FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH BEFORE AND AFTER THE RECENT FINANCIAL CRISIS: EVIDENCE FROM EU COUNTRIES

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Declarations

This thesis is submitted to Oxford Brookes University in permanent binding as approved by the examiners following viva. The contents of this thesis are based on my own research in accordance with the regulations of Oxford Brookes University. This thesis represents my original work towards this research degree, conducted under the supervision of Dr. Dimitrios Asteriou and Dr. Emmanouil Trachanas. It does not contain material which has been previously submitted for a degree or diploma at this university or any other institutions; except where due acknowledgement is made.

I certify that all my information sources and literature used are specified in the thesis.

I declare that Part of my work with my Dr Dimitrios Asteriou is already published in the **Financial Research Letters**.

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Abstract

This thesis investigates the finance-growth relationship in view of the recent financial crisis for the EU countries from 1990 to 2016. The empirical approach examines two sub-periods before and after the crisis and employs static and dynamic panel models. The results from the static panel approach suggest that financial development promoted economic growth at regular times, with market sector prevailing in this positive effect. In contrast, at stress times, financial development hindered economic activity, with the bank sector dominating in this adverse effect. The findings of the dynamic models in the long-run suggest a positive and significant effect of the market sector before the crisis, while after the crisis, there is an inverse finance-growth relationship. However, the overall results reveal that the post-crisis economic growth recovery rather weak and the financial system has not enhanced the economic activity.

With respect to the previous literature, the present research provides new evidence on the finance-growth nexus in view of the recent crisis, suggesting that the weakness of the financial system to enhance economic growth exhibits high persistence eight years after the occurrence of financial crisis and the banking system evolves significantly in a worse way compared to the pre-crisis period. Moreover, when the financial development is examined in conjunction with the role of fiscal policy, the findings reveal that banks and other institutions held more government bonds to enhance the governments' credibility not to default, and the ability of intermediaries to invest on assets was limited. Furthermore, a significant finding in this study is that of the deposit guarantee schemes, and the capital adequacy of banks during 2008-2009 protected depositors and promoted the stability of the financial system which restrained the economy to permissible growth levels thus not leading to a collapse. A further remarkable finding is that the stock market participants during crisis periods, because of the doubt about the direction of the stock market, are reluctant to act as investors, and thus future trading on specified securities tends to increase as well as share prices fell.

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Abbreviations

EU	European Union
CEE	Central and Eastern Europe
FE	Fixed effects
RE	Random effects
PCA	Principal component analysis
PMG	Pooled Mean Group
MG	Mean Group
DFE	Dynamic Fixed Effects
ARDL	Autoregressive Distributed Lagged Model
GMM	Generalized Methods of Moment
GDP	Gross Domestic Product
GGDP	Annual growth rate
LLY	Liquid Liabilities
PRIVY	Credit to private sector
BTOT	Ratio of total Bank Assets
MCAP	Stock Market Capitalization
TVT	Stock Market Total Value Traded
TOR	Stock Market Turnover Ratio
FDI	Foreign Direct Investments
INFL	Inflation Rate
OPEN	Trade Openness
DEBT	Government Debt
EXP	Government expenditures
TAX	Tax revenues

Chapter One

Introduction

1.1 Overview of the Research Project

This doctoral thesis forms empirical research investigating the impact of financial development on economic growth on the face of the recent financial crisis. The research aims to examine the role of the financial system in the economy before and after the financial crisis. This role, in turn, illustrates how the financial system should be structured and regulated for the recovery of the real economy after a shock and effectively deal with a future crisis.

The study investigates the countries of the European Union (EU) during the period 1990-2016. Also, it examines three regional panels of countries to capture the different characteristics among the EU countries. More precisely, the full sample of EU countries is divided into three regional groups according to the background of their economy, and geography:[1] North West; Central-Eastern and Baltic; and South group.[2] The advantage of regional panels of countries is that the finance-growth relationship can be investigated for a more homogeneous group of countries, thus capturing the panel heterogeneity, and compare the results from the different regions.

