THE RELATIONSHIP BETWEEN EXPORTS AND GROWTH IN THE EUROZONE AREA

A Bachelor Thesis of

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Thessaloniki, October 2021

Abstract

This thesis investigates the relationship between economic growth and exports for 19 euro-area countries for the period 2000-2020 using a panel data approach. We check for unit roots both in levels and in first differences employing both first-and second-generation unit root tests in case cross-sectional dependence exists between the countries of the sample. The constructed model consists of real GDP, real exports, real imports, real general government final consumption expenditure, and real gross fixed capital formation. After proving that a long-term relationship between the variables of our model exists, with the application of a Dynamic OLS estimator, we can calculate this estimation's results. At last, we utilize Granger causality tests by Dumitrescu-Hurlin (2012) to define the causal relations. Regarding the results, D-OLS showed that all variables hold a relation of significant importance towards GDP. However, there is a lack of causal relationship between exports and GDP, thus rejecting the existence of the ELG/GLE hypothesis. Additionally, a bidirectional relationship between GDP and government expenditure stands out. Moreover, we found that exports, imports, and investment granger cause government spending for various reasons. Lastly, there is a one-way causal relationship between GDP and investment, GDP and imports, and imports and investment.

Keywords: economic growth; exports; panel; Granger causality; eurozone

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Acknowledgment

I would like to express my gratitude to my parents who have supported me throughout my studies since without them I would not have reached where I am. Also, I would like to thank professor Theodore Panagiotidis for the excitement and dedication he showed during his lectures on the topic of econometrics. Moreover, I wish to acknowledge the guidance and valuable scientific assistance he provided so I can complete my thesis without any problems. Finally, I am deeply grateful to my friends and loved ones for the encouragement they showed me.

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List of Abbreviations

EEC	European Economic Community
GDP	Gross Domestic Product
ELG	Export-Led-Growth
FDI	Foreign Direct Investment
GLE	Growth-Led-Exports
OLS	Ordinary Least Squares
ILG	Import-Led-Growth
VECM	Vector Error Correction Model
FOLS	Fully Modified Ordinary Least Squares
ADF	Augmented Dickey-Fuller
LM	Lagrange Multiplier
CIPS	Cross-Sectionally Augmented IPS
CADF	Covariate Augmented Dickey-Fuller
AR	Autoregressive
d.f	Degrees of Freedom
2FE	Two-way fixed effects
RE	Random effects
FE	Fixed effects
AMECO	Annual Macro-Economic Database
IMF	International Monetary Fund
VECM	Vector Error correction Model
UNCTAD	United Nations Conference on Trade and Development
LLC	Levin-Lin-Chu
VAR	Vector Autoregression
IPS	Im Perasan Shin
WDI	World Bank Indicators
SUR	Seemingly Unrelated Regressions
GMM	Generalized Method of Moments
CPI	Consumer Price Index
DOLS	Dynamic Ordinary Least Squares

1. Introduction

The subject of determining the factors that affect economic growth has been at the center of attention during the last decades. Researchers have been studying the relationship between economic growth and other key elements seeking the best answer on what policies countries should adopt to further increase their economic development.

One of the main factors that can determine the course of an economy is exports. This can be attributed to the multiplier effect, according to which a boost in exports can cause a larger increase in GDP. Moreover, exports can contribute to an increase in foreign exchange reserves, which can give businesses the ability to import both capital and intermediate goods. These, in turn, can play a decisive role in utilizing a combination of economies of scale and technology to produce final goods that can further increase exports of higher quality, higher quantity, and less cost than before, thus promoting economic growth (Vamvali, 2011). In this case, when Export-Led-Growth (ELG) is mentioned it refers to the stimulation of a country's output that is driven by export expansion.

However, the opposite phenomenon may occur according to which a boost in output can contribute to an increase in exports. Neoclassical trade theory supports that export expansion can be attributed to economic growth throughout productivity gains. This hypothesis is named Growth-Led-Export (GLE) and it can also coexist with the ELG hypothesis meaning that there can be a bidirectional causality between these two economic variables.

The analysis of these two gives us the chance to also examine the effects of other economic variables such as imports of goods, domestic investment, or government expenditure, on economic development. In particular, imports can directly affect the economic standpoint of a country because they work as technological upgrades with beneficial effects on labor productivity. This is an alternative hypothesis which is called the Import-Led-Growth or otherwise ILG as an abbreviation and is of considerable interest to researchers. It should be noted that for this to happen countries and their citizens must be ready to assimilate this foreign influx of technology, which is observed not to happen in many developing countries due to lack of social infrastructure and appropriate institutions.

Following the expanded bibliography, most of the studies examining the ELG and GLE hypotheses concern developing countries and not developed ones, as they are the ones we will study in this particular paper. Furthermore, most studies employ time-series and cross-sectional data that are not appropriate for datasets with a small number of periods such as ours. For this reason, a panel data approach is being utilized due to its advantages against the others providing in that way lower risk of biased results and better estimates overall. Empirically, among the most recent studies that examine the ELG hypothesis for European countries, those of Pavlos P. Stamatiou (2017) and Panagiota Vamvali (2011) stand out. These studies conclude in the validity of the hypotheses ELG and GLE using a panel approach thus making them a good reference point for our investigation.

This study examines the relationship between economic growth and exports for 19 eurozone countries throughout 2000-2020. In order not to omit any useful variable we will expand our model using three more key variables. Consequently, except for real GDP and real exports of goods and services, which are our main variables, the model also contains real imports of goods and services, real general government final consumption expenditure as a proxy for real government spending, and real gross fixed capital formation as a proxy for real domestic investment.

We continue with a brief presentation of the rest chapters. In chapter 2 the literature review is being introduced in which a list of 15 papers is being presented. In addition, the details of these papers are categorized in a table. Chapter 3 contains a description of the data in combination with useful knowledge about the nature of their characteristics. In chapter 4 the econometric methodology is being demonstrated, the results of which can be found in Chapter 5. In the final chapter, namely Chapter 6, the conclusions of the thesis are being discussed thoroughly.

2. Literature review

While most of the studies around the ELG-GLE investigation employ cross-sectional data and time-series data, we are going to focus only on studies using the panel data approach. A collection of 15 papers has been cited to show a wide range of methodology that is being used by different researchers in recent years thus carrying out an update on the relevant bibliography. It needs to be mentioned that the studies have been sorted chronologically from 2005 onwards.

Hsiao and Mei-Chu W. Hsiao (2006) analyses a sample of eight economies located in East and South Asia whose growth is expeditious for 1986-2004 using time series and panel data. They found out that causality runs from exports to gross domestic product but also in the opposite direction. In addition, the results showed that Foreign Direct Investment (FDI) affects GDP directly and also indirectly through exports.

László Konya (2006) investigated the ELG hypothesis for 24 OECD countries over the period of 1960-1997. Konya constructed two models, the first containing exports and GDP and the second adding openness to the previous, with the options of a linear time trend. He based his panel data analysis on Seemingly Unrelated Regressions (SUR) systems including the use of the bootstrap procedure. He concluded that the ELG hypothesis stands for 7 countries and the GLE for 8 countries out of the 24. The results also showed the simultaneous confirmation of both ELG and GLE for 3 of them.

In the case of Parida and Pravakar Sahoo (2007), the validity of the ELG and the not-so-common manufacturing ELG hypothesis is being tested for India, Sri Lanka Bangladesh, and Pakistan from 1980 to 2002. The empirical study found strong evidence in support of both mentioned hypotheses. In addition to that, the importance of fixed capital formation, government spending on health and education to higher economic growth is highlighted.

Hakan Cetintas and Salih Barisik (2009) tried to clarify the relationship between imports, exports, and GDP using the panel Granger causality test, which is based on a multivariate error correction model for 13 transition countries. The empirical studies provided support for Growth-Led-Exports (GLE) hypothesis. In addition, GDP and import can granger cause its other and at the same time, this type of relationship incurs for imports and exports too. Therefore, GDP is being influenced by exports with the help of imports.

Khairul Hanim Pazim (2009) researched the ELG hypothesis over the period of 1982-2004 for 3 member countries of BIMP-EAGA, a Southeast Asian economic association. He chose the pooled Ordinary Least Squares (OLS) approach with one-way fixed effects, one-way random effects, two-way fixed effects using only 2 variables, GDP and exports. The empirical results showed no support of the ELG hypothesis nor the existence of cointegration.

A group of economists, that consists of Vinod Mishra, Susan Sunila Sharma, and Russell Smyth presented 2010 their paper about the relationships between imports, exports, and economic growth in similar ways Hakan Cetintas and Salih Barisik (2009) did on their paper with the only difference being the countries that they studied. The results indicated that for the five countries located in the Pacific Ocean, exports granger cause growth and imports, growth causes exports, and at last imports cause growth.

Aviral Kumar Tiwari and Mihai Mutascu (2011) and Mduduzi Biyase Talent Zwane (2014) used the same technique as Khairul Hanim Pazim (2009) with the addition of the Hausman specification test and tests for nonlinearity. In the first case, Tiwari and Mutascu concluded that a causal relation runs from exports to growth and the fact that foreign direct investment and exports play an enhancing role for the Asian growth. On the second one, Biyase and Zwane ‘s analysis provided modest results that support the ELG hypothesis.

