory holds that government spending leads to increased growth through the Keynesian multiplier, unlike Wagner's theory. In addition, the results of these studies vary in terms of statistical and economic significance according to the different regions and countries selected, as well as the standard methodology used. As for our study, it deals with modeling the impact of government spending on economic growth for a sample of 15 developing countries during the period (2005-2019). We studied the stability of the cross-sectional data and the co-integration test, then we made a comparison between the mean group estimator (MG) and the Pooled Mean Group Estimator (PMG).

We concluded that the Pooled Mean Group Estimator (PMG) is the best for estimating, as its results for the long and short run show the existence of a significant and direct relationship between government spending and economic growth rates in developing countries. This was explained based on Keynes' effective demand. It can also be noted that current spending on education and health allows individuals to perform their activities more efficiently, as the more this type of spending increases, the more it significantly contributes to increasing production.

Finally, the study recommends decision makers in developing countries to direct government spending towards productive projects, while rationalizing current spending and searching for new revenues as an alternative to petroleum revenues that are subject to fluctuations in oil prices. This is in addition to focusing on government spending policies that stimulate economic growth and encourage local investment by providing the appropriate environment for local investors to invest within the country.

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The evolution of consumer prices – the main brake on economic growth

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Abstract. *The current period, subject to the pandemic and economic and financial crisis, requires an increased focus on price analysis, in both ways, the calculation of inflation based on the consumer price index, but also the calculation of the harmonized index of consumer prices. The latter is an indicator of inflation used by the Member States of the European Union.*
The economic and financial crisis is hitting hard in the economy of all countries. Therefore, in some circumstances the error is made to express an insufficiently analysed correlation, of the correlation between the increase of inflation on the one hand and the increase of the Gross Domestic Product on the other hand. In terms of current prices, this indicator is based on reality, but from the point of view of the real indicator, Deflated Gross Domestic Product, the situation is not exactly like that. Therefore, in this article we have sought, based on the data we have, to identify and suggest elements that are important in terms of price developments in the national economy of Romania.
As a methodology, we focused, using the data provided by the National Institute of Statistics and Eurostat, to use this data to calculate a series of indicators and parameters, which suggest the trend of inflation and, consequently, the effect that this inflation will have an impact on economic growth. We also used a number of elements of inductive and deductive analysis to highlight those elements that make sense in this approach that we have taken in order to determine the influence that the loss of control of consumer prices is an element particularly serious in terms of economic growth.

Keywords: crises, inflation, unemployment, prices, indices, economic evolution.

JEL Classification: C10, E30.

Introduction

In this article, *The evolution of consumer prices - the main brake on economic growth*, we started from the fact that the consumer price index is the element that can be the most destabilizing in the national economy. In this regard, using the available data, I interpreted the consumer price index and the harmonized consumer price index. Due to the methodology and the respective content of the two indicators there are some differences.

We used a series of graphs and data sets in tabular data to highlight how these two indicators are evolving, which is normally a cause of the decline in Gross Domestic Product growth in real terms.

We specified that by deflation the Gross Domestic Product calculated in current prices is transformed into the indicator calculated after deflation, which reveals the real value that this indicator has, Gross Domestic Product.

We also made an analysis of the three categories of products and services, namely food, non-food goods and services, to highlight the role of each category now, nowadays, explosive, on inflation.

The effect of inflation is also explosive, but in a negative sense, in the sense of reducing the Gross Domestic Product in current prices and, as a consequence, reducing the living standards of the population.

Literature review

A number of authors have focused over time on the evolution of inflation, the unemployment rate and economic developments in general. Thus, Anghelache, C and others published an article on the correlation between GDP growth rate, inflation and unemployment rate, and Anghelache, C. (2015) and others analyse in a study the evolution of gross domestic product under the influence of consumption. Anghel, Mirea and Badiu (2018) studied fundamental elements of price indices used to measure inflation. Anghel (2015), as well as Anghelache, Niță and Badiu, A. (2016) conducted studies on the evolution of the price index in Romania. Anghelache and Sacală (2015) presented a series of basic notions of inflation. Armantier and co-workers (2015) addressed a number of issues regarding inflation forecasts. Kim and Henderson (2005) addressed issues related to inflation and the influence on nominal income growth. Kroft and Notowidigdo (2016), as well as Krueger and Mueller (2010) presented significant elements related to unemployment insurance. Iacob, Ș.V., Radu I. (2021) addresses issues related to the evolution of the employment and underemployment rate in Romania. Moscarini and Postei Vinay (2012) studied how employers, depending on their size, contribute to job creation during periods of unemployment. Nekoei and Weber (2017) sought to identify how job quality is improved by extending unemployment benefits.

Methodology

In order to facilitate the understanding of the analysis made in this article, we will further present the main methodological aspects used by the National Institute of Statistics and Eurostat. Thus, the consumer price index (CPI) covers the monetary expenditure of goods and services for final consumption, for all types of resident households, except institutional households, in order to provide a more relevant and accurate picture of inflation. The CPI can be seen as a broad method of measuring the evolution of the prices of a fixed expenditure model.

The Harmonized Index of Consumer Prices (HICP) is a set of EU consumer price indices, calculated according to a harmonized approach and a single set of definitions. The HICP is designed primarily for assessing price stability in the euro area and price convergence in the European Union, as well as for comparisons of inflation at European level. As of January 2016, the HICP series are published with the reference year 2015 = 100.

Expenditure item is a group of expenditures made by consumers to meet specific needs for consumption of foodstuffs, non-foodstuffs or services.

The weight is a coefficient of measurement used to calculate a synthetic index (aggregate) for a group of non-measurable elements directly, having the function of establishing the relative importance of each element in the statistical community investigated.

The monthly inflation rate is the change in consumer prices in one month compared to the previous month, and the average monthly inflation rate is the average monthly change in prices. It is calculated as a geometric mean of the monthly consumer price indices with a chain base minus the base of comparison equal to 100.

The average annual inflation rate is the change in consumer prices in one year compared to the previous year. This rate is calculated as a ratio, expressed as a percentage, between the average price index for one year and that of the previous year, minus 100. In turn, the average price indices for the two years are determined as simple arithmetic averages. of the monthly indices for each year, calculated against the same basis (October 1990 = 100).

The annual inflation rate is the change in consumer prices in one month of the current year, compared to the same month of the previous year. This rate is calculated as a ratio, expressed as a percentage, between the price index for one month of the current year and the index for the corresponding month of the previous year, calculated against the same basis, minus 100.

The measured prices are those actually borne by consumers, so they include sales taxes on products, such as value added tax, and the CPI is calculated on the basis of elements that go into the direct consumption of the population and excludes the consumption of own resources representing the equivalent value. quantities of products consumed by the population from sources other than purchases, investment and accumulation costs (purchase of housing, construction materials used to build new homes or make major repairs to old homes), insurance rates, fines, gambling, taxes, expenses related to the

payment of labor for the production of the household (ploughing, sowing, hoeing, care of gardens and orchards, vineyards, harvesting, hay mowing, medical treatment of animals, etc.) and interest and credit, referring to them as a financing cost, not as an expense For consumption.

The observation and registration of prices is carried out in the 42 county seat cities from which 68 research centres were selected, depending on the number of inhabitants. The units in which the prices/tariffs are registered were selected locally, from the research centres, according to the volume of sales of goods and services. Included in the nomenclature are approx. 8000 units, which must be maintained for as long as possible to ensure the continuity of price observation. The prices collected monthly are retail prices, including VAT.

The CPI is calculated as a fixed base Laspeyres index. Starting with January 2021, the calculation of the monthly indices with a fixed base is made using the average prices from 2019 (year 2019 = 100) and the weights from the same year determined based on the average expenses resulting from the Family Budget Survey.

Data, results and discussions

Economic development is still hampered by the conditions of the current health and financial-economic crisis, which has an unprecedented effect and depth. We are in the fourth wave that has already gone to the beginning of the fifth wave of the coronavirus crisis. We are already at the beginning of wave five.