The sampling period is selected to start in 1990, as it includes data for Central and Eastern Europe and the Baltic States (also known as transition economies). Also, it examines two different phases of crisis periods. The first phase is from 2008 to 2016, where the assumption is that the crisis period has not finished yet; and because the sample finishes in 2016 the dummy variable that captures the crisis specification is defined as continuing from 2008-2016. The second phase of the crisis period is the sub-prime crisis

[1]Geography affects the quality of institutions through the demand and supply side of financial development. For instance, the production of particular agricultural products or primary goods and exploitation of some natural resources could reduce the demand for external finance, relative to other countries at a similar level of GDP.

[2]See details in Chapter 3 (List of countries Table 3.1).

period (2008-2009), which refers to the crisis that occurred in the mortgage industry due to borrowers being approved for loans they could not repay. For a better understanding of the different examined periods, a graph is provided below (section 1.1, Figure 1.1).

1.2 Background of the study

Financial development is defined as the improvement in the quality of five critical financial functions by:

- providing information about possible investments and allocating capital based on these assessments;
- monitoring individuals and firms and exerting corporate governance after allocating capital;
- facilitating the trading, diversification, and management of risk;
- mobilizing and pooling savings;
- easing the exchange of goods, services, and financial instruments.

The Global Financial Development Database[3] is an extensive dataset of financial system characteristics, measuring all the above functions and includes data for determinants of financial development. Specifically, it includes measures for the size of financial institutions and markets (financial depth); the degree to which individuals can use financial institutions and markets (access); the efficiency of financial institutions and markets in providing financial services (efficiency); and the stability of financial institutions and markets (stability) (Levine et al., 2012). These four characteristics are measured for financial institutions and financial markets.

The importance of the financial sector can be dated back to Schumpeter (1911), who proposed that the increase of the financial intermediaries lowers the information and the transaction costs. The intermediation role of the financial system links lenders to borrowers, resulting in the transfer of resources to the most productive uses. However, a leading view of economics was that financial development is beneficial for economic growth (Hicks, 1969; Goldsmith, 1969; Gurley and Shaw, 2006).

After the financial liberalization, the endogenous growth theory has increased interest in the growth-enhancing effects of finance. Jappelli and Pagano (1994) and Greenwood and Smith (1997) have all documented that the impact of financial development on economic growth is positive, through savings, investment, the productivity of capital, and the

[3]Published by the World Bank Data

efficient use of information. Along with improvements in theoretical research, a growing body of literature has evolved to analyze the relationship between finance and growth using empirical methods, e.g. cross country, time series, panel data, and firm-level studies, suggesting that higher levels of financial development are robustly related with faster rates of economic growth (King and Levine, 1993b; Gregorio and Guidotti, 1995; Levine and Zervos, 1996; Demetriades and Hussein, 1996; Levine, 1997; Rajan and Zingales, 1998; Levine, 1999; Arestis et al., 2001) among many others. All the above studies employed cross-sectional or time-series data, providing substantial evidence in favor of the positive growth effects of financial development.

However, more recent studies that used panel data models arrived at a less uniform conclusion. Loayza and Rancière (2006), Seetanah (2009) and Grossman and Rossi-Hansberg (2008) showed that there is a positive association between financial development and growth, whereas Wu et al. (2010) Arcand et al. (2015), Samargandi et al. (2015) have demonstrated that the financial sector has a negative effect on growth. Also, researchers have recently suggested that financial development is beneficial up to a specific point, after which hinders economic activity (Checherita-Westphalb and Rother, 2012; Law and Singh, 2014; Arcand et al., 2015). This indicates a non-linear relationship between financial development and economic growth, implying that the more rapid the development of the financial system, the slower the growth of the economy.

1.3 Motivation for the research

By and large, researchers have demonstrated a positive relationship between financial development and economic growth. In general, they suggest that a well-developed financial system is growth-enhancing. Also, before 2008, the focus in many studies was on the determinants or sources of financial development, rather than the financegrowth link itself. Furthermore, the period from 1994 to 2008 was characterized as a period of euphoria (see Figure 1.1) where the financial liberalization, the higher economic integration, and the low-interest rates led to a credit boom and a rise of private demand. The latter included a rise in imports and created trade deficits. Alesina et al. (2005) noted that increasing integration leads to more cross-country spillover effects,[4] and hence there is a need for international cooperation.