Samia Nasreen (2011) used different methods compared to others. By using a Fully Modified OLS technique and Hurlin and Venet panel causality test, he came to some conclusions. First, he found the ELG hypothesis applies to the Philippines and India. Secondly, he confirmed strong support of ELG for Malaysia and Thailand and GLE for Pakistan, Sri Lanka, and Indonesia. Finally, he didn't find any indication of causality for Bangladesh.

Panagiota Vamvali (2011), in her master's thesis, carried out an extensive study around the topic of our interest. Specifically, she analyzed 33 OECD countries over the period

1985-2010 using both a time series approach and a panel data approach. Her results were ambiguous concerning the countries examined separately throughout the time series approach. However, regarding the group of countries as a whole through the process of analyzing panel data, she concluded that both the ELG, ILG and their reverse hypotheses are confirmed in the long run. In addition, there exists a one-way causality from economic growth to exports of goods and services and from exports of goods and services to imports of goods and services in the short term.

Christian Dreger and Dierk Herzer (2013) were some of the few that analyzed a big sample of countries and in the instance 45 developing countries from 1971-2005. They used both within and between-dimension group means panel Dynamic OLS estimator. Moreover, to test the assumption of causality from capital and exports to GDP net of exports in the long-term a panel Vector Error Correction Model (VECM) is applied. Taken as a whole, these studies suggest a statistically significant short-term positive relationship between exports and non-export GDP and vice versa. However, the results are diverse among different countries concerning the long-run equilibrium.

Another paper that uses random and period fixed effects estimation is the one of Ribeiro et al. (2016). The empirical results show strong support for ELG. With the help of the relative literature, they suggest European countries should have a diverse list of developed countries-partners to promote their exports who are geographically close and with possible high growth rates.

One of the most recent research and at the same time highly recognized is that of Chia Yee Ee (2016), who examined 4 Sub-Saharan African countries using data from 1985-2014. By employing both the FMOLS and the DOLS estimators, he figured out the positive and statistically significant effect of exports on economic growth, thus validating the ELG hypothesis. Furthermore, he emphasized the importance of macroeconomic stability, primary sector productivity, and economic infrastructure to the growth of a country.

Pavlos P. Stamatiou, (2017) in his lengthy doctoral dissertation he tried to clarify mainly the relationships between exports, FDI, and economic development for two sets of the 28 EU countries from 1970-2013. After testing for the existence of unit roots and panel cointegration he proceeded to display the differentiation between Pooled OLS, Fixed Effects, and Random Effects models and the tests given for the appropriate model selection. Finally, using the Generalized Method of Moments (GMM) method to measure the VECM he concluded that there exists strong support for the ELG and GLE hypotheses and at the same time a one-way causality from foreign direct investment to GDP.

The last paper we are going to mention is that of Maimuna Akter, Md Nahid Bulbul (2017). After the investigation of the member countries of Developing-8 from 2001-2015 and making use of VAR and VECM models, the results were differentiated in each case country. Specifically, the ELG and ILG apply for Bangladesh in the short term and Nigeria in the long term. In addition, in the cases of Egypt, Indonesia and Malaysia the GLE finds a solid foundation, while the GLI applies for Turkey. Finally, the results didn't show any indication of ELG and GLE for Pakistan and Iran.

A detailed presentation of the previously mentioned studies can be found in the form of tables in Table 1.

Table 1 : Panel data studies

Authors names and Year of publication	Data	Methodology	Conclusions
Frank S.T. Hsiao and Mei-Chu W. Hsiao (2006)	8 countries located in East and South Asia (annual)1986-2004, UNCTAD, ICSEAD	Granger causality test for time series panel data FE and RE models Granger causality (FDI; exports; GDP)	Support of ELG and GLE.
László Kónya (2006)	24 OECD countries, (annual) 1960-1997, WDI (2006)	Panel Granger causality tests bivariate and trivariate with and without trend Panel data approach SUR systems with bootstrap procedure (real exports and real GDP; openness)	Support of ELG for some countries, GLE for others while in some cases both ELG and GLE are valid
Purna Chandra Parida and Pravakar Sahoo (2007)	India, Sri Lanka Bangladesh and Pakistan (1980-2002, annual), WDI (2004) IFS CD-ROM, IMF (2004)	FM-OLS estimation (real GDP; domestic investment; manufacturing imports/exports; real government spending on health and education; infant mortality rate; life	Support of ELG Support of manufacturing ELG, Statistically significant relationship from exports, domestic investment, government

		expectancy; workforce; CPI; rate of exchange)	spending on health and education to economic growth
Hakan Cetintas and Salih Barisik (2009)	13 transition countries 1995: Q2-2006: Q4, IMF online database	panel Granger causality test (GDP; exports; imports).	Support of GLE,
Khairul Hanim pazim (2009)	Indonesia, Malaysia, and the Philippines, (1985-2002, annual), (GDP; exports)	Panel data analysis pooled OLS, FE, RE, 2FE models (GDP; exports)	No support of ELG
Vinod Mishra, Susan Sunila Sharma and Russell Smyth (2010)	5 countries located in the Pacific Ocean (annual) 1982–2004, WDI (2009)	panel Granger causality approach (real GDP; real exports of goods and services; real imports of goods and services	Support of ELG, GLE, ILG
Aviral Kumar Tiwari and Mihai Mutascu (2011)	23 Asian countries (annual) 1986-2008, IMF, World Economic Outlook Database, Historical Statistics of the World Economy	FE, RE, 2FE models Hausman specification test Tests for nonlinearity (exports; foreign direct investment, GDP per capita; gross capital formation as % of GDP; labor force)	Statistically significant positive ELG and FDI-to-GDP relationship

Panagiota Vamvali (2011)	33 OECD countries, (annual) 1985-2010, IMF online database, OECD database	ECM granger causality test (GDP; non-export GDP; domestic investment; Real exports; real imports; rate of employment; interest rate)	Support of long-run ELG and GLE Support of short-run GLE and existence of causality from exports to imports.
Samia Nasreen (2011)	8 Asian developing countries (annual)1975-2008, WDI (2010)	FM-OLS by Pedroni Hurlin and Venet panel causality test. (GDP; exports)	Support of both ELG and GLE for India and the Philippines Support of ELG for Malaysia and Thailand Support of GLE for Pakistan, Sri Lanka and Indonesia,
Christian Dreger and Dierk Herzer (2013)	45 developing countries, (1971-2005, annual), WDI (2008)	within and between D-OLS and CCE mean group estimation, panel vector ECM, (Exports; domestic investment; GDP no export), Ratio of primary	A statistically significant short-term positive relation between exports and non-export GDP and vice versa Different results among different countries

		export dependence; school enrolment rate; ease of doing business index; rigidity of employment index)	concerning the long-run equilibrium
Mduduzi Biyase Talent Zwane (2014)	30 African countries, (annual) 1990-2005, Quantec	Pooled OLS FE, RE 2SLS models Hausman specification test (exports; government spending; inflation; domestic investment; workforce)	Support of ELG
Ribeiro et al. (2016)	26 European Union members, (annual) 1995-2014 Eurostat (accessed in January 2016), UnctadStat4 (accessed in January 2016), WDI	FE/RE models (average real per capita GDP growth rate; growth rate of population; gross capital formation; consumer price; trade partners; partner 's growth; HHI-destination; HHI-product; HHI-technology exports; exports)	A statistically significant relationship between exports and GDP
Chia Yee Ee (2016)	Botswana, Equatorial Guinea and Mauritius (1985-2014, annual), WDI (2014) (IMF).	FM-OLS, and D-OLS estimation, (RGDP; INV; GOV; EXPORT)	Support of ELG, A statistically significant relationship between exports, government spending, investment, and economic growth

Pavlos P. Stamatiou (2017)	2 set of groups out of 28 EU countries, (1970-2013, annual), AMECO (2014), WDI (2014), UNCATD (2014)	FM-OLS and D-OLS VECM using GMM (GDP; EXPORTS; FDI; UN)	Support of ELG and GLE, One-way causality from FDI to GDP Different results regarding the relation of UN-GDP and Exports-FDI
Maimuna Akter, Md Nahid Bulbul (2017)	Developing-8 countries (2001-2015, annual) WITS TradeStat Database and UNdata website	VAR, VEC models panel Granger causality (GDP growth; imports; exports)	Support of ELG, ILG for Bangladesh (short-term) Support of ELG, ILG for Nigeria (long-term) Support of GLI, for Turkey Support of GLE, for Egypt and Indonesia (short-term) Malaysia (long-term), No support of ELG/GLE for Pakistan nor for Iran

3. Data

3.1 Data categories

Econometric analysis requires the collection of the appropriate statistical data, which is one of the most basic stages in the elaboration of the methodology. In the field of econometrics, the data are categorized into four (4) groups: i) time series, ii) cross-sectional data, iii) pooled data, and iv) panel data.