According to some theories, starting from the Gaussian curve, it follows that insofar as a maximum point of this pandemic has been reached, wave five follows, which has two important characteristics. The first is that it has an unprecedented ability to spread (infect). The second is that the intensity, the gravity, is much lower. This means that we are on the decreasing Gaussian curve, in which quantitatively there are a large number of infections, and in intensity, as results that lead to loss of life, decreasing.

We can take some examples from Western European countries where there is talk of a particularly high infection with the five micro wave virus, but deaths are declining. At the time of writing, there are also signs of an increase in coronavirus, covid-19 infection in Romania, but with declining deaths.

It would be from this point of view to show separate attention. The effects of this crisis as a whole in Europe and consequently in Romania have also caused other contradictions that lead to confusion, especially in terms of economic damage. First of all, it is about the economic and financial crisis that was triggered by the restrictive measures, which were taken by the government in the desire to place us on a curve that would prevent the spread of this virus.

These have had the effect of reducing economic activity, tourism and HoReCa are practically completely destabilized, tourism is also seasonal in terms of coronavirus effects,

and the economy as a whole is affected. In addition the issue of vaccination and non-vaccination in a complex strategic framework, starting with testing then compliance with rules that prevent coronavirus liability (physical distance, wearing a mask, personal hygiene, etc.), which eventually led to the emergence of disputes over the fight between vaccinated and unvaccinated.

As the number of vaccinations in Europe and even in Romania increases, there is already the issue of establishing a quarantine status for all citizens, regardless of whether they are vaccinated or unvaccinated. If it is not understood that the strategy must include, as mentioned above, a complex program that includes testing, the provision of medicines to prevent and treat infections, compliance with the general rules of personal hygiene, vaccination or non-vaccination become two elements without falling into the situation. especially from the perspective of the evolution of this virus.

This covid-19 pandemic caused an unprecedented increase in inflation in Romania. According to some, prices have gone crazy, but in terms of concrete situations they are determined by the food crisis, the energy crisis and the health crisis. Of course, the production and the results of the work are affected, labour is made available, which is not established in Romania but goes abroad, other and other particularly difficult aspects appear.

The conclusion of this state is that the three combined crises have caused the concern and even fear of the population. There is a danger of introducing a state of total quarantine which is an additional concern. It also perpetuates the situation and the prospect of introducing a law let's say green, which provides for the impossibility of employees to go to work to carry out their work.

Against this background although the senior macroeconomic management gave some assurances of calm during the summer (July - August) the evolution of consumer price indices, the one that measures inflation internally, has exploded. In the last two months of November and December 2021, and even in the first quarter of 2022, the level of the inflation rate, which has already reached 7.9% at the end of October, is expected to fall and may even be recorded with two digits.

The forecasts of the profile institutions (Forecast or Central Bank) were overturned. It is now anticipated that by the end of 2021, when the consumer price index calculation data will be finalized, annual inflation could reach even a double-digit rate. In this context, the evolution of prices, through the consumer price index, would become the main brake on the real growth of the economy. This is how the standard of living decreases, and the remaining winter (January - March) brings great trouble to the Romanian population, especially in the context in which gas and energy prices have exploded, the bills at the end of 2021 indicating increases up to five times.

In these conditions, even if some measures have been taken to freeze these already very high prices by the end of March, it offers a not very pleasant outlook for the future period

of 2022. In these conditions, the evolution of prices, measured by the consumer price index, has become the main brake on the real growth of the economy.

We can appreciate the current context of the world, European and Romanian economy is in a process of stagflation. In trying to define stagflation we must start from the fact that this is a feature of the economic crisis. It results from a recession or crisis that is reflected in the stagnation or slowdown of economic growth and the continuation of an inflationary process. The result of long-term rising inflation must be analysed in the context of economic developments, resulting in a lack of growth or, worse, a reduction in economic developments. Stage inflation is known for the correlation that must be established between inflation, growth and unemployment.

After the Second World War and even now, a number of researchers have considered that inflation and the effects of a crisis (recession) are mutually exclusive. Economists give two main explanations for the prospect of stagflation. The first would be that stagflation results in conditions where economic growth is slowed or slowed down. Stocks appear, consumer prices increase, general prices increase, as in the case of Romania, determined by the three crises, of energy, agri-food and sanitary production, and it is not possible for the evolution of the economy to take place in at least a macro-stable situation.

We could even argue here that Eurostat has provided a scoreboard of indicators that determine economic development, which can provide a possibility for a proper interpretation of the economic situation. Certainly by applying a statistical-econometric model based on the relationship between economic growth, inflation and unemployment, we could conclude that we are in the process of stagflation.

This concept of inflation also raises some dilemmas in the way of strategies that ensure macroeconomic management in that part of the actions to combat inflation aggravates the economic situation and vice versa.

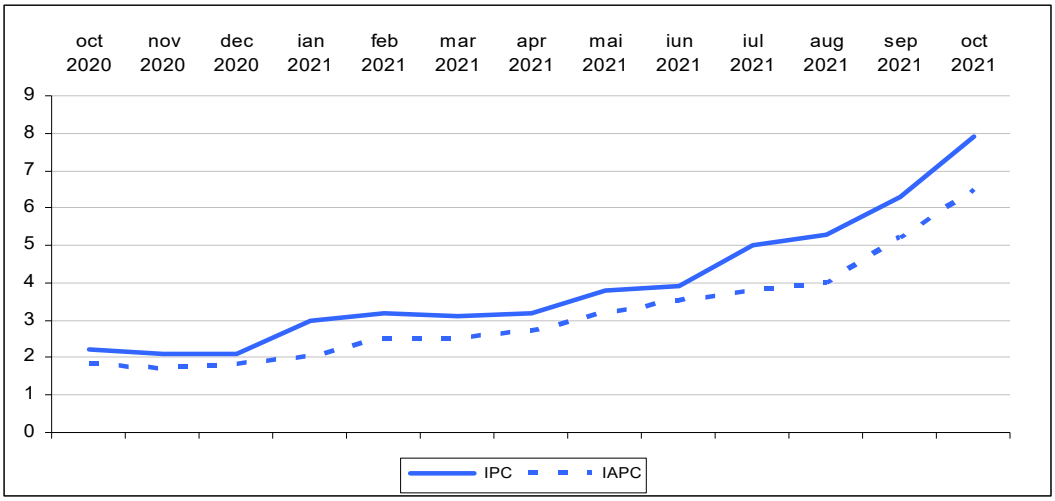
There is another current, another explanation that stagflation and inflation can result from over-regulation of goods and labour markets. The labour market is affected by the deterioration of the market for the production of goods and services and thus increases unemployment. The effects of this stagflation process are global it equally influences the world evolution, the evolution of the European community and of each country, a context in which in this way the problem arises in Romania as well.

To put the views expressed above in the page, we will perform an analysis of the evolution of inflation and the economy using the data we have until October 30, 2021. Thus, consumer prices in October 2021 compared to September 2021 increased by 1.8 %. At the same time, the inflation rate at the beginning of the year (October 2021 compared to December 2020) is 7.4%. Also, the annual inflation rate in October 2021 compared to October 2020 is 7.9%, and the average rate of consumer prices in the last 12 months (November 2020 - October 2021) compared to the previous 12 months (November 2019 - October 2020) is 4.1%.

The Harmonized Index of Consumer Prices (HICP) - an indicator of inflation calculated in all Member States of the European Union, has had the same evolution. Thus, the harmonized index of consumer prices in October 2021 compared to September 2021 is 101.32%, and the annual inflation rate in October 2021 compared to October 2020 calculated on the basis of the harmonized index of consumer prices (HICP) is 6.5% and the average rate of consumer prices in the last 12 months (November 2020 - October 2021) compared to the previous 12 months (November 2019 - October 2020) determined on the basis of the HICP is 3.3%.