[4]Spillover effect refers to the impact that events the economy of one nation can have on the economies of other nations. The term is usually applied to the negative impact that a national event has on other parts of the world.

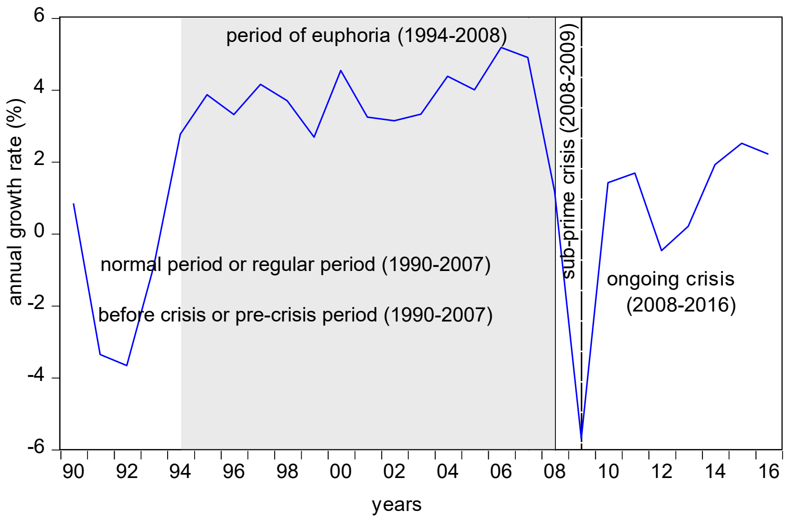


Figure 1.1: The mean of GDP growth rate over the period 1990-2016.

Even though the global financial crisis did not originate from Europe, it spread rapidly and remained there, affected the economic stability, exposing the fragilities and gaps in the EU's financial system. More precisely, in 2008 and 2009 there is a sharp drop in the growth rate to 6% for the EU countries, and by the end of 2016, the economic growth is moving slightly less than 2%. This is an indication that the total economic activity in Europe had not yet fully recovered by the end of 2016. Also, after 2008, many European Union (EU) countries presented unsustainable public debts, and unpopular fiscal measures were undertaken by policymakers to reduce the budget deficit and stabilise the debt. The effectiveness of liberalisation in the financial sector was questioned across financially developed and stable economies such as those in the EU. While it is clear that the finance relationship between financial development and growth is positive, there are still questions regarding the role, and the contribution of the financial system to economic activity in the pre- and after-crisis periods. Therefore, the initial motivation was relied on the weaknesses of the financial system to stimulate the economy of the EU countries. In addition to that, the severe decline in the activity of the real sector indicates the need for both policymakers and economists to investigate the finance-growth relationship before and after the crisis.

Furthermore, in many EU countries, the infrastructure to cope with a financial crisis was inadequate or non-existent. Despite the financial integration achieved through coordination and harmonization of the national legislation of the member states, significant heterogeneities were exhibited after the recent crisis. This highlights the significance of the research into what is essential to the development of the financial sector and what is the key for policymakers to develop a sound financial system and follow prudent economic policy. Also, it motivates the researcher to investigate different groups of countries, being more homogeneous, according to their economic background and geography as well.

A drawback related to the existing literature is that many studies used cross-sectional data and could not analyze the changes of variables over time as well as the differences in variables between countries, thus not helping to estimate the causal effects. After 2000, there is a considerable number of studies investigating the finance-growth relationship using panel data and employing standard and dynamic panel models. However, the sample period considered in the majority of these studies does not exceed the crisis period (2008-2009); and no consideration has been given so far, of which conventional measures of financial development led to economic growth across the EU countries, before and after the recent financial crisis. This motivates the current thesis to apply the techniques that enable doing empirical investigations in standard and dynamic panel framework.