Time series data is a collection of evenly distant from each other observations sorted in chronological order (mostly yearly, quarterly, monthly, and daily). This type of data is regularly used for trend predictions purposes utilizing previous years' data.

The term cross-sectional is attributed to every data that consists of one or more variables values for several samples of units at a given point of time. An example of this data could be the crime rates in countries consisting of the European Union for one year.

The third type of data is the pooled data which is a combination of both time-series and cross-sectional data. Panel data constitutes a special case of pooled data. In particular, the main difference between these two is that panel data requires the observations of each cross-section to refer to the same unit, while the pooled data doesn't. A notable example of panel data is the examination of GDP, exports, and imports of Asian countries for the years 1990-2010. It’s widely known that these types of data are difficult to handle and that’s the reason that they are not so frequently selected for econometric analysis. Nonetheless, they display quite a few advantages over cross-section and time-series data

3.2 Panel data advantages

The panel data approach is being used due to its advantages over cross-section and time series. In particular cross-section and time-series fails to control for heterogeneity in contrast with panel data, which according to Moulton (1986,1987) lowers the bias results risks. When we study individuals, firms, and countries such as in our study we consider them heterogeneous because each one of them contains different characteristics.

The countries we are examining could differ in terms of tax system rates, infrastructure, borrowing capacity, geographic location, and quantity of manpower, factors that could affect the course of a country's economic development. It is very important to take into consideration the heterogeneity because differently, the regression analysis could potentially produce biased coefficients and error terms and consequently, biased parameter estimations.

According to Hsiao (2007) "panel data usually contain more degrees of freedom and more sample variability than cross-sectional data". Hence, panel data models can be used to determine and measure effects that otherwise we would not be able to do and with more reliable results regarding the parameter estimates.

3.3 Panel data categories

It is important to recognize the two different types of panel data to identify their differences thus selecting the appropriate one. A panel can be characterized as balanced when each panel member is observed every year. Therefore, in a panel that consists of N panel members and T periods, the number of observations needs to be equal to $n = N \times T$. On the contrary, if $n < N \times T$ the panel is unbalanced meaning that at least one-panel member isn't observed in every period of the dataset that is, data is missing.

3.4 Description of the data

The EU has managed to be a political and economic entity consisting of 27 member states primarily located in the region of Europe, in which all member states have agreed to act as one under a standardized system of laws creating in this way an internal single market. Inside the borders of this market, free movement of people, services, goods, and capital is established as well as policies that aim at sustainable development, environmental protection and the ability for everyone to make a decent living.

On the way of expansion, a monetary union of 19 member states of the EU was assembled endorsing the euro (€) as their main and only accepted currency. This union is called the euro area or as it is unofficially called the eurozone. The eurozone consists of Austria (AT)1999, Belgium (BE)1999, Finland (FI)1999, France (FR)1999, Germany (DE)1999, Ireland (IE)1999, Italy (IT)1999, Luxembourg (LU)1999, Netherland (NL)1999, Portugal (PT)1999, Spain (ES)1999, Greece (GR)2001, Slovenia (SI)2007, Cyprus (CY)2008, Malta (MT)2008, Slovakia (SK)2009, Estonia (EE)2011, Latvia (LV)2014, Lithuania (LT)2015. The dates that accompany each country are the dates of this currency adaptation.

While there are data for most of the 19-euro area countries from 1971 up to 2020, for the cases of Slovenia, Lithuania, Latvia, Estonia the data starts from 1995, for Cyprus from 1975, for Malta from 2000, and Slovakia from 1992. Due to this unavailability of data we had to shorten our sample to avoid any unbalanced panel data formation.

Consequently, this study examines the ELG hypothesis for 19-euro area countries, which are being mentioned previously in this paper, over the period of 2000-2020. This paper explores the causal relationship between exports, imports, government spending, domestic investment, and economic growth. Economic growth can be reflected with the use of gross domestic product or GDP which accounts for the total value of all of the goods and services produced by a nation in a given time. However, in order to capture more accurately the course of economic output, we will use real GDP because it takes into consideration the existence of inflation or deflation. The same logic applies to the other economic variables too. Furthermore, exports of goods and services consist of all goods and services that are being produced inside the borders of a country and are being sold to foreign customers. On contrary, imports consist of all goods and services that are being bought from foreign markets instead of domestic ones. In addition, gross fixed capital formation represents the domestic investment and it’s the total amount of produced assets acquired or any upgrades after we remove disposals (Schreyer et al., 2009).

Finally, general government final consumption expenditure is the formal definition of government spending, which comprise the total amount of goods and services bought by the general government to cover the expenses of its administration in order to maintain the perfect function of the education and health system, and any other provided services in general.

The values are calculated using constant prices of the year 2010 expressed in US dollars. The name codes of the five key variables are GDP (constant 2010 US dollars), exports of goods (constant 2010 US dollars), services and imports of goods and services (constant 2010 US dollars), general government final consumption expenditure (constant 2010 US$) and gross fixed capital formation (constant 2010 US$). The data and information about their definitions have been extracted from WDI (2021).

The above variables have been declared as GDP, X, IMP, GOV, INV, and the natural logarithms of these variables are denoted as L_GDP, L_X, L_IMP, L_GOV, L_INV respectively. Finally, the first differences are being created and stored in the variables DLGDP, DLX, DLIMP, DLGOV, DLINV. The software that is going to be put in use to conduct our analysis is STATA version 15.

I have cited nineteen graphs that depict the variables GDP, X, IMP, GOV, INV, over the period 2000-2020, overlaid on its other to better understand the course of economic development for each country. For presentation purposes, I have divided the nineteen countries into two categories, those with big GDP, namely Germany, Italy, France, Spain, Netherlands, and those with small GDP compared to the previous. Figure 1 and Figure 2 contain the graphs of these two categories and can be found down below.