Graph number 1 shows the evolution in the last 13 months of the two indicator years (CPI and HICP).

Chart 1. *Annual change in consumer prices (%)*



Source: INS communiqué no. 288 / 10.11.2021.

Regarding the evolution of the consumer price index on the calculation structure, in October 2021, table number 1 shows how this indicator has evolved.

Table 1. *Consumer price index and average monthly inflation rate (%)*

	October 2021 to:			Average monthly inflation rate, in the period 1 I - 31 X	
	September 2021	December 2020	October 2020	2021	2020
Foodstuffs	101,06	105,03	105,25	0,5	0,3
Non-food goods	102,78	110,51	111,39	1,0	0,0
Services	100,42	103,84	103,96	0,4	0,3
TOTAL	**101,78**	**107,43**	**107,94**	**0,7**	**0,2**

Source: INS communiqué no. 288 / 10.11.2021.

In order to reveal the effect of certain components on the increase of the CPI, we performed calculations by exclusion, the results being summarized in table number 2.

Table 2. *Partial indices calculated by excluding certain components from the CPI (previous month = 100)*

	October 2021 %
(a) Total CPI excluding alcoholic beverages and tobacco	101,93
(b) Total CPI excluding fuels	101,33
(c) Total CPI excluding regulated products	101,88
(d) Total CPI excluding vegetables, fruit , eggs, fuels, electricity, natural gas and regulated products	100,54
(e) Total CPI excluding vegetables, fruit , eggs, fuel, electricity, natural gas and regulated prices, alcoholic beverages and tobacco	100,61
TOTAL	**101,78**

Source: INS communiqué no. 288 / 10.11.2021.

The weighting coefficients and indices of consumer prices in October for the main food, non-food and service items are presented in Table 3.

Table 3. *Consumer price index in October 2021 for the main goods and services*

Weighting coefficient	**Name of goods / services**	**October 2021 to:**		
		September 2021 %	**December 2020 %**	**October 2020 %**
10000	TOTAL	**101,78**	**107,43**	**107,94**
3069	TOTAL FOODSTUFFS	**101,06**	**105,03**	**105,25**
515	Milling and bakery products	101,43	105,77	106,26
30	Milling products	101,56	106,34	106,51
411	Bread, pastries and specialties	101,57	106,12	106,62
332	Vegetables and canned vegetables	103,23	107,25	108,92
181	Other vegetables and canned vegetables	103,55	105,83	107,04
206	Fruit and fruit preserves	100,43	108,97	103,25
72	Oil, bacon, fat	102,26	120,46	123,58
737	Meat, meat preparations and preserves	100,53	103,45	103,65
120	Fish and canned fish	100,66	105,18	106,03
478	Milk and dairy products	100,64	103,73	103,99
118	Cheese - total	101,01	105,40	105,94
52	Eggs	103,56	101,25	105,58
137	Sugar, sugar products and honey	100,97	103,98	104,62
86	Cocoa and coffee	100,29	102,39	102,70
126	Alcoholic beverages	100,28	102,85	103,28
208	Other food products	100,53	103,29	103,74
4879	TOTAL NON-FOOD GOODS	**102,78**	**110,51**	**111,39**
549	Clothing, haberdashery, trimmings and haberdashery	100,42	102,20	102,52
379	Footwear	101,02	102,97	103,64
346	Household products, furniture	100,43	102,43	102,67
240	Chemical articles	100,48	102,04	102,45
276	Cultural and sports products	100,36	102,80	103,00
665	Hygienic, cosmetic and medical articles	100,21	101,93	102,22
875	fuel	106,48	121,38	123,51
656	Tobacco, cigarettes	100,00	105,55	107,11
825	Electricity, gas and central heating	107,71	129,98	130,77
68	Other non-food goods	100,74	105,23	106,01
2052	TOTAL SERVICES	**100,42**	**103,84**	**103,96**
22	Made and repaired clothing and footwear	100,72	104,07	104,50
102	Rent	100,64	102,78	102,97
235	Water, sewer, sanitation	100,77	106,98	106,51
188	Cinemas, theatres, museums, spending on education and tourism	100,59	103,02	103,03

Weighting coefficient	Name of goods / services	October 2021 to:		
		September 2021 %	December 2020 %	October 2020 %
26	Car, electronics and photo repair	100,66	104,57	105,16
181	Medical care	100,84	104,97	105,58
122	Hygiene and cosmetics	100,57	104,35	104,80
82	Urban transport	100,07	103,08	103,08
75	Intercity transport (other modes of transport)	99,59	101,66	102,14
524	Post and telecommunications	100,02	101,26	101,25
201	Restaurants, cafes, canteens	100,55	104,20	104,34
92	Other industrial services	100,38	104,56	105,01
202	Other services	100,48	106,74	107,03
69	Payment for accommodation in hotel units	99,98	101,23	101,34

Source: INS communiqué no. 288 / 10.11.2021.

We also presented an evolution of the rate of the consumer price index, in each of the 13 months, to highlight the periods in which the indicator increased the most. Table 4 shows these data with reference to both indicators the consumer price index and the harmonized index of consumer prices.

Table 4. *Consumer Price Index and Harmonized Index of Consumer Prices (%)*

Date	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sept 2021	Oct 2021
IPC	2,2	2,1	2,1	3	3,2	3,1	3,2	3,8	3,9	5	5,3	6,3	7,9
IAPC	1,8	1,7	1,8	2	2,5	2,5	2,7	3,2	3,5	3,8	4	5,2	6,5

Source: INS communiqué no. 288 / 10.11.2021.

As we mentioned in the first part of the article, the application of a statistical-econometric model, based on the relationship between economic growth, inflation and unemployment, could highlight the fact that we are in the process of stagflation. Thus, the quarterly data collected from the National Institute of Statistics for the three mentioned macroeconomic indicators were structured in table number 5.

Table 5. *Quarterly evolution of growth, inflation and unemployment*

Year	Quarter	Economic growth	Consumer price index	Unemployment rate
2018	Q1	0.6	1.52	4.7
	Q2	1.3	1.16	4.1
	Q3	1.5	0.04	3.9
	Q4	0.6	0.89	4.1
2019	Q1	1.7	1.6	4.1
	Q2	0.9	1.44	3.8
	Q3	0.3	-0.14	3.8
	Q4	0.7	0.8	3.9
2020	Q1	0.4	1.1	4.3
	Q2	-11.2	0.73	5
	Q3	5.7	-0.01	5.2
	Q4	3.8	0.31	5.2
2021	Q1	2.2	2.01	6.1
	Q2	1.5	1.29	5.1
	Q3	0.3	1.78	5.3

Source: National Institute of Statistics. Data processed by the authors.

Based on the data presented above and using a multiple linear regression model, we will further determine the regression parameters, based on which we will be able to estimate the future evolution in terms of economic growth in the current conditions we mentioned. Thus, the regression equation has the following form:

$$EG = a + b \cdot CPI + c \cdot UR + \varepsilon$$

where:
EG (economic growth) is the dependent variable;
CPI (consumer price index) is the independent variable;
UR (unemployment rate) is the independent variable;
a, b and c are the regression parameters;
ε represents the residual variable.

The estimation of the parameters of the regression equation using the least squares method, as well as the testing of the significance of the model, was done using the statistical-econometric analysis program EViews, and the results are presented in figure number 1.

Figure 1. *Results of the analysis of the dependence of economic growth on the evolution of the consumer price index and the unemployment rate*

Dependent Variable: EG
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.368769	1.449580	-6.463093	0.0000
CPI	-1.707759	0.621872	-2.746156	0.0177
UR	2.739909	0.335170	8.174692	0.0000

R-squared	0.848369	Mean dependent var	0.686667
Adjusted R-squared	0.823097	S.D. dependent var	3.601362
S.E. of regression	1.514728	Akaike info criterion	3.845205
Sum squared resid	27.53279	Schwarz criterion	3.986815
Log likelihood	-25.83903	F-statistic	33.56969
Durbin-Watson stat	1.453119	Prob(F-statistic)	0.000012

According to the results presented in figure number 1, we conclude that the model is valid and can be used in estimating the evolution of economic growth. The analysis also confirms the influence of the evolution of independent variables on the consumer price index and the unemployment rate on economic growth. Based on the data presented and analysed above and due to the dependence confirmed by the regression model used, we can say that at this moment the Romanian economy is in the stagflation phase.