Apart from the finance-growth relationship before and after the crisis; a further issue relates the fact that in the existing studies, the structure of the financial sector, whether it constitutes a bank-or-market based financial system has not received considerable attention among researchers. However, the investigation for the impact of financial bank and stock market sectors development on economic growth provides ambiguous results. In an earlier study, Levine (2002); Beck and Levine (2004) documented that bank-based financial systems promote faster economic growth than market-based financial systems in the short-term that are at an early stage of development. Also, Allen et al. (2012) argued that the banking system plays a crucial role in the growth process, while Narayan and Narayan (2013) suggested that the role of the stock market is more significant than the banking sector. Therefore, the role of financial structure for the finance-growth association requires further investigation and is essential to identify which countries are either bank or market based or both.

However, for the majority of the existing studies, the prime objective was to investigate the relationship between financial development and economic growth, and therefore, either monetary aggregates (such as liquid liabilities to capture the overall size of the financial sector) or credit to private sector (that enables the utilization of funds and their allocation to productive activities) were used. Stock market capitalization was also widely used as an alternative proxy of financial development rather than an indicator of the stock market. This motivates the thesis to undertake a new investigation in order to establish whether the behavior of two sectors of the economy, namely the banking sector and the market sector, have a positive or negative effect economic growth before and after the crisis.[5]

[5] Allen et al. (2012) as well as Law and Singh (2014) suggested for further research to examine the link between the financial structure and the recovery of the real economy after a financial crisis as well

1.4 Objectives of the research

The research aims to investigate the effect of financial development on economic growth before and after the recent crisis through a systematic analysis of the literature followed by the contact of an in-depth case study of the EU countries. Specifically, the study focuses on uncovering how financial development affects economic growth during the pre-and after-crisis period, and the aim was achieved through the following specific objectives:

1. To analyze how the financial development affected the economic growth based on a review of the literature.
2. To critically review and evaluate the literature on the various econometric methods employed for the finance-growth relationship.
3. To develop the appropriate econometric models (static and dynamic) based on the type of dataset and examine the finance-growth relationship before and after the crisis.
4. To investigate the role of the financial structure for the economy on the face of the crisis periods and evaluate the diverse country characteristics of the regions in the EU.
5. To refine the finance-growth relationship, because of the insights derived from empirical research as a part of original contribution to knowledge.

1.5 Contribution to the research

This research will help to generate policy insights for policymakers, regulators, and investors. The work is a timely contribution to policy because the EU governments are currently developing new regulatory reforms to build a safer financial system. The thesis focuses on the behavior of two sectors during the pre-crisis and post-crisis periods, as well as for the short and long-term, which has not been addressed in the existing literature. The contribution to the knowledge provides important policy implications for reforms need to put forward in order to enforce the financial system's stability.

Also, the investigation of the three different regional groups provides new insights into the panel heterogeneity in a group of countries that implement the same regulations. If there is clear evidence that more financial banking or stock market development promotes or hinders economic activity, then policymakers should propose new regulations accordingly. Furthermore, the findings have important implications for investors, as the higher degree

as the critical role of equity markets.

of financial integration in one group of countries means that this place might be more attractive for investments.

The thesis also contributes to the empirical literature through the sub-studies to the following points:

1. The first study extends the literature regarding the relationship between financial development and economic growth through a comparative approach on the face of the recent financial crisis in a group of countries that implement the same regulations for the financial sector.

2. The second study extends the literature providing an investigation of the finance-growth relationship using two new aggregate indices, one for the banking sector and one for the stock market. It contributes to the knowledge by considering which sector prevails in any positive or negative impact on economic growth before and after the crisis. It also extends the literature taking into account the response of both financial sectors to the quality of fiscal policy, both crisis periods being considered.

3. Both studies extend the literature by investigating the effect of financial development on economic growth in two phases of crisis periods; the sub-prime crisis period, which represents the finance-growth association two years (2008-2009) after the crisis; and the ongoing crisis period, which represents the finance-growth association eight years after the crisis (2008-2016).

4. The third study extends the literature exploring the dynamic relationship between financial development on the face of the crisis employing the panel ARDL models with two indices for the financial system. It contributes to the knowledge by considering of which sector dominates in any positive or negative effect on economic growth in the short-run (one year-according to the lags of the estimated models) and the long-run, before and after the crisis.

5. All studies extend the literature investigating three different regional groups, thus capturing country heterogeneities in the EU and providing new insights into their financial structure.