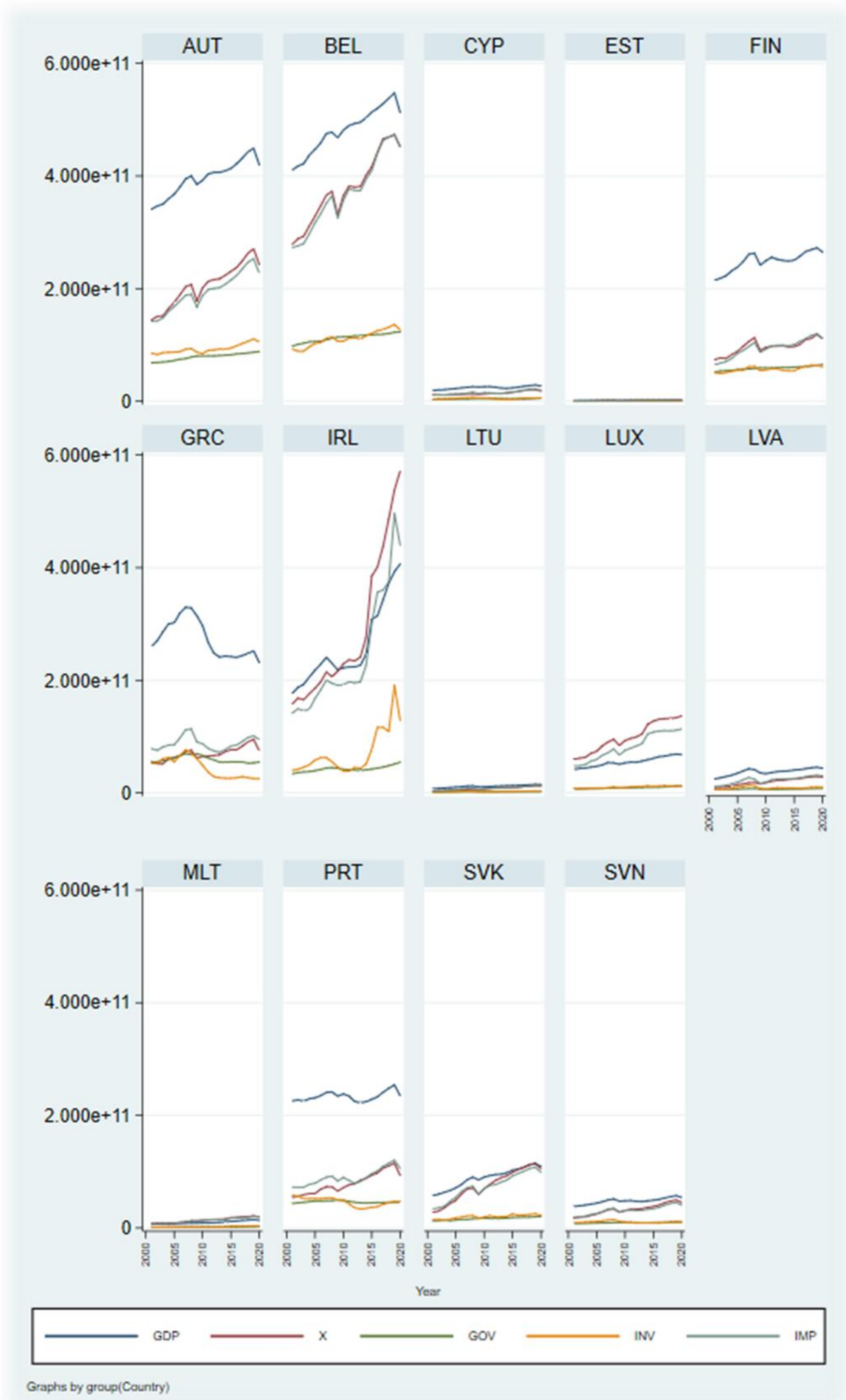

Figure 1 : Graphical representation of the data of countries with small GDP

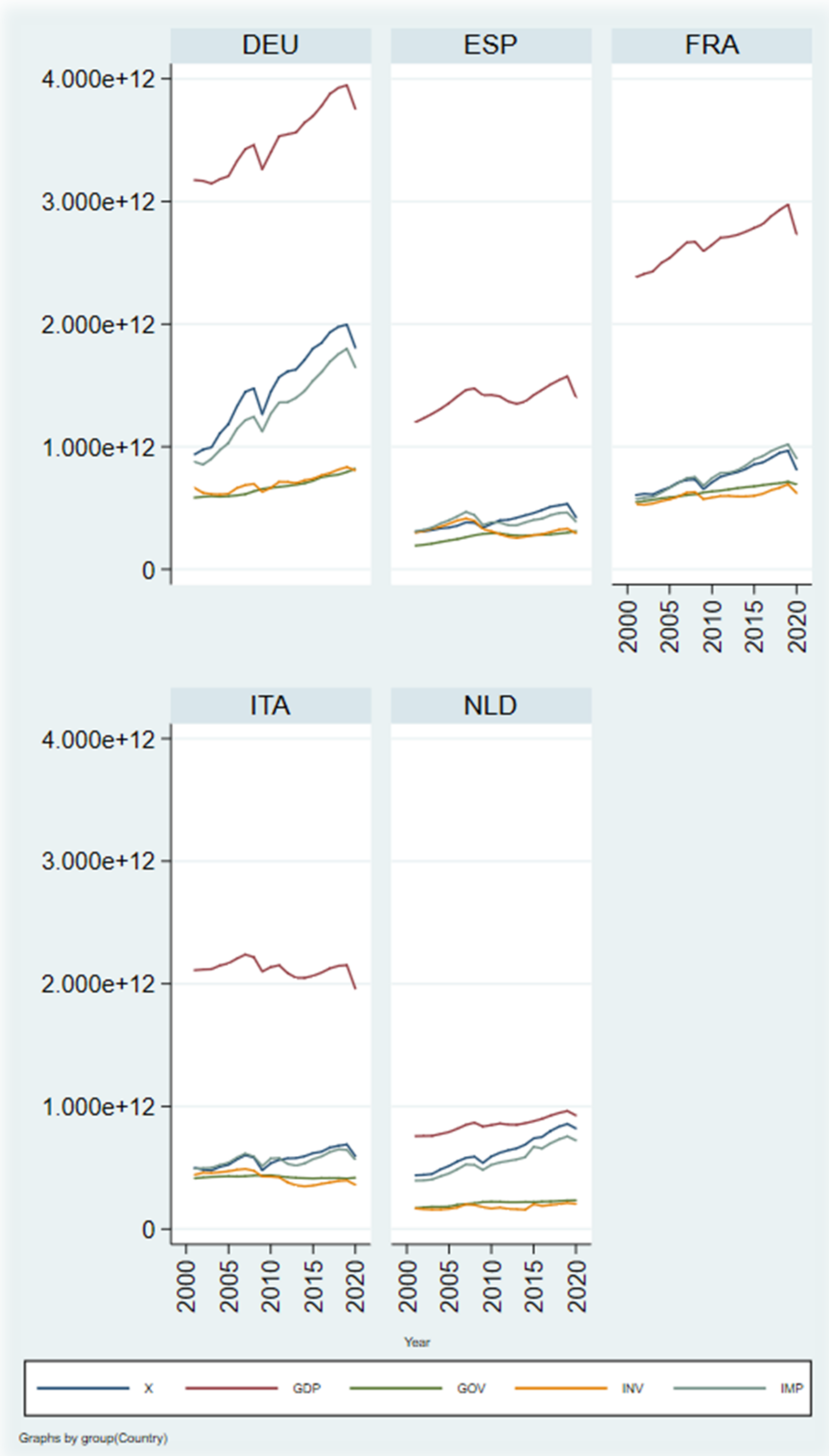

Figure 2 : Graphical representation of the data of countries with big GDP

4. Econometric methodology

4.1 Methodological structure

In this chapter, we describe the tests we executed in order to test the ELG hypothesis. In addition, we check the relations of these two main variables with imports, government spending, and investment. We start by testing for stationarity with unit root tests. We take into account both first- and second-generation unit root tests. Given that the variables are integrated to a certain degree we perform three cointegration tests, namely Pedroni (1999), Kao (1999), and Westerlund (2007), so we can investigate if a relationship exists between these variables in the long term. If this relation holds, we use the Dynamic OLS so we can calculate the results of this estimation. Finally, in an effort to define the causal relations between our variables, we employ the Dumitrescu and Hurlin (2012) Granger causality test.

4.2 Panel unit root tests

4.2.1 1st generation unit root tests

To begin with the analytical presentation of the methodology, we are going to examine if the variables used (GDP, X, IMP, INV, GOV) are stationary. There are a few ways we can test for stationarity in panel data, that are different from those used in standard individual time series. For our analysis, we are going to use the tests provided by Breitung and Pesaran (2008), Im et al. (2003), Levin et al. (2002), and Hadri (2000). The reason we use more than one test is that each one can produce different results. In all the tests, except the one of Hadri (2002), the H_0 states that unit-roots exist in all panels.

4.2.1.1 Levin, Lin, and Chu (LLC) test (2002)

As reported by Levin, Lin, and Chu (2002), the Levin– Lin–Chu test examines the existence of unit roots in panels using a three-step procedure. The first step is the implementation of ADF regressions for each individual using the equation down below noting that the lag order P_i can differ between individuals

$$\Delta y_{i,t} = a_i + \delta_i y_{i,t-1} + \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + \varepsilon_{i,t}$$

The second step requires the estimation of two equations considering they have the same lags.

$$\Delta y_{i,t} = a_i + \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + e_{i,t}$$

$$y_{i,t-1} = a_i + \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + \nu_{i,t-1}$$

The residuals are also transformed as below in order to control for heterogeneity between individuals.

$$\tilde{e}_{it} = \frac{\tilde{e}_{it}}{\hat{\sigma}_{\varepsilon i}} \ (4), \ \ \tilde{v}_{it-1} = \frac{\tilde{v}_{it-1}}{\sigma_{\varepsilon i}}$$

The third and final step is to estimate the equation we have provided below with the purpose of analyzing the t statistic and evaluating the δ coefficient.

$$\tilde{e}_{it} = \delta \tilde{v}_{it-1} + \tilde{\varepsilon}_{it}$$

δ coefficient is the key to figure out which of the two hypotheses of the Levin, Lin, and Chu test we accept. Specifically, the null hypothesis states that all panels contain unit roots contrary to the alternative that supports the stationarity of all panels. Finally, according to Levin– Lin–Chu (2002) the preferred size of the dataset examined should be between 10 and 250 concerning the number of panels and 25 to 25 observations for each panel. Unfortunately, our dataset consists of 19 panels and 20 observations and doesn't fit the recommendation but we are going to check it out for comparative reasons.

4.2.1.2 Breitung test (2000)

Breitung's (2000) test and Levin, Lin, and Chu's (2002) test are similar regarding the first step of their approach except for the fact that there are no defining terms. Therefore, ADF is applied in each cross-sectional unit using the equation below:

$$\Delta_{yit} = \delta_i y_{it-1} + \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + \varepsilon_{i,t}$$

Additionally,

$$\Delta y_{i,t} = \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + e_{i,t}$$

and

$$y_{i,t-1} = \sum_{j=1}^{P_i} \beta_{i_i j} \Delta_{yi,t-j} + \nu_{i,t-1}$$

are used in order to obtain the residuals $\hat{e}_{it}$ and $\tilde{v}_{it-1}$ respectively.

Finally, after the orthogonalization transformation of the residuals $\hat{e}_{it}$ the examination of the regression takes place.

$$e_{it}^{*} = \delta v_{i,t-1}^{*} + \varepsilon_{it}^{*}$$

The null and alternative hypotheses are declared below.

$$H_0: Panels\ contain\ unit\ roots\ if\ \delta = 0$$

$$H_1: Panels\ are\ stationary\ if\ \delta < 0$$

It should be noted that, according to Breitung (2000), his test holds its strong power even when small panel data are being examined.