Conclusions

From the study conducted by the authors and presented in the article Evolution of consumer prices – the main brake on economic growth, there are a number of practical issues. Thus, inflation in the current period and, extending in the future, is one of the main causes for which the evolution of the Gross Domestic Product will be hindered. Consequently, in real terms, economic growth will also be sufficiently affected.

The second conclusion is that the evolution of the consumer price index or the harmonized index of consumer prices must not be out of control, so as not to seriously affect economic growth.

To this end, it is necessary to take measures that are effective and lead, at the very least, to stopping if not eradicating the rise in consumer prices. In other words, the effects of the pandemic crisis, combined with the economic and financial crisis, will stimulate an accelerated increase in the inflation rate. This should lead to the conclusion of very rapid measures to stabilize and slow down this development.

The consumer price index and the harmonized index of consumer prices are two calculated indicators that should be followed mainly and, as far as possible, a forecast should be made of their evolutionary trend.

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Analysis of income inequalities in the pre-pandemic COVID-19 period

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Abstract. *The degree of income inequality has increased in recent years in most EU Member States, raising concerns from both the perspective of sustainable growth and social cohesion. Given that the Europe 2020 strategy focuses on poverty reduction, we must keep in mind that this phenomenon is closely linked to income inequality. In this article, an analysis was carried out on the evolutions of the main indicators of income inequality (Gini index and the S80/S20 quintile ratio) in the European Union and in Romania. Several income concepts were investigated: disposable income with social transfers, disposable income without social transfers, with or without the inclusion of pensions in social transfers. The evolution of the indicators for measuring income inequalities has indicated that both in the European Union and especially in Romania, inequalities have increased, and this increase is more pronounced for market income inequality (i.e. inequality before taking into account taxation and social transfers) as the tax and social security system has an equalizing effect.*

Keywords: income inequalities, Gini coefficient, disposable income.

JEL Classification: J31, I31, H24.

1. Introduction

Income inequality is a synthetic measure of income distribution, which captures its general characteristics. Traditionally, research in the area of inequalities addresses the situation of vulnerability of households or individuals from a static point of view. Although there is a great strand of research on this topic, the patterns and implications of economic inequalities are not fully understood. In this context, we aimed to contribute to the development of the conceptual and empirical framework for understanding the causes and consequences of economic inequality, as well as the evolution of this phenomenon in our country.

The economic and financial crisis of 2007-2008 triggered a period of recession that generated a standard negative interaction, especially in the corporate and household sectors, in the typical manner of any recession. Thus, the companies reduced/stopped investments, reduced working hours and staff levels. Households – faced with increased uncertainty, cuts in property prices, but also new lending restrictions – have tried to save more although they have suffered losses in income; general consumption decreased, worsening the situation of companies by affecting supply, which intensified the process of job losses.

The effects of the economic crisis, even in a strong economy, affect households by subjecting them to unexpected changes in economic needs or resources, commonly referred to as economic shocks. In general, events that affect income can take different forms and can be classified as: 1) reduction of earnings – by loss of employment, reduction of working hours or the loss of an income earner household member (by separation, divorce or death); 2) reduction of revenues to the public budget – which puts pressure on social assistance systems; 3) reduced support for private income – by reducing support from the public budget.

The income of the population plays an important role in the recovery from the period of economic recession. The stagnation of global wage income in the pre-crisis 2007-2008 period has also contributed to some extent to the onset of the economic recession, weakening the ability of economies to recover rapidly, as the prolongation of the recession has its structural roots in declining the aggregate demand as a result of declining incomes. At the same time, the redistribution of salary income from middle-income to high-income employees has reduced the aggregate demand by transferring income from people with a higher disposition to spend/consume to people who save more.

The global economic crisis of 2007-2008 had devastating consequences for labour markets. Worldwide unemployment rose to 210 million, the highest level ever recorded and many millions more were too discouraged to continue looking for work, especially as wages were also affected. The ILO report (2010) indicated that in 2008 and 2009 real average wages fell by half compared to previous years. At the same time, in addition to the fact that many people lost their jobs, the reduction in wage income severely affected the purchasing power and well-being of those who kept their jobs. While unemployment rose primarily in advanced economies, the impact of the crisis on low- and middle-income developing countries (which generally have a less developed level of social protection systems) deteriorated in terms of the quality of employment.

Indicators in advanced countries also show that recession affected the level of wages, the number of hours worked and other dimensions of what the ILO calls "decent work". Wage trends during the crisis should be taken into account amid rising wages and widespread and growing wage inequality in the years leading up to the crisis. In the context of the recession, a particular concern was that an economic crisis could lead to an increase in low-wage and short-term workers, either in the short or medium term.

Global post-crisis trends in wages and the share of wages should be seen against the background of large-scale and rising wage inequality, characterized by rapidly rising wages in the upper quartiles and stagnant or declining wages in the middle and lower quartiles. Globally, the ILO analysis shows that in the period 2007-2009 the pay gap increased between the 10% of the lowest paid employees and the 10% of the highest paid employees. The recession has caused high-income earners to increase or maintain their income levels, and middle-income earners to move closer to low-income earners. In addition, most countries experienced a short-term increase in the share of wages in GDP between 2007 and 2009. This trend shows that, despite declines in both total wages and profits during the crisis, profits were more volatile than the total wage and indicates that wage rate fluctuations are usually countercyclical – rising during recessions and declining during recovery periods.

The European Commission's Report (2009) on labour market developments and earnings in 2008 found that there was a delay in the European labour market in manifesting the effects of the economic crisis that broke out in 2007 in the USA. Faced with the strict financial conditions, companies were forced to reduce the salary component or to reduce the number of employees. In 2009, for the first time since 1999, real wages had the lowest growth rate (only 0.2%), which allowed resident aggregate consumption to remain afloat. The low inflationary expectations and the confidence of households in the recovery measures on the social side (social protection) also contributed to this situation. Public sector wage behaviour varied across eurozone countries in 2008, but the general trend has been upward, leading to additional pressure on private sector wages, so that firms, after making efforts to increase wage incomes in 2008, in 2009 were unable to pay existing salaries, excluding the option to increase them. Wages fell most in the countries hardest hit by the economic crisis – Spain, Ireland, Italy, Greece and Portugal.

Mills and Amick (2011) conducted a longitudinal analysis of USA households from the Survey of Income and Employment Participation Survey. The results indicated that American households, regardless of income levels, but especially those with low incomes, experienced substantial income variability during 2009-2010. Shocks to income or expenditure pose threats to the well-being of low-income families, but the results of the analysis indicate that households with liquid assets in the form of savings can alleviate the risk of living difficulties. The effects of the economic crisis have led to an increase in income volatility, especially in the lower quartiles.

Acs, Loprest and Nichols (2009) examined changes in income during 2009 (post-crisis) among individuals aged between 25 and 61 in families with children. The analysis focused on how often individuals experienced substantial (over 50%) decreases in income within a year. The results showed that the largest decreases in income in the post-crisis period were

among low-income individuals (20%), and of these 16% failed to recover these decreases within a year, i.e. their income was reduced by more than half for more than 12 months. 33% of those who had lost their income managed to partially recover some of the losses suffered within a year, and 51% fully recovered the income reduction in the next 12 months.

In Romania, the economic crisis began at the end of 2008, profoundly affecting the living standards of the population. From the beginning, a significant number of people lost their jobs, while income levels declined significantly. The consequence was a decrease in consumer spending, precipitating a further decline in production and investment. Internally, the balance was severely affected and public spending significantly exceeded revenue. Public debt rose, and the government had to lend heavily. In 2009, Romania concluded a loan agreement with the IMF to support expenditures, given a short-term reduction in budget revenues (Duguleană, 2011).