1.6 Structure of the research

The structure of thesis is relied on six chapters, including an introduction and a conclusion. The introduction and the conclusion help to present the work as a coherent body of research. The introductory chapter provides an overview of the research, the background of the study, the motivation, the aim and objectives as well as the contribution. The intermediate chapters have been written to facilitate each of the five key objectives of the thesis. The concluding chapter summarises how the overarching aim of the thesis was achieved.

Chapter one presents an overview of the thesis, as well as the overarching aim and objectives of this research.

Chapter two looks at empirical studies that explored the relationship between financial development and economic growth. The analysis focuses on the type of data and the econometric methods used in the studies as well as on the hypothesis of supporting the view that financial development had a positive or negative effect on economic growth. The chapter concludes by critically reviewing and evaluating the methodology and the results of the finance-growth relationship.

Chapter three describes the dataset in detail, including its source, format, and characteristics. Also, figures and combined graphs of all countries are presented with further explanations of their characteristics and describing any trends over time.

Chapter Four discusses the methodological framework of this thesis. It describes all the econometric techniques used to estimate the parameters.

Chapter Five presents the empirical results revolving around three empirical sub-studies concerning the finance-growth relationship in view of the financial crisis. The first section provides the results from a preliminary analysis of data including descriptive statistics, correlation analysis, stationarity tests as well as Hausman and cross-sectional dependent tests. The model specifications, the empirical results and the discussion of results are provided in each of these sub-studies.

Study one. The first study of chapter five aims to explore the relationship between financial development and economic growth on the face of the recent financial crisis, using a panel dataset of 26 European Union countries over the period 1990-2016. The empirical approach employed panel country-fixed effects models and used multiplicative dummies to compare two sub-periods, namely the regular or normal periods and the crisis periods. Finally, the study provides an investigation for three regional groups of countries (as defined in the first section) to capture the country heterogeneity in the EU.

Study two. The second study of chapter five aims to examine the finance-growth relationship across EU countries using the same dataset of the previous study. The principal component analysis is employed to produce two new aggregate indices, one for the banking sector and one for the stock market sector and capture the overall size of both sectors. Similarly to the previous study panel, data regressions are employed using multiplicative dummies to compare the normal and crisis periods. Next, the response of banks and markets to the quality of fiscal policy is investigated, which plays an essential role in the current and future directions in economic growth. Similarly to the previous study the finance-growth relationship for the three regional groups of countries is investigated.

Study three. The third study of chapter five aims to examine the dynamic effect of financial development on economic growth before and after the financial crisis using the indices of the bank and stock market sectors. The empirical approach employed panel cointegration tests to examine the existence of a long-run equilibrium between financial bank sector and stock market development. Next, the error-correction based models were employed for analyzing dynamic heterogeneous panel to examine the short and long-run effects of financial development on economic growth for the pre-crisis and the ongoing crisis periods. Similarly to the previous study three regional groups of countries were investigated.

Chapter six summarises and discusses the main findings of the thesis. It lays forth the empirical contributions of the work and presents the policy implications. Finally, it presents areas for future research.

Chapter Two

Literature review

2.1 Introduction

This chapter provides both a theoretical and empirical review of the relationship between financial development and economic growth. First, it describes the theoretical background of economic growth and presents the neoclassical and endogenous growth models. Second, it presents the theoretical framework of economic development published by McKinnon (1973) containing models in which financial liberalisation and development accelerate the rate of economic growth. Third, the chapter provides an in-depth review of the research of the finance-growth association.

The research on the role of financial development in growth can be traced at least to Bagehot (1873) who argued that well-organized capital markets in England enhanced resource allocation towards more productive investments. Studies before 1973 emphasize the critical role of the banking system for economic growth in mobilizing savings and encouraging investments (Schumpeter, 1911; Hicks, 1969; Goldsmith, 1969). Indeed, there are studies of the theoretical framework before 1973 that found negative or, at best neutral effects of financial development on growth (Keynes, 2018). After 1973, McKinnon (1973) and Gurley and Shaw (1955) produced the theoretical framework which has been formalized and extended over the last decades.