4.2.1.3 Im, Perasan, and Shin test (2003)

The Im, Perasan, and Shin (2003) test present differences in relation to the Levin, Lin, and Chu test even though it is based too on ADF. The test is very useful because heterogeneity can exist between the variables and because it can be used with unbalanced panel datasets, though there can be missing data. According to H_0 all panels contain unit roots while the H_1 assumes some of them are stationary. The individual t-statistic ($t_{\rho i}$) is used to test if $\rho_i < 0$ or $\rho_i = 0$. We first use $\tilde{t}$ resulting from $\tilde{t} = \frac{1}{N}\sum_{i=1}^{N} t_{\rho i}$ in order to construct the final $Z\tilde{t}$ statistic using this equation:

$$Z\tilde{t} = \frac{\sqrt{N}\left\{\tilde{t} - N^{-1}\sum_{i=1}^{N} E\left(t_{\rho i}\right)\right\}}{\sqrt{N^{-1}\Sigma_i Var\left(t_{\rho i}\right)}}$$

4.2.1.4 Hadri test (2000)

Hadri's (2000) test is contrary to the other tests presented reverses the hypotheses so that the null hypothesis supports the stationarity of all panels while the alternative supports that at least one panel contains a unit root. The test performs better when datasets consist of moderate N and large T. As far as the methodology applied, the series that results from the employment of the Ordinary Least Square methods is written as:

$$y_{it} = r_{it} + \beta_i t + \varepsilon_{it}$$

, where the random walk is denoted by $r_{it} = r_{it-1} + u_{it}$. In addition, $\beta_i t$ is the deterministic term and ε_{it} and u_{it} are random errors following the $N(\mu, \sigma^2)$. The LM is being applied in order to test the following hypotheses.

$$H_0: \mu = \frac{\sigma_u^2}{\sigma_\varepsilon^2} = 0,\, H_1: \mu > 0$$

The LM statistic results from $LM = \frac{\frac{1}{N}\sum_{i=1}^{N}\frac{1}{T^2}\sum_{t=1}^{T}S_{it}^2}{\hat{\sigma}_\varepsilon^2}$

, where $S_{it} = \sum_{j=1}^{t}\hat{e}_{ij}$ and $\hat{\sigma}_\varepsilon^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\varepsilon}_{it}^2$.

4.2.2 2nd generation unit root tests

However, the first-gen limitation is the assumption of cross-sectional independence across units. That's why we introduce second-generation tests that take into consideration the phenomenon of cross-sectional dependence.

4.2.2.1 Cross-section dependence tests

But before a second-generation unit roots test is applied, we need to check if cross-sectional dependence exists at all. Therefore, the Lagrange Multiplier (LM) based test by Breusch and Pagan (1980) is being put to use.

$$LM = T\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2\right) \rightarrow \chi^2 \text{ with d.f = N(N-1)/2}$$

, where $\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T}\hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T}\hat{u}^2{}_{it}\right)^{1/2}\left(\sum_{t=1}^{T}\hat{u}^2{}_{jt}\right)^{1/2}}$

The residuals $\hat{u}^2{}_{it}$ are being obtained by the OLS estimating of the model $y_{it} = a_i + \beta'_{X_{it}} + u_{it}$, while $\hat{\rho}_{ij}$ represents the correlation coefficient of those residuals. The null hypothesis (H_0) states that there isn't a cross-section dependence. We chose Breusch and Pagan's (1980) 's test because the provided results are very reliable due to the fact that the test is suitable for panels in which the periods of the sample (T) are bigger than the number of cross-sectional units, such as our sample.

4.2.2.2 Cross-sectionally augmented IPS (CIPS) test

With the condition that cross-sectional dependence among the units of the dataset exists and in our case among the countries specified it is required to examine the presence of stationarity of our variables using second-generation unit root tests. For that purpose, we have introduced the CIPS test by Pesaran (2007) that employs the Ordinary Least Squares (OLS) estimate considering the CADF regression that we have cited below.

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it}$$

, where $\bar{y}_{i,t-1} = N^{-1} \sum_{i=1}^{N} y_{i,t-1}$ and $\Delta \bar{y}_t = N^{-1} \sum_{i=1}^{N} y_{i,t}$

The $t - ratio$ of the coefficient b_i of $y_{i,t-1}$ in the Covariate Augmented Dickey-Fuller (CADF) regression is used in order to calculate the CIPS-statistic and is denoted by $t_i(N,T)$.

$$CIPS - statistic\ (N,T) = N^{-1} \sum_{i=1}^{N} CADF_i = N^{-1} \sum_{i=1}^{N} t_i(N,T)$$

Pesaran (2007) has summed up detailed tables that consist of the critical values for the respective significance level. The content of the tables contains three sets of options: i) without any deterministic term ii) with intercept and ii) with intercept and a linear trend. When the CIPS-statistic is lower than the corresponding critical value, based on the significance level we want, then H_0 is rejected, and there exists stationarity. In addition, the Monte Carlo experiments are very notable due to the size of our dataset. Specifically, the simulations showed that the CIPS test provides satisfying results even when it comes to panel data with small values of N and T like our own (Barbieri, 2009).

4.3 Panel cointegration test

Given the fact that the variables are integrated in a certain order, we proceed with the panel cointegration tests and in particular those of Pedroni (1999), Kao (1999), and Westerlund (2007).

4.3.1 Pedroni cointegration test

Pedroni (1999) introduced seven (7) statistics to test for cointegration among variables in panel data. These statistics are divided into two categories based on its models Autoregressive (AR) parameters, those who are panel specific, and those with identical AR parameter for all panels. Thus, we break down the statistics into within- and between-dimension as presented below.

Within-dimension

1. **Panel v-Statistic**

$$T^2N^{3/2}Z_{\hat{v},N,T} \equiv T^2N^{3/2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1}$$

2. **Panel ρ-Statistic**

$$T\sqrt{N}Z_{\hat{\rho}_{N,T}-1} \equiv T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i\right)$$

3. **Panel t-Statistic (Non-Parametric)**

$$Z_{t_{N,T}} \equiv \left(\tilde{\sigma}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_i\right)$$

4. **Panel t-Statistic (Parametric)**

$$Z^{*}_{tN,T} \equiv \left(\tilde{s}^{*2}_{N,T} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}^{-2}_{11i} \hat{e}^{2}_{i,t-1} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}^{-2}_{11i} \, \hat{e}^{*}{}_{i,t-1} \Delta \hat{e}^{*}{}_{i,t}$$

Between-dimension

1. **Group ρ-Statistic**

$$TN^{-1/2} \tilde{z}_{\hat{\rho}N,T^{-1}} \equiv TN^{-1/2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}^{2}_{i,t-1} \right)^{-1} \sum_{t=1}^{T} (\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i)$$

2. **Group t-Statistic (Non-Parametric)**

$$N^{-1/2} \tilde{Z}_{t_{N,T}} \equiv N^{-1/2} \sum_{i=1}^{N} \left(\hat{\sigma}^{2} \sum_{t=1}^{T} \hat{e}^{2}_{i,t-1} \right)^{-1/2} \sum_{t=1}^{T} (\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i)$$

3. **Group t-Statistic (Parametric)**

$$N^{-1/2} \tilde{Z}^{*}{}_{t_{N,T}} \equiv N^{-1/2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}^{2^*}_{i} \hat{e}^{2^*}_{i,t-1} \right)^{-1/2} \sum_{t=1}^{T} \hat{e}^{*}{}_{i,t-1} \Delta \hat{e}^{*}{}_{i,t}$$

, where $i_i = \frac{1}{T} \sum_{s=1}^{M_i} \left(1 - \frac{s}{M_i + 1}\right) \sum_{\tau=s+1}^{T} \hat{\mu}_{i,t} \hat{\mu}_{i,t-s}$, $\hat{s}^{2}_{i} = \frac{1}{T} \sum_{\tau=1}^{T} \hat{\mu}^{2}_{i,t}$,

$$\hat{\sigma}^{2}_{i} = \hat{s}^{2}_{i} + 2\hat{\lambda}_i \, , \tilde{\sigma}^{2}_{N,T} \equiv \frac{1}{N} \sum_{i=1}^{N} \hat{L}^{-2}_{11i} \, \hat{\sigma}_{i^2} \, ,$$

$$\hat{s}^{2^*}_{i} \equiv \frac{1}{T} \sum_{t=1}^{T} \hat{\mu}^{2^*}_{i,t} \, , \tilde{s}^{2^*}_{N,T} \equiv \frac{1}{N} \sum_{i=1}^{N} \hat{s}^{2^*}_{i} ,$$

$$\hat{L}^{2}_{11i} \equiv \frac{1}{T} \sum_{t=1}^{T} \hat{\pi}^{2}_{i,t} + \frac{2}{T} \sum_{s=1}^{Mi} \left(1 - \frac{s}{M_i + 1}\right) \sum_{f=S+1}^{T} \hat{\pi}_{i,t} \hat{\pi}_{i,t-s}$$

The Pedroni panel cointegration test is built around the residuals $\hat{e}_{i,t}$ of a time series panel regression. $\hat{L}^2_{11i}$ represents the long-run covariance of the first difference of the estimated residual $\Delta\hat{e}_{i,t}$. Moreover, $\hat{e}_{i,t} = \delta_i \hat{e}_{i,t-1} + u_{i,t}$ is used for the non-parametric statistic in order to calculate the long-run variance of $u_{i,t}$, which is denoted as $\hat{\sigma}^2_i$. On the other hand, $\hat{e}_{i,t} = \delta_i \hat{e}_{i,t-1} \gamma_{i1} \Delta\hat{e}_{i,t} + \cdots + \gamma_{ip_i} \Delta\hat{e}_{i,t-p_i+} \mu^*{}_{i,t}$ is utilized as a mean to determine the variance of $\mu^*{}_{i,t}$, which we have previously cited as $\hat{s}^{2^*}_i$. It should be noted that Pedroni (2004) and Newey-West (1994) suggested the use of the Newey-West method in an effort to select the appropriate lag length.