During the recession, Romania's economy was characterized by a low and middle -skilled workforce and a low use of technology, based on low value-added industries. Productivity was affected, and the business models used allowed productivity to increase only through wage cuts, which was essentially a strong additional source of reduced welfare. The structure of employment in Romania indicates that it lags far behind other European countries in terms of economic structure, this being one of the causes of low productivity in general (Enache, 2012).

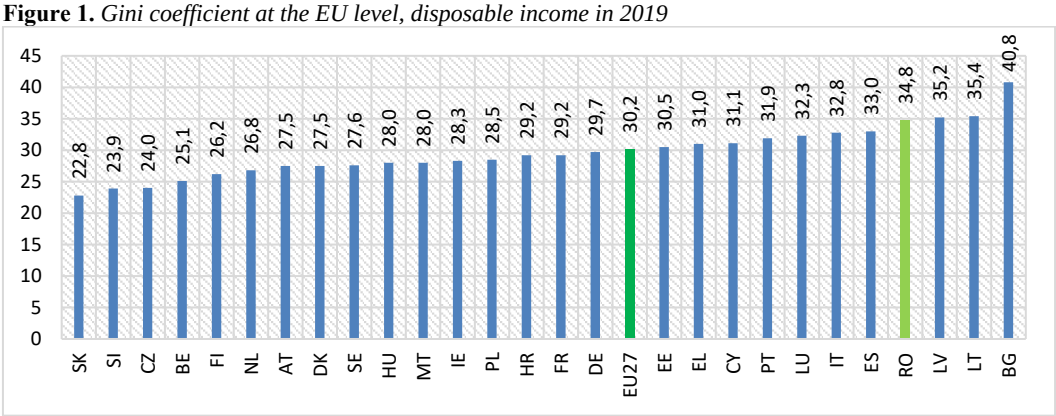
2. Data analysis

In this section, an analysis was carried out on the evolutions of the main indicators of income inequality (Gini index and quintile ratio S80/S20). Several income concepts were investigated: disposable income with social transfers, disposable income without social transfers, with or without the inclusion of pensions in social transfers.

The Gini coefficient is the most common tool for measuring income inequality internationally. Thus, it measures the distribution of income by comparing the income of each household with the income of the other households. The Gini coefficient is expressed as a percentage value between 0 and 100, so that a Gini coefficient equal to 0 indicates perfect income equality, while a Gini coefficient equal to 100 means that all income obtained in the economy belongs to a single household, which indicates perfect income inequality.

At EU27 level (excluding the United Kingdom), the Gini coefficient calculated for disposable income, after the application of direct taxes and the granting of social transfers, had values in the range of 30-31 in the period 2010-2019. With the lowest values recorded even at the end of the analysed time interval (30.2), the highest value was recorded in 2014, being 30.9 (Gini coefficient calculated for disposable income).

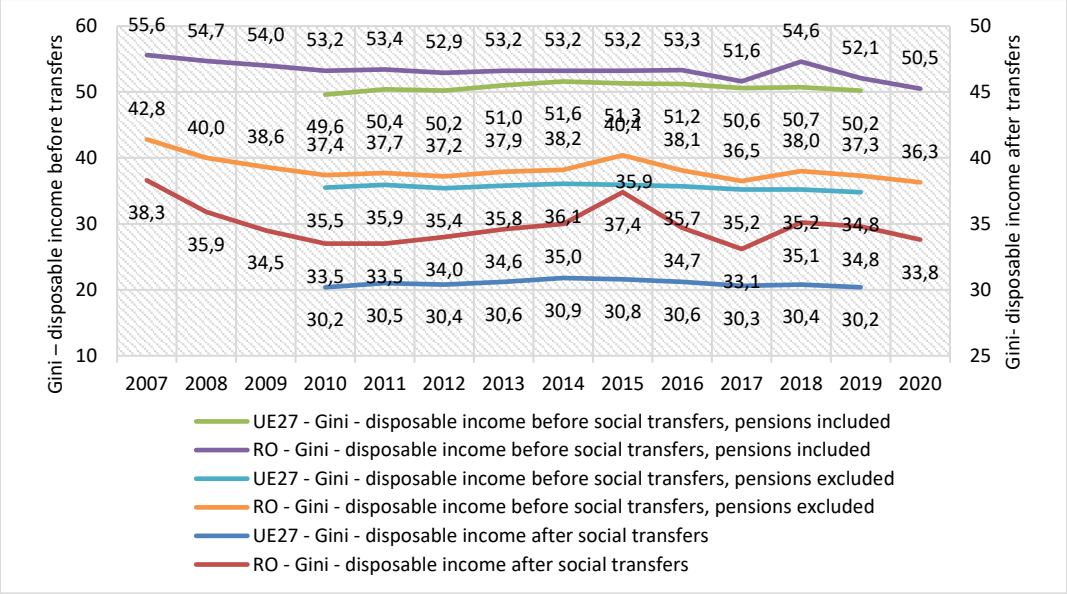
Figure 1. *Gini coefficient at the EU level, disposable income in 2019*



Source: Eurostat.

The highest values of the Gini coefficient, calculated for disposable income in 2019, were recorded in Bulgaria (40.8), Lithuania (35.4) and Latvia (35.2). Income inequality appears to be the lowest in 2019 in Slovakia, Slovenia and the Czech Republic, with Gini values below 24. In Romania, in the same period, the Gini coefficient exceeds the average values registered at the level of the European Union. However, there was a declining trend in the first years after 2007, even in the period when the crisis 2008-2009 broke out (in 2007, the Gini coefficient was 38.3, the highest in the European Union at that time, falling to 33.5 in 2010 and 2011). However, as soon as the economy started to recover, the Gini coefficient started to increase again, reaching 37.4 in 2015, being surpassed at the EU level only by Lithuania (37.9). In recent years, there has been a downward trend again, with the Gini coefficient being 33.8 in 2020 for disposable income after granting social transfers.

Figure 2. *Gini coefficient at the EU27 level and Romania, disposable income in 2007-2019*



Source: Eurostat.

One of the ways to assess the success of social protection measures in reducing inequalities is to compare indicators of inequality before and after social transfers. Thus, if we analyse the Gini coefficient for the disposable income before the social transfers, it is found that it has higher values. In the case of the Gini coefficient calculated for disposable income before transfers, but with pensions included in disposable income, it is observed that in the European Union it has values in the range 34-36, while in Romania the values are in the range 36-43. However, the trend in our country is decreasing, the value recorded in 2020 being the lowest in the analysed time interval.

However, looking at the data available for 2020 and other European Union countries, it can be seen that Bulgaria is the only one with a higher Gini coefficient than Romania. In the previous year, when the EU27 had a Gini coefficient of 34.8, our country was in a better position than Bulgaria, Latvia, Lithuania, Luxembourg and Ireland with a Gini coefficient of 37.3. This indicates that before transfers income inequality is lower in these few countries than in our country. However, taking into account the values recorded in 2019 for the Gini coefficient calculated on disposable income after transfers, Romania is better positioned only in relation to Bulgaria, Latvia and Lithuania, indicating that the social transfer systems in Ireland and Luxembourg are more efficient in reducing inequalities than the social transfer system in our country.

If we analyse the Gini coefficient calculated before the transfers, before receiving the pensions, it has significantly higher values than in the case of the coefficient calculated including the pensions, being in the range 49-52, at the level of the European Union. In Romania, the Gini coefficient in this case registered the lowest value in 2020, of 50.5, the trend being also decreasing. Looking at the year 2019 (for which there is data from all EU27 countries) we find that Romania had a lower Gini coefficient than Bulgaria, Germany, Greece, Luxembourg, Portugal and Sweden. This shows that in these countries, the inequality of income obtained by the population in the form of wages, income from self-employment, income from property, etc. (so-called market revenues) was more pronounced than in Romania, but tax and social transfer systems intervene more successfully in reducing inequities.