Since the publication of the theoretical framework by McKinnon (1973), the impact of financial development on economic growth has received a considerable investigation in the empirical literature. The survey of the empirical research primarily focuses on perspectives of econometric methodologies and mainly starts from the period of 1990 when the transition economies liberalized their financial sector. In particular, this thesis identifies the methods that the authors employed according to the information given by the collected data. There are three major types of data. First, the cross-sectional, which is a type of data collected for many entities (e.g., countries, firms, regions.) at the same point in time. Second, the time-series, which is a type of data collected for one entity over time of period using the information contained in their past value. Third, the panel data, which include observations obtained over time of period for the same entity. Most of the cross-sectional studies concluded that financial development positively affects economic growth (King and Levine, 1993c; Levine and Zervos, 1996; Gregorio and Guidotti, 1995; Levine, 1997; Azman-Saini et al., 2010), while more recent empirical studies that used time-series or panel data models arrived at a less uniform conclusion (Arestis et al., 2001; Demetriades and Hussein, 1996; Levine, 1999; Caporale et al., 2015; Samargandi et al., 2015; Bumann et al., 2013).

In addition to the information that gives the type of data, the literature identifies the conventional measures of financial development that are widely selected by the authors from various sources. The variables that have received much attention in the empirical literature are measures of the financial development and capture the size of the banking and market sector relative to the economy. Also, the literature identifies the country classification, which is based either on the level of development or on their level of development as measured by per capita gross annual income. Accordingly, countries have been grouped as developed economies, economies in transition and developing economies or as high-income, upper-middle-income, lower-middle-income, and lower-income. Finally, macroeconomic policy variables are examined in the literature to capture the macroeconomic mismanagement and fluctuations.

The remainder of this chapter is organized as follows: Section two describes the theoretical background of economic growth and financial development, while section three conducts an extensive survey of the literature on finance and growth.

2.2 Theoretical background

2.2.1 Economic growth

Economic growth is the annual percentage change in the National Income of a country (Begg et al., 1994). Acemoglu (2012), argues that economic growth is one of the most critical areas of social science and theoretical models below are the frameworks to study and understand the potential sources of this.

2.2.1.1 Harrod-Domar Model

Harrod (1939) and Domar (1946) argued in their model that economic growth depends on the level of savings and the productivity of capital investment. According to their model, the strategy is the mobilisation of savings and generation of investment to accelerate economic growth. However, in this model, economic growth (g) is viewed as the direct function of savings ratio (s) and an inverse function of the capital-output ratio ($1/k$). It is evident in the function below that higher-income corresponds to higher saving, thus higher investment:

$$g = s/k$$

2.2.1.2 Neoclassical Growth Model

Acemoglou (2009) reviewed the Solow growth model and argued that takes into account the principles of the Harrod-Domar model and the fact that there will be diminishing returns to the capital as increasing it. Also, he showed that the central element of their theory is the notion of an aggregate production function, where technology appears separately, and the technology itself may not be constant over time. It can be written in general form as:

$$Y(t) = F(K(t), L(t), A(t)),$$

where Y is the output of the total economy, K is capital, L is employment, t is the time index, and A is technology.

2.2.1.3 Endogenous growth theory

Based on the Solow-Swan growth model, Romer (2012) points out that: *"the only determinant of income in the models other than capital is the effectiveness of labour A" (p. 72).* The model involves four variables: labour L, capital K, technology A, and output Y in a continuous set of time. There are two sectors, a goods-producing sector, which produces real output and a research and development area, which adds to the stock of knowledge. The output produced at time t is:

$$Y(t) = [(1 - aK)K(t)]^a[A(t)(1 - aL)L(t)]^{1-a} \quad where \quad 0 < a < 1$$

Fraction aL, of the labour force, is used in the RD sector and $1-aL$ in the goods-producing sector. Similarly, the term aK, of the capital stock is used in RD and the rest $1 - aK$, in goods production. Both aL and aK are exogenous factors and constant. Aside from $1 - aK$ and $1 - aL$ terms and the restriction to the Cobb-Douglas form, this function is identical to those of our earlier models.