Finally, as far as the structure of the hypotheses, the null hypothesis of non-cointegration (H_0) appears to be the same for every statistic and it's accepted when $\delta_i = 1$ for $i = 1,2,\ldots,$ N. However, the alternative (H_1) is supported differently when it comes to within or between dimensions with the first being $\delta = \delta_i < 1$ and the second being only $\delta_i < 1$.

4.3.2 Kao cointegration test

In this test, the Dickey-Fuller (DF) and the ADF are being implemented. Regarding the first type, Kao (1999) assumes the following mode in which

i=1, …, N and t=1, …, Tl:

$$y_{it} = a_i + \beta X_{it} + e_{it}$$

Analytically, y_{it} and X_{it} are independent random walks and equals to $y_{it-1} + u_{it}$and $X_{it-1} + u_{it}$respectively. In addition, a_i represents the constant, β the slope, and e_{it} the residuals, which are preferred to be integrated of order 1.

Then, an Ordinary Least Squares (OLS) regression of e_{it} on its lags is estimated as far as the DF type and also a version corrected for serial correlation as far as the ADF type test.

$$e_{it} = \rho e_{it-1} + u_{it}$$

$$e_{it} = \tilde{\rho} e_{it-1} + \sum_{j=1}^{p} \Psi_j \Delta e_{it-j} + u_{it}$$

The ρ and t-statistic are calculated using these equations:

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}\hat{e}_{it-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it-1}^{2}}$$

$$t_{\rho} = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it-1}^{2}}}{s_e}, \text{ where } s_e^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}(\hat{e}_{it} - \hat{\rho}\hat{e}_{it-1})^2$$

The DF test produces the first four statistics while the last statistic corresponds to the ADF. DF_{ρ} and $DF_{t}$are based on exogenous variables and standard errors in contrary to $DF_{\rho}^{*}$and DF_{t}^{*}. Finally, $\hat{\sigma}_v^2 = \hat{\sigma}_u^2 - \hat{\sigma}_{u\varepsilon}^2\sigma_{\varepsilon}^{-2}$ refers to the estimated variance with $\hat{\sigma}_{0v}^2 = \hat{\sigma}_{0u}^2 - \hat{\sigma}_{0u\varepsilon}^2\sigma_{0\varepsilon}^{-2}$ being its long-run adaptation. Both hypotheses and their assumptions are cited below as well.

$$DF_{\rho} = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}}{\sqrt{10.2}}$$

$$DF_{t} = \sqrt{1.25}t_{\rho} + \sqrt{1.875\mathrm{N}}$$

$$DF_{\rho}^{*} = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}\hat{\sigma}_u^2 / \hat{\sigma}_{0v}^2}{\sqrt{3 + 36\hat{\sigma}_u^4 / (5\hat{\sigma}_{ov}^4)}}$$

$$DF_{t}^{*} = \frac{t_{\rho} + \sqrt{6N}\hat{\sigma}_u / (2\hat{\sigma}_{0v})}{\sqrt{\hat{\sigma}_{0v}^2 / (2\hat{\sigma}_u^2) + 3\hat{\sigma}_u/(10\hat{\sigma}_{ov}^2)}}$$

$$ADF = \frac{t_{ADF} + \sqrt{6N}\hat{\sigma}_u / (2\hat{\sigma}_{ov})}{\sqrt{d\hat{\sigma}_{0v}^2 / (2\hat{\sigma}_u^2) + 3\hat{\sigma}_u/(10\hat{\sigma}_{ov}^2)}}$$

$$H_0: No\ cointegration\ (\rho = 1)$$

$$H_1: All\ panels\ are\ cointegrated(\rho < 1)$$

4.3.3 Westerlund cointegration test

Westerlund (2007) constructs his test around the error correction parameter which is denoted by $\hat{a}_i$ and this model:

$$\Delta y_{it} = \delta' d_t + a_i\, y_{it-1} + \lambda' x_{it-1} + \sum_{j=1}^{\rho_i} a_{ij} \Delta\, y_{it-j} + \sum_{j=0}^{\rho_i} \gamma_{ij} \Delta x_{it-j} + e_{it}$$

, where δ' is the associated vector of parameters

He builds four tests that are calculated using the following methodology. In both cases, the first procedure is to establish the proper individual lag order ρ_i . Next, he estimates $\hat{a}_i$ using the equation $\tilde{a}_i(1) = 1 - \sum_{j=1}^{\rho_i} \hat{a}_{ij}$ but considering the poor performance of small samples, a kernel estimation is being employed for the same reason. Either way, the final step is to measure G_τ and G_a statistics.

$$G_\tau = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{a}_i}{S.E.(\hat{a}_i)}$$

$$G_a = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{a}_i}{\hat{a}_i(1)}$$

Regarding the panel statistics, the second step after determining the lag order as mentioned is to regress Δy_{it} and y_{it-1} onto d_t, which represents the deterministic components. Furthermore, regressions of the lags of Δy_{it}, and the lagged values of Δx_{it} needs to take place.

$$\Delta\tilde{y}_{it} = \Delta y_{it} - \hat{\delta}' d_t - \hat{\lambda}'_i x_{it-1} - \sum_{j=1}^{\rho_i} \hat{a}_{ij} \Delta\, y_{it-j} + \sum_{j=0}^{\rho_i} \hat{\gamma}_{ij} \Delta x_{it-j}$$

$$\tilde{y}_{it} = y_{it} - \hat{\delta}' d_t - \tilde{\lambda}'_i x_{it-1} - \sum_{j=1}^{\rho_i} \tilde{a}_{ij} \Delta\, y_{it-j} + \sum_{j=0}^{\rho_i} \tilde{\gamma}_{ij} \Delta x_{it-j}$$

To conclude he uses the above to find the $\hat{a}$ and its $S.E.(\hat{a})$ to evaluate the two statistics left.

$$P_t = \frac{\hat{a}}{S.E.(\hat{a})}$$

$$P_a = +\hat{a}$$

$$H_0\text{: } No\ cointegration\ if\ a_i = 0$$

$$H_1 : for\ panel\ statistics\text{: } if\ a = a_i < 0\ for\ all\ i$$

$$: for\ group\ mean\ statistics\text{: } if\ a_i < 0\ for\ at\ least\ i$$

The difference of this test from the other two (Kao and Pedroni) is that not only it provides solid results when we take into account the cross-sectional dependence but also the significance of these results stays put even with smaller samples.

4.4 Estimation of the long-run relationship

In the most recent literature, a number of different types of estimations are being used to investigate the long-term relationship among a variety of relevant economic growth variables in the panel spectrum. The most common of these are the fixed-random effects approach, employed by Hsiao and Hsiao (2006), Pazim et al. (2009), Tiwari and Mutascu, (2011), Biyase (2014), Ribeiro et al. (2016), and the Fully-Modified-Dynamic Ordinary Least Squares approach, which are used in the papers of Parida and Sahoo (2007), Nasreen (2011), Dreger and Herzer (2013), Ee (2016) and Stamatiou (2017). It's very important to clarify that we are dealing with dynamic models, that is the present value of our variables strongly depends on its own lagged values. This means that the static models such as fixed and random effects OLS produce inconsistent estimates when it comes to economic variables with dynamic nature and features such as ours (Baltagi 2001). To solve this problem, Pedroni (2001) suggested the use of a Fully-Modified OLS model with Kao and Chiang (2000) proposing in their paper for the application of a Dynamic OLS model. However, Kao and Chiang (2000) noted that even though these two allow for more flexibility, in general, the FM estimator doesn't show any improvements compared to the OLS estimator, especially in small samples. For that reason, we are going to use the D-OLS to estimate the cointegrated panel regressions.

Using the equation below we are able to find the D-OLS estimator.

$$y_{it} = a_i + \beta x_{it} + \sum_{j=-q}^{j=q} c_{it} \Delta X_{i,t-j} + v_{it}$$

, where c_{it} represents the lag coefficient.

$$\hat{\beta}_{\text{DOLS}} = \left[\sum_{i=1}^{N} \sum_{t=1} z_{it} z_{it} \right]^{-1} \left[\sum_{i=1}^{N} \sum_{t=1} z_{it} \hat{y}_{it} \right]$$

, where $z_{it} = [x_{it} - \bar{x}_i, \Delta_{X_{i,t-q}}, \dots, \Delta_{X_{i,t+q}}]$ equals to a $2(q+1)x1$ vector.