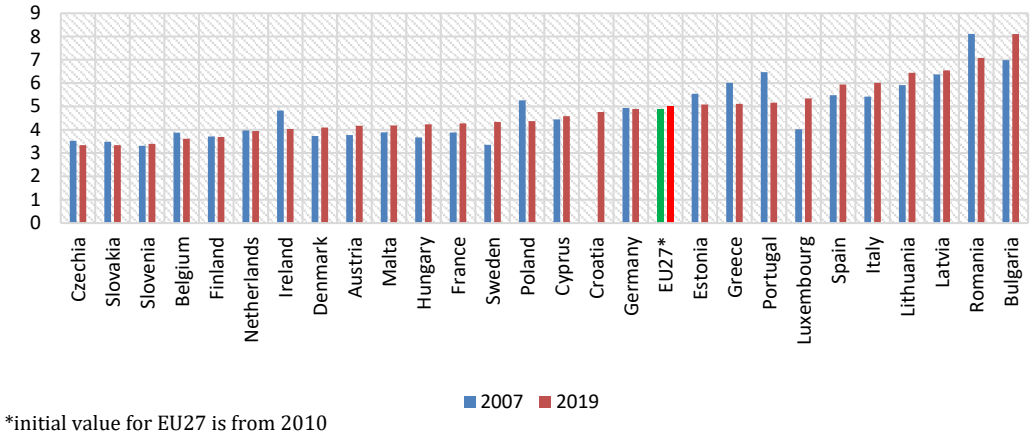
A Gini coefficient of disposable income calculated before the application of direct taxes and social transfers which is higher than the Gini coefficient for disposable income before social transfers, but including pensions indicates that the pension system helps to reduce income inequality.

The S80/S20 quintile ratio measures the annual incomes of the richest 20% of people, compared to the poorest 20% of people. If, for example, the S80/S20 ratio is 5, it means that the richest 20% of individuals have an annual income five times higher than the annual income of the poorest 20% of individuals. A higher S80/S20 ratio indicates a higher degree of income inequality, while a lower ratio indicates a lower degree of inequality. An S80/S20 ratio of 1 indicates perfect income equality (all households would have the same annual income).

At the level of the European Union (considering the 27 member states in 2021) we find that the S80/S20 ratio, for disposable income, had the lowest values in 2019 in the Czech

Republic, Slovakia and Slovenia. In these countries, the richest 20% of individuals earned about 3.3 times more than the poorest 20% of individuals. On the other hand, this ratio displayed the highest values in Latvia, Romania and Bulgaria (over 6.5). The EU27 average was 4.99 in 2019. Analysing the dynamics, in most of the countries, the S80/S20 ratio increased from 2007 to 2019, the biggest changes being registered in Luxembourg (increase of 1.32) and Bulgaria (increase of 1.12). In Romania, this ratio was the second highest in 2019, and in 2007 it was the highest and at a considerable distance from most other countries.

Figure 3. *Disposable income inequality, S80/S20 quintile ratio in EU27 countries, 2007 and 2019*

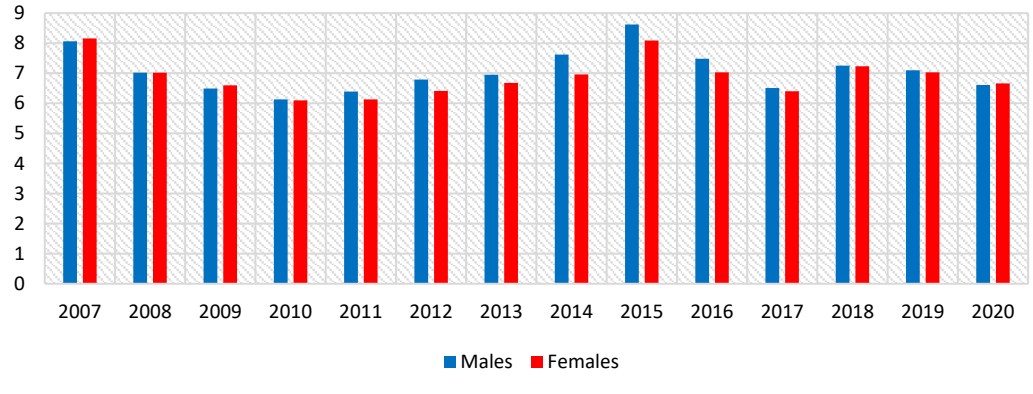


*initial value for EU27 is from 2010

Source: Eurostat.

In Romania, the S80/S20 ratio is on a downward trend. During the global economic crisis of 2008, this ratio declined, but starting 2011 it began to rise. The growth continued until 2015, the values registered by Romania during this year being the highest in the European Union again. Subsequently, the S80/S20 ratio decreased.

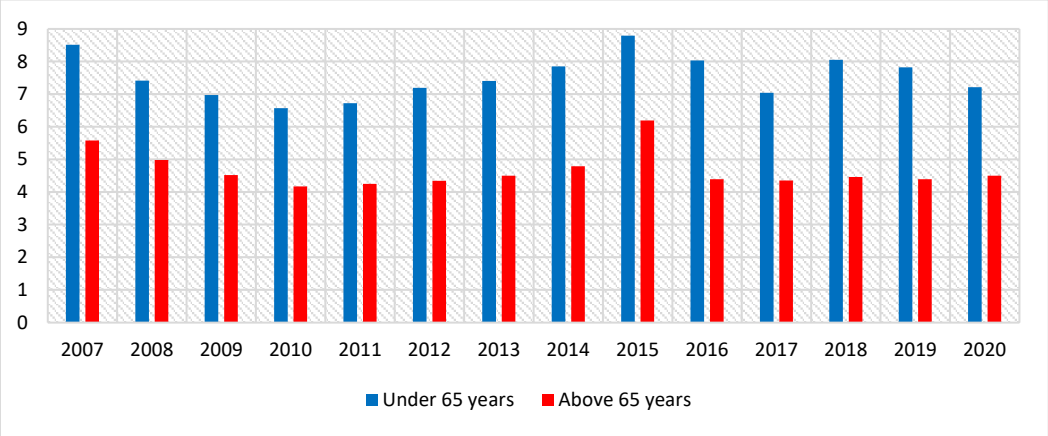
Figure 4. *Inequality of disposable income by gender, quintile ratio S80/S20 in Romania, 2007-2020*



Source: Eurostat.

In terms of gender differences, in most years of the period under review (2007-2020) this ratio was higher among men. However, in 2020 the difference is very small, practically both the richest 20% of men and the richest 20% of women earn 6.6 times more than the poorest 20% of men and women, respectively.

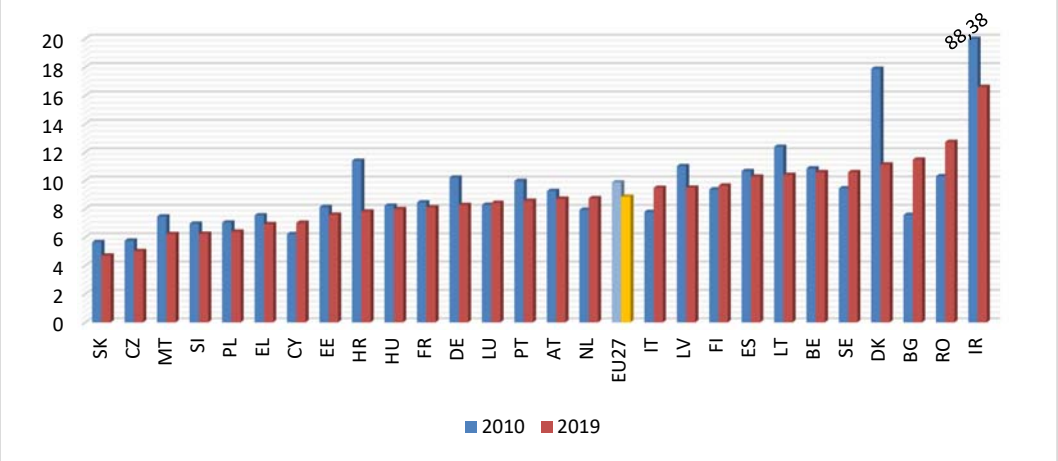
Figure 5. *Inequality of disposable income by age, quintile ratio S80/S20 in Romania, 2007-2020*



Source: Eurostat.