2.2.2 Financial development

2.2.2.1 Financial repression

After World War II, many allied countries faced large debts (also known as postwar debts), and financial repression was a common practice to reduce their debt (Reinhart and Sbrancia, 2011). The idea of financial repression began with some historical precedents of Bank of England and the U.S Federal Bank, where the governments used banks to raise funds. Specifically, the financial repression required banks and other financial institutions to hold more government bonds than they would, when the government had an urgent need to issue debt. This was the case of funding the war expenditures for those two banks. In other words, financial repression involved this period of regulatory measures requiring banks and other financial institutions to hold government debt and impose restrictions on international capital flows. Hence, the ability of intermediaries and consumers to invest in assets other than for their government debt was limited.

The policy of financial repression prevailed in developing countries over the period 1970-1980 and used this practice to generate revenues for financing public expenditures. The urgent need to issue debt resulted from the refusal of foreigners to lend money to their domestic governments. In the 1990s, substantial financial liberalization occurred, although the degree and timing varied across countries. More precisely, in Latin America, financial liberalization occurred in the 1970s but financial repression returned in the 1980s, with debt crises, high inflation, and massive deficits (Dornbusch and Edwards, 1991). In East Asia, the major countries liberalized in the 1980s, while In South Asia, financial liberalization started in the early 1990s. African countries, as well as the transition economies, turned to liberalisation in the 1990s.

Recent studies illustrate that the repression policy is most successful in liquidating debts (Reinhart et al., 2011). Other scholars have observed that banks in the periphery countries of the European Union (EU) have raised the holdings of their own governments' debts as a consequence of the recent crisis. They documented that, by the end of 2013, the share of government debt held by the domestic banking sectors of EU countries was more than twice that held in 2007 (Becker and Ivashina, 2017; Broner et al., 2014; Acharya and Steffen, 2015). Chari et al. (2016), suggest that policies that allow financial institutions to hold a small amount of their own country's government securities may not be desirable. Under such a policy, the EU governments undergoing austerity measures, and structural reforms created fiscal stress and found that the best strategy is to pressure banks to hold more government debt to enhance their credibility not to default.

2.2.2.2 Financial liberalisation: McKinnon-Shaw 1973

From repression to liberalisation

McKinnon (1973) and Shaw (1973) argued that the notion of financial repression refers to policies that are a set of market regulations, and other non-market restrictions to prevent the bank sector of an economy from functioning at their full capabilities. Also, they argued that the outcome of repression would be low savings, high consumption, low investments, and depressed economic growth. Their framework focused on liberalisation of interest rate, especially in developing countries, which leads to increase the real interest rate, as well as savings, spur investments, and eventually, drive to economic growth (see figure 2.1 below).