4.5 Granger causality test

The Dumitrescu-Hurlin (2012) approach is going to be based on this starting model:

$$\Delta x_{it} = a + \sum_{k=1}^{k} \beta_k \Delta x_{it-k} + \sum_{k=1}^{k} \gamma_k \Delta y_{it-k} + \varepsilon_{it}$$

, where the number of countries is denoted by $i = 1, \dots, N$, the number of years by $t = 1$, ..., T, and the error term by ε_{it}.

To test for the existence of causality between y and x on the panel spectrum, we need to examine whether the coefficients γ_k are jointly statistically different from zero. It should be noted that the coefficients don’t change over time although their value can vary across cross-sectional units.

In the position of y and x, we replace the variables DLGDP, DLX, or any of the other 3 variables. If the statistics show a rejection of the null hypothesis, it's an indication of causality running from GDP or else economic growth to exports. Of course, this can be tested also vice versa and for every pair of variables, we want.

Therefore, the null hypothesis (H_0) states that whenever $\gamma_{i1} = \gamma_{i2} = \cdots = \gamma_{ik} = 0$ for every $i = 1, \ldots,$ N causality doesn't exist for all the cross-sectional units of the dataset and in our case countries, while the alternative hypothesis (H_1) suggest that there is a causality for at least one country. Using the F-test, we produce the Wald statistic w_i, the standardized statistic $\bar{z}$, and the approximated standardized statistic $\tilde{z}$. In our case, we are focused only on the outcome of $\tilde{z}$.

In addition, the Akaike information criterion is being applied to select the number of lags and the bootstrap procedure to bypass the cross-sectional dependence across countries.

5. Empirical results

5.1 First-generation unit root test results

First and foremost, we need to test if the gross domestic product, exports, imports, investments, and government spending are stationary. The tests used for this purpose are Levin– Lin–Chu (2002), Im–Pesaran–Shin (2003), Breitung (2000), Hadri (2000) and are implemented both in levels and first differences and include two sets of options: i) individual intercept and ii) individual intercept and trend. The results are presented in Table 1.

Table 2 : First-generation unit root test results

Level Unit Root Test Results							
			L_GDP	L_X	L_IMP	L_GOV	L_INV
Panel Level Series	LLC	Individual intercept	-4.2693 (0.0000)***	-4.6485 (0.0000)***	-4.5949 (0.0000)***	-2.3016 (0.0107)*	-3.4382 (0.0003)***
		Individual intercept and trend	-4.0034 (0.0000)***	-2.0228 (0.0215)**	-4.2511 (0.0000)***	-3.9346 (0.0000)***	-5.1144 (0.0000)***
	Breitung	Individual intercept	4.6434 (1.0000)	5.2604 (1.0000)	4.4783 (1.0000)	8.4183 (1.0000)	0.3655 (0.6426)
		Individual intercept and trend	3.9907 (1.0000)	3.2848 (0.9995)	0.7848 (0.7837)	3.8804 (0.9999)	-0.9879 (0.1616)
	IPS	Individual intercept	-0.8027 (0.2111)	0.1042 (0.5415)	-0.4158 (0.3388)	1.0597 (0.8554)	-0.7129 (0.23790)

		Individual intercept and trend	-0.8027 (0.2111)	0.1242 (0.5494)	-0.9212 (0.1785)	0.4602 (0.6773)	-2.7014 (0.0035)***
	Hadri	Individual intercept	41.6584 (0.0000)***	46.4844 (0.0000)***	42.9211 (0.0000)***	40.2616 (0.0000)***	29.6408 (0.0000)***
		Individual intercept and trend	17.1319 (0.0000)***	15.5239 (0.0000)***	12.6561 (0.0000)***	21.3700 (0.0000)***	14.8814 (0.0000)***
First Differences Unit Root Test Results							
Panel 1st Dif. Series			DLGDP	DLX	DLIMP	DLGOV	DLINV
	LLC	Individual intercept	-4.2828 (0.0000)***	-9.6768 (0.0000)***	-11.4403 (0.0000)***	-5.8693 (0.0000)***	-9.2060 (0.0000)***
		Individual intercept and trend	-2.3425 (0.0096)***	-7.9534 (0.0000)***	-9.4322 (0.0000)***	-5.3871 (0.0000)***	-6.9199 (0.0000)***
	Breitung	Individual intercept	-6.9425 (0.0000)***	-9.2806 (0.0000)***	-9.3147 (0.0000)***	-4.3922 (0.0000)***	-9.0956 (0.0000)***
		Individual intercept and trend	3.7180 (0.9999)	-0.8470 (0.1985)	-3.3500 (0.0004)***	-1.1778 (0.1194)	-3.5081 (0.0002)***
	IPS	Individual intercept	-5.7080 (0.0000)***	-9.7554 (0.0000)***	-10.6575 (0.0000)***	-5.4754 (0.0000)***	-9.3450 (0.0000)***
		Individual intercept and trend	-3.3230 (0.0004)***	-7.1825 (0.0000)***	-8.1252 (0.0000)***	-2.9536 (0.0016)***	-6.3611 (0.0000)***
	Hadri	Individual intercept	3.1785 (0.0007)***	0.8527 (0.1969)	0.3294 (0.3709)	6.3152 (0.0000)***	-0.6255 (0.7342)
		Individual intercept and trend	3.6927 (0.0001)***	-0.4563 (0.6759)	-0.3465 (0.6355)	12.1124 (0.0000)***	2.8909 (0.0019)***

1. p-values are demonstrated inside the parentheses

2. significance levels of 1%, 5% and 10% are indicated using ***, ** and *commonly
3. LLC and IPS tests' lag length is chosen using the AIC criterion

The results from Table 1 show that the variables GDP, X, IMP, INV, and GOV contain unit roots in their respective levels according to three out of four tests used with the exception being the LLC test that has low power in our dataset as we have mentioned before. However, stationarity exists in the first differences of all the variables at least when they only include individual intercept except in the case of Hadri ‘s test, in which DLGOV and DLGDP contain some unit-roots. When it comes to trend stationarity, the results were inconclusive due to the differentiated outcomes of the tests.

5.2 Cross-sectional dependence test results

Despite the importance of first-generation unit root tests, they come with a disadvantage, which is that they assume there isn’t a cross-sectional dependence between the units of the panel. For that reason, the application of Breusch and Pagan's (1980) LM test is necessary, the results of which are demonstrated in Table 3.

Table 3 : Cross-sectional dependence test results

Cross-sectional Dependence Test		
	Statistic	Probability
Breusch-Pagan LM test	20.18	0.0000***

1. significance levels of 1%, 5% and 10% are indicated using ***, ** and *commonly

As we can see the probability takes the value of zero so a statistically significant 1% level rejection is occurring, thus cross-sectional dependence exists. We can interpret these results by saying that in our panel sample that consists of 19 euro countries, an unexpected economic shock to one of these countries can cause disturbances to the others. This of course happens due to the high level of integration that has been achieved inside the boundaries of the euro area.

5.3 Second-generation unit root test results

Having proved the presence of cross-sectional dependence among the countries of our panel dataset we conduct second-generation unit root tests as follows. The CIPS test is executed both in levels and first differences and includes two sets of options: i) individual intercept and ii) individual intercept and trend

Table 4 : CIPS test results

CIPS Test						
Level						
		L_GDP	**L_X**	**L_IMP**	**L_GOV**	**L_INV**
Statistic	Intercept	-1.101	-1.816	-1.62	-1.336	-1.089
	Intercept and trend	-1.764	-1.92	-2.132	-2.008	-2.679
First Differences						
		DLGDP	**DLX**	**DLIMP**	**DLGOV**	**DLINV**
Statistic	Intercept	-2.375**	-2.947***	-3.217***	-3.19***	-3.314***
	Intercept and trend	-2.405	-3.101***	-3.206***	-3.371***	-3.273***

1. significance levels of 1%, 5% and 10% are indicated using ***, ** and *commonly
2. when CIPS-statistic is smaller than the critical values of the t-distribution we reject the null hypothesis that supports the non-stationarity of the variables
3. The critical values for the CIPS (Perasan (2007)) test are the following: -2.1, -2.21, -2.4 for the 10%, 5% and 1% significance level when it comes to intercept only included and -2.63, -2.73, -2.92 commonly when it comes to intercept and trend included.

Looking at the results of the CIPS test in Table 2 we can see that none of the variables are stationary in levels. However, each variable is trend stationary except in the case of GDP, which is stationary only when it included individual intercept. Consequently, guided by the results of all the previous tests, we come to the conclusion that GDP, X, IMP, INV, and GOV are integrated of order 1 or I (1).

5.4 Panel cointegration test results

Provided that the variables we are interested in are stationary in their first differences I (1), we continue our analysis with the use of panel cointegration tests, the results of which are presented in Table 4.