Concerning age, the data allow us to analyse the situation of those under the age of 65 versus those over 65. Thus, the S80/S20 ratio is significantly higher for the working age: in 2020, the richest 20% individuals under the age of 65 earned 7.2 times more than the 20% individuals with the lowest incomes. In contrast, of those over the age of 65, the richest 20% earned 4.5 times more in 2020 than the poorest 20% of the people of the same age.

Figure 6. *Gross income inequality, quintile ratio S80/S20, in the EU and Romania, 2010 and 2019*

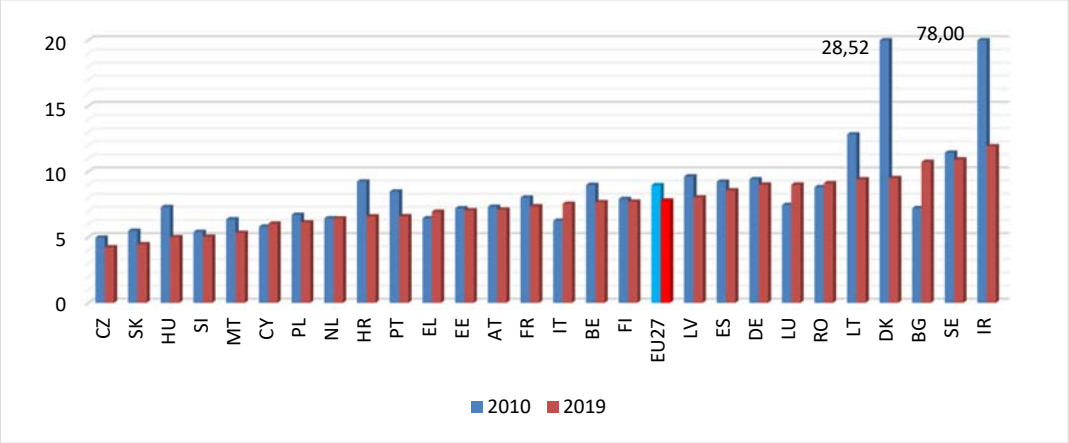


Source: Eurostat.

In terms of market income inequality, investigated by the S80/S20 ratio calculated for gross revenues, the figure above shows the situation in 2010 and 2019. This ratio has lower values for Slovakia and the Czech Republic, both in 2010 and in 2019. Most countries in the

European Union have seen slight changes in reducing the gap between the richest 20% and the poorest 20%, with the exception of Luxembourg, Finland, Cyprus, the Netherlands, Sweden, Italy, Romania and Bulgaria. The evolution of Ireland is also noteworthy as in 2010 had an S80/S20 ratio of 88.38, reaching 16.61 in 2019.

Figure 7. *Net income inequality, S80/S20 quintile ratio, in the EU, 2010 and 2019*



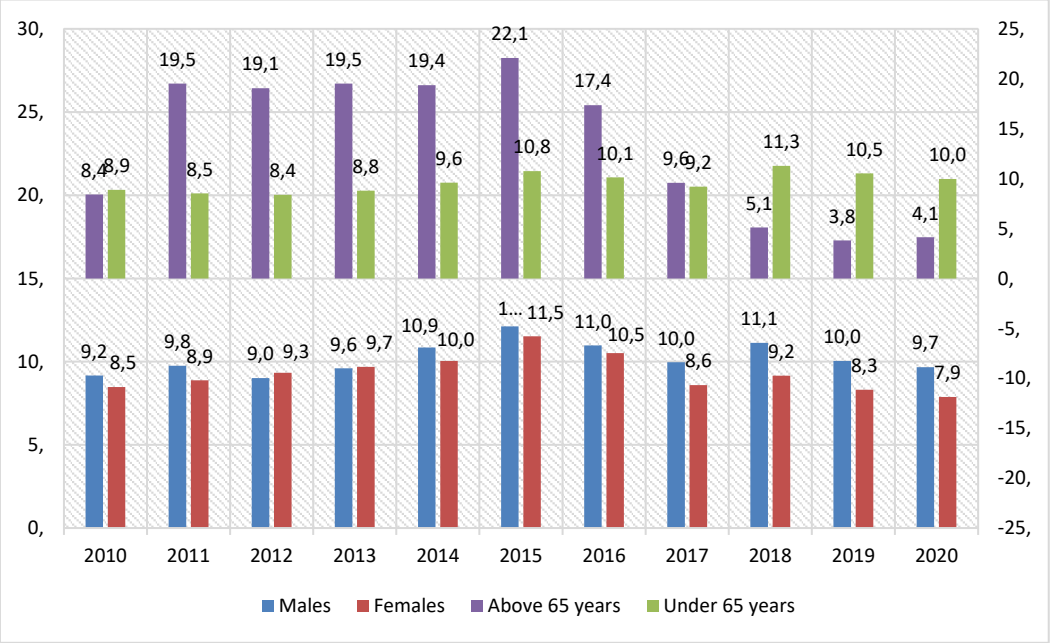
Source: Eurostat.

Net income inequality (gross income minus direct taxes) increased in Bulgaria, Luxembourg, Italy, Greece, Romania and Cyprus, while in other countries inequality decreased. It seems interesting the situation of Greece, since gross income inequality decreased over the same period, but it can be explained by the fact that the direct income taxation system contributed to the increase of inequalities.

The S80/S20 ratio calculated for net income, i.e. after direct taxes were applied, is in most cases lower than in the case of gross income, which can be explained by the fact that the tax system has some equalizing effect. However, in Germany, Luxembourg, Sweden and Greece, the S80/S20 ratio is higher when it comes to net income.

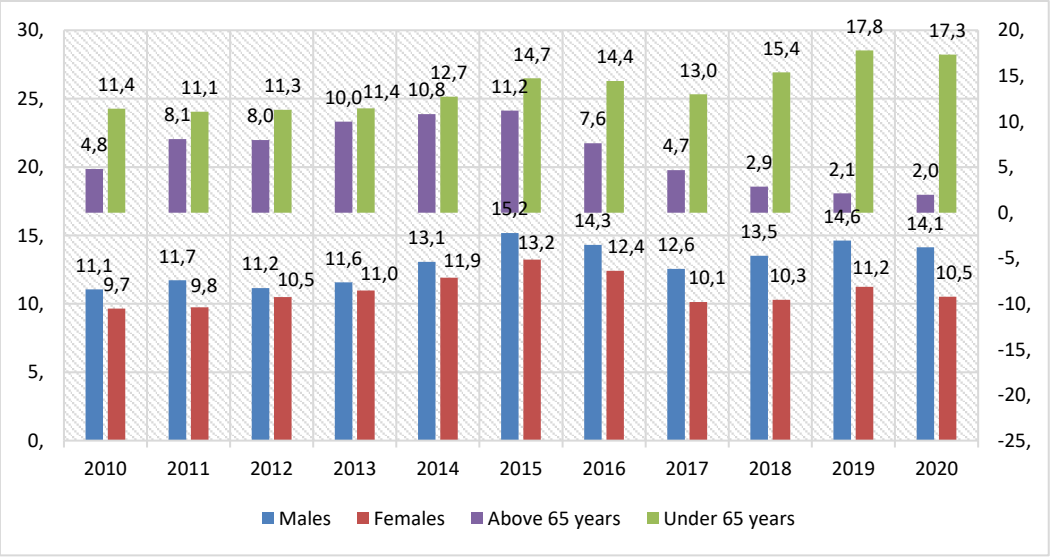
Regarding the evolution of the S80/S20 ratio for gross incomes in Romania, we notice that inequality is more pronounced in the case of men, compared to women and among those under the age of 65, compared to those over the age of 65. The gender gap widened over time, from 1.41 in 2010 to 3.61 in 2020, probably due to a sharper increase in the salaries of the wealthiest men compared to the increase in the salaries of the richest women. In terms of gross market income inequality by age, while inequality has decreased in recent years for those over 65 (from 4.8 in 2010 to 11.2 in 2015, and then in 2020 the S80/S20 ratio reached 2), in the case of the working age the inequality increased. If in 2010 the richest 20% of individuals earned 11.4 times better than the poorest 20% of individuals under the age of 65, in 2020 the ratio reached 17.3.

Figure 8. *Gross income inequality in Romania, S80/S20 quintile ratio, age and gender*



Source: Eurostat.

Figure 9. *Net income inequality in Romania, S80/S20 quintile ratio, age and gender*

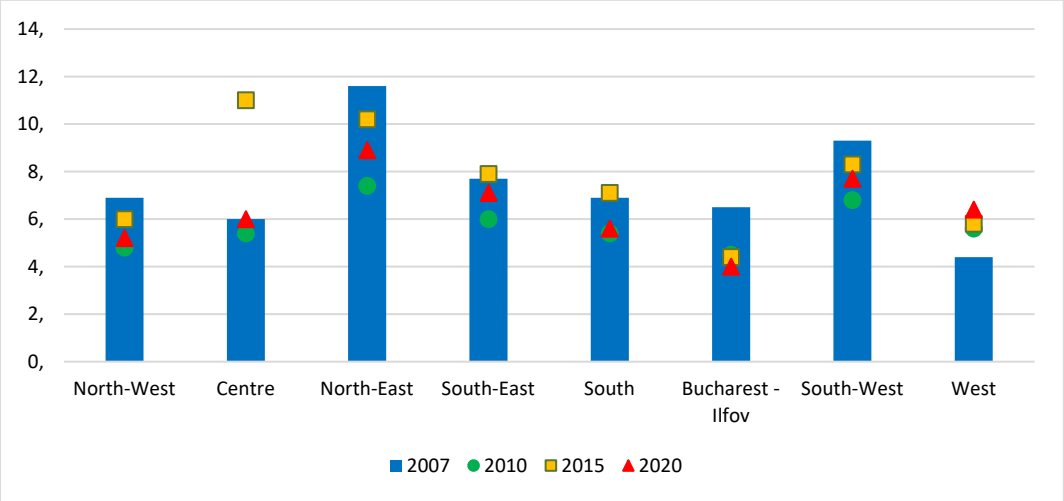


Source: Eurostat.

The S80/S20 ratio for the net income in Romania shows for the period 2010-2020 that after the application of taxes the inequality among men versus that among women becomes similar, in the sense that the differences between the two S80/S20 ratios for men and women respectively are lower than those calculated for gross market income. The situation is more interesting in terms of the net income inequality by age, because during the period

2011-2017 the inequality was higher and increasing for those over the age of 65, compared to those under 65. This happened because starting from 2011, pensioners with low pensions paid more to health insurance than before, as the contribution rate would apply on the entire amount of pension above a threshold, and not only on the amount exceeding the threshold, as it was up to 2011. After 2016 inequality for people aged over 65 declined, most likely because a lower threshold for the income tax duty has been introduced, this being in favour of low pensions.

Figure 10. *Disposable income inequality at regional level in Romania, S80/S20 ratio*



Source: Eurostat.

At regional level, income inequality in 2020, analysed through the S80/S20 ratio, is the lowest in the capital region, where the richest 20% of individuals earn 4 times more than the poorest 20% of the region's inhabitants. At the other end of the spectrum is the Northeast region, where the richest 20% earn 8.9 times more than the poorest 20%. The difference between the two regions is more than double.

In dynamics, inequality in most regions declined immediately after the 2008 economic crisis, as very rich people suffered greater income losses. Starting with 2011-2012, inequality began to increase slightly until 2015-2016, and in the last years has been again on a decreasing trend. The largest reductions in income inequality in 2007-2014 were in the North-East and Bucharest-Ilfov regions.

The exception to this trend in the analysed interval seems to be the West region, a region in which income inequality increased throughout the period 2007-2014, and the subsequent decrease was small, so that in 2020 the S80/S20 ratio was higher than in 2007. The declining trend that started in 2015 was interrupted in 2020 when there was an increase from 4.8 in 2019 to 6.4 in 2020. If we look at the evolution of this ratio in 2020 compared to 2019, we find that in the South-West region the value of the analysed ratio also increased, this time from 7.3 to 7.7.

3. Conclusions

The issue of inequality has become more important in recent years. The effects of the 2007-2008 economic crisis on the European Union have been profound, reversing the trend of convergence of living standards for many years and putting considerable pressure on the social protection systems. Inequality has increased in most Member States, raising concerns from both the perspective of sustainable growth and social cohesion.

There are also concerns about the inclusive nature of the economic growth. When the income produced in a country, as measured by GDP, grows faster than the income received by households in that country, it means that economic growth is not conducive to inclusion and that its benefits are not felt by all households.

The unequal distribution of wealth has been felt in all EU countries. In some countries, such as Austria, the Netherlands and Germany, although income inequality is not very high, the unequal distribution of wealth has increased in recent years. In general, wealth tends to be more unequally distributed than income, due to the role of inheritance and rising house prices. According to the GINI index of net worth in 2011-2014, the unequal distribution of wealth increased in most euro area countries.

It is well known that when inequality becomes too high, it can jeopardize economic growth. This is especially true when inequality is driven by rising poverty at the bottom of the income distribution scale. When people at the bottom of the income (or wealth) scale do not have the resources to invest in their skills and education, they may not be able to reach their full potential which is detrimental to the global economic growth. In addition, income redistribution can also help boost demand in the economy, as low-income households tend to spend more. Inequality also undermines social equity. A too unequal distribution of economic resources can jeopardize social cohesion and a common sense of belonging.

These two effects can be particularly noticeable if high levels of inequality are caused by more people living in poverty. These people may face increased material deprivation, homelessness or social exclusion.

In the period 2007-2019, income inequality increased to some extent across the EU. The S80/S20 ratio had a more pronounced increase in the period 2015-2017, followed by a return to the pre-crisis levels in the period 2018-2019. The Gini coefficient shows a similar evolution. This increase is more pronounced for market income inequality (i.e. inequality before tax and social transfers is taken into account), as the tax and social security system has an equalizing effect. Inequality results from weak income growth among poorer households. Although the rise in inequality is caused both by the faster growth of incomes at the top of the income distribution scale and by the slower-than-average growth at the bottom of the scale, in the post-crisis period the latter had the greatest effect on the global level of inequality.

This effect was particularly strong in Romania and Portugal, but also in Italy and Germany.

The EU average hides considerable and growing differences between countries. While in Slovakia the S80/S20 ratio has fallen since the beginning of the crisis and is now among the lowest in the EU, in Romania it has risen considerably and is the highest. The market income inequality has increased the most in Portugal, Greece and Bulgaria, but has hardly changed in many Member States (Hungary and France), even decreasing in some of them (Ireland, Luxembourg, Italy).

In Romania, the income ratio between the richest 20% of people and the poorest 20% was 7.1 in 2020, registering one of the highest values at the EU level. The income of 20% of the highest paid population is 6.5 times higher than the income of 20% of the lowest paid population. High levels of income inequality are a consequence of the fact that the poorer population becomes relatively poorer than the fact that the richer population is becoming relatively richer.

Among the political levers aimed at addressing the challenges of income inequality, we can recommend investments in education and skills, a fair system of taxation and social benefits, the provision of quality social services, etc.

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