Table 5 : Panel cointegration test results

Pedroni cointegration test		
	Test Statistic	**Prob.**
Within Dimension		
Panel v	-2.1244	0.0168**
Panel rho	-0.928	0.1767
Panel PP	-4.5466	0.0000***

Panel ADF	-5.1148	0.0000***	
Between Dimension			
Group rho	1.1015	0.1353	
Group PP	-5.0832	0.0000***	
Group ADF	-5.1337	0.0000***	
Kao residuals cointegration test			
	t-statistic	Prob.	
Modified Dickey-Fuller t	-9.7439	0.0000***	
Dickey-Fuller t	-10.8144	0.0000***	
Unadjusted modified DF t	-20.5129	0.0000***	
Unadjusted DF t	-13.4042	0.0000***	
ADF t	-7.5123	0.0000***	
Westerlund cointegration test			
Statistic	Value	Z-value	Robust P-value
Gt	-2.495	-2.186	0.320
Ga	-8.048	1.122	0.080*
Pt	-7.894	-0.668	0.990
Pa	-7.748	-0.974	0.940

1. significance levels of 1%, 5% and 10% are indicated using ***, ** and *commonly
2. p-values are calculated using the x^2 distribution
3. lag length selection has been chosen according to the AIC criterion
4. determination of bartlett kernel window by New-West is being done using $\left(\frac{T}{100}\right)^{\frac{2}{9}}$
5. GDP is considered the dependent variable

First, we are going to examine the results of the Pedroni (1999) test. The H_0 hypothesis, which declares there is no cointegration has been rejected by all the available test statistics except the rho statistic both in within and between dimensions in favor of the H_1 that supports the cointegration between GDP, exports, imports, government spending, and investments. It should be noted that the Barlett kernel with Newey-West lags is used for serial correlation adjusting. Moreover, all Kao‘s test statistics concluded also on a strong rejection of the null hypothesis with a significance level of 1 %. However, only one out of four Westerlund statistics, the Ga statistic, is statistically significant at 10 %. The analysis has been estimated based on robust p-values given that we account for cross-sectional dependence between the units. Nevertheless, we need at least one of the statistics Gt or Ga to be rejected so we can reject the H_0. Overall, the results point out a long-run relationship among the variables, a relationship we are going to estimate in the next phase.

5.5 Long-term relationship estimation's results

As mentioned in the methodology section, since our variables are cointegrated, we are going to use the Dynamic OLS estimator to estimate the long-term function, the results of which are being presented in Table 6.

Table 6 : Results of Dynamic OLS estimations

Independent. Variable	**Coefficient**	**Standard error**	**P-value**	**[95% Conf. Interval]**
DLX	0.2744593	0.0274293	0.000***	0.2206988 0.3282198
DLIMP	-0.0806873	0.0339338	0.017***	-0.1471963 - 0.0141782
DLGOV	0.4299411	0.0357789	0.000***	0.3598157 0.5000665
DLINV	0.2146645	0.0145821	0.000***	0.1860842 0.2432448
R-squared	0.8625			
Adj R-squared	0.8156			

1. significance levels of 1%, 5% and 10% are indicated using ***, ** and *commonly
2. DLGDP is the dependent variable
3. number of lag length is 2
4. the confidence level is 95 %

The results indicate that exports of goods, government expenditure, and investment have a positive influence on economic growth at a significance level of 1 %. The findings from Table 6 also show that an increase of 1 % in exports causes an increase of 0.27 % in economic growth. Moreover, an increase of 1 % in government spending and investment causes an increase of 0.42 % and 0.21 % respectively. However, the import of goods and services affects negatively the economic growth with a 1 % increase in imports causing a decline of 0.08 % on growth. At last, R-squared takes the value of 0.86 and 0.81 if adjusted, thus 86 % and 81 % respectively of the data fit the regression model, meaning that 86 % and 81 % of the variation in the GDP can be attributed to X, IMP, INV and GOV.

5.6 Granger causality test results

The final test we are going to employ is that of Granger causality by Dumitrescu-Hurlin (2012) the results of which are listed in Table 7.

Table 7 : Granger causality test results

	DLGDP	DLX	DLIMP	DLINV	DLGOV
DLGDP		0.7711 (0.6929)	3.3340 (0.0833)*	3.5355 (0.0543)**	5.2855 (0.0086)***
DLX	-0.8589 (0.7086)		1.0174 (0.6143)	1.0638 (0.47)	2.7252 (0.0257)**
DLIMP	-0.2493 (0.9086)	-0.8850 (0.6614)		2.4057 (0.0814)*	3.88 (0.0157)**

DLINV	-0.1331 (0.9157)	-0.0288 (0.9929)	0.9190 (0.55)		3.667 (0.0157)**
DLGOV	2.3937 (0.0950)*	1.7485 (0.1614)	1.2572 (0.3029)	1.6349 (0.1671)	

1. significance levels of 1 %, 5 % and 10 % are indicated using ***, ** and *commonly
2. lag length selection has been chosen according to the AIC criterion
3. bootstrap's procedure replications are 700
4. the confidence level is 95 %

As are discernible in the table, we have tested both directions of causality for each pair of variables. There is no significant causal relationship between exports and economic output. This means that there isn't any sign of support neither for ELG or GLE hypotheses.

Furthermore, we found that economic growth can granger cause government spending and vice versa. This can also be confirmed by the economic theory using the multiplier effect (Dupor and Guerrero, 2016). Governments can purchase goods and services in a way that can boost the spending of the internal market. In other words, that means that when the government spends a certain amount on the economy throughout purchases, this amount circulates through transactions between companies and citizens, thus creating an additional gross domestic product. Nonetheless, this can have negative results on the economy in case a crowding-out effect occurs, that is reducing the economic activity of the private sector (Carlson and Spencer, 1975). This effect takes place either when the government's spending leads to an increase in interest rates thus reducing the private sector's investment returns or when it replaces a large part of the private sector.

Equally, an important connection appears between GDP, imports, and investments. There is a one-way causality running from GDP to imports and another one running from GDP to investments. Also, there is a unidirectional causal relationship running from imports to investments. According to the literature, we are anticipating the widely known relationship of causality running from investment to GDP through imports, but this is not the case. In fact, the directions are reversed. The phenomenon Growth-Led-Imports (GLI) can be attributed to high levels of imports due to the increase in their real income as the economy grows. However, this depends on whether the GDP growth has a satisfying effect on real income and to what extent the marginal propensity to consume affects the increase in imports.

In addition, it appears that a strong causality runs from exports, imports, and investment to government spending. The first of these effects can be explained as follows: Government expenditure aimed at the economic development of the domestic economy can be financed through foreign exchange derived from exports (Bakari et al., 2018).

Moreover, according to Benarroch and Pandey (2017), the one-way causality running from imports to government spending may be caused by pressures to the government for more spending in case the job market or/and the domestic production sector get significantly negatively affected by foreign competition. Hence, governments dedicate their resources to social welfare, infrastructure, and investment projects to combat this impact.

To summarize, a diagrammatic illustration (Figure 3) has been included so that it is easier for the reader to understand the relationships between the variables.

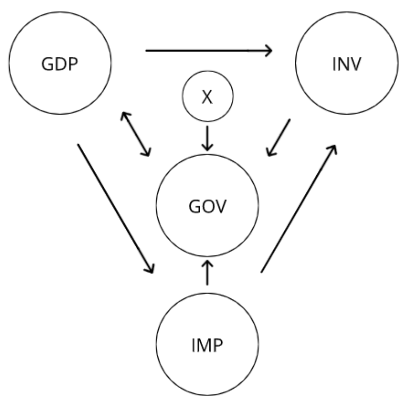

Figure 3 : Diagrammatic representation of the granger causality test results

6. Conclusions

The original goal of this thesis was to investigate the relationship between economic growth and exports in the euro area. In order to broaden our model, we introduced three more economic variables, namely imports of goods and services, domestic investment, and general government expenditure.

Regarding the methodology, the first step was to check for unit roots in levels and then in first differences using both first- and second-generation unit roots tests in case cross-sectional dependence exists among the investigated countries, as suggested by Breusch and Pagan (1980). Secondly, after concluding that the variables are stationary in their first differences and cross-sectional dependence exists, we utilized three cointegration tests to determine the existence of a long-term relationship. Since the test results showed a strong cointegration among the variables we performed the Dynamic OLS method to estimate these relationships. We found that all variables hold a relation of significant importance towards GDP. Finally, the Dumitrescu and Hurlin (2012) granger causality test got employed to define the causal relations.

The results were proven to be inconclusive because of the lack of a causal relationship between exports and GDP. However, we found a bidirectional relationship between GDP and government expenditure. In addition, we found that exports, imports, and domestic investment granger cause government spending. The final conclusion we made was that GDP can influence with significant importance the domestic investment both directly and indirectly through imports.

To summarize, even though, the ELG and GLE hypotheses were not verified we took the opportunity to explore other relations between the variables in our model, providing in that way useful knowledge to the reader and potentially the next researcher. We should not forget that these hypotheses are challenging to validate because a difference in a sample’s timeframe, in the number of countries, in the characteristics of those countries, and in the econometric methodology that is being used can significantly influence the final results.

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