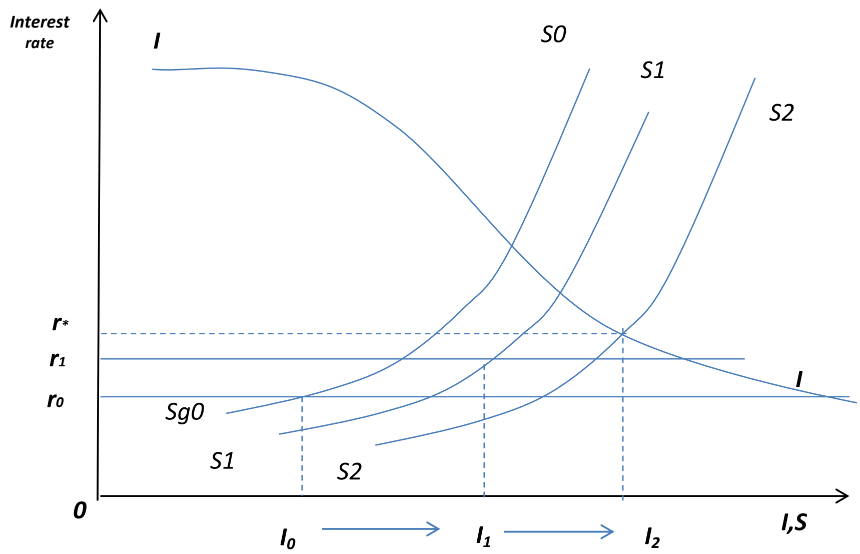


Figure 2.1: Saving and Investment under Interest rate ceilings

The diagram above illustrates the link between interest rates savings and investment. The vertical axis Y measures the real deposit interest rate, and the horizontal axis X measures the investment and saving. The curve II represents the investment function with a negative slope because saving is a negative function of the regular real interest rate, and the curves SS represent the saving function with positive slope because saving is a positive function of the formal real interest rate. In the neoclassical model, the equilibrium interest rate or clearing market level is r^*, which is determined by the point of intersection of the curves II and S_2. Under financial repression, the interest rate ceiling below the market-clearing level (r^*), such as r_1, ensures that there is an excess demand for loans given by $(I_2 - I_1)$. Under these circumstances, the quantity of investment will be determined by the supply of saving S_1. Any increase in the volume of saving that is a movement to the right along the saving curve, gives a higher real formal interest rate, *(as illustrated in the diagram, from* r_0 *rises to* r_1 *and* r^**)*, which leads to increased investment.

Thus, as long as the interest rate is below its market-clearing level since for the interest rates below r^*, the investment would be tracing out along the curve SS. The simple saving-investment diagram is the most widely accepted mechanism linking higher interest rates to increased investment in repressed economies. Indeed, the II and SS curves would both depend on some other variables other than that of real interest rates and the equilibrium point can be affected. The policy prescription that follows the McKinnon-Shaw analysis is straightforward: interest rates should be free from administrative restrictions, and restrictions on bank lending that take the form of high reserve requirements should be eased. Such policies would increase total saving, improve the overall investment because of the increased availability of credit.

Generally, the financial liberalisation is a conversion from financial repression and is a strong theoretical presumption for the financial sector to promote economic growth. Additionally, one of the most critical factors that provided an impetus for moving to financial liberalization was the pressure from globalization. For example, the increasing pressure from the growth of trade, travel, and migration, as well as the improvement of communications, were some of them. The increased demand for access to international financial markets broke the controls on capital outflows, which in turn resulted in more international and flexible mobility of goods, services, and people. Thus, financial liberalization and financial development are two distinct concepts. While financial liberalisation refers to the removal of barriers in the international movement of capital flows, financial development refers to the upgraded quality of financial transactions.

2.2.2.3 Critics for liberalisation policies

In contrast to the work of McKinnon and Shaw (1973), there are arguments against financial liberalisation policies. Keynes (2018), Singh (1997) and Krugman et al. (1998), state that financial development is an obstacle to economic growth because of the inherent instability of the financial system. This school of thoughts argued that there is a role for government intervention in the working of financial markets and argue that a low-interest rate bolsters investments and income, resulting in higher savings. There are more critics of financial liberalisation policies for the potential role in triggering financial and economic crises.

Stiglitz and Weiss (1981), Stiglitz (1994) and Stiglitz (2000) argued that financial liberalisation may deteriorate information problems and that asymmetric information prevails in financial markets. Also, more competition in financial markets may even imply a reduction of marginal profits and a rise of the fragility of financial intermediaries such as banks. Furthermore, in favour of the arguments above, authors claim that financial liberalisation has in many cases, led to disappointing results and in some cases, even to economical and financial crises. Finally, they argued that repression has several positive effects. Firstly, an improvement of the average quality of the pool of loan applicants by lowering interest rates. Secondly, an increase of the equity by reducing the price of capital, and finally, the acceleration of growth rate if credit is targeted towards profitable sectors such as exporters or industries with high technological effects.

2.2.2.4 Empirical research for financial liberalisation

Liberalisation-real interest rates and saving rates

The empirical literature suggests that the link between saving rates and real interest rates is ambiguous as the researchers have not concluded unanimously to identify an effect of changes in interest rates on domestic savings, especially in developing countries.

Giovannini (1985) examined the issue for 18 developing countries and concluded that for the majority of cases, the impact of changes in interest rates on consumption growth and savings were negligible and therefore should be ignored. Ostry and Reinhart (1992) confirmed these results and argued that only when the disaggregated commodity structure for traded and non-traded goods is assumed, interest rates lead to higher consumption growth and lower savings.

In a different study, Ogaki et al. (1996) examined the relationship between real interest rates, saving, and growth in developing economies, using a model in which the intertemporal elasticity of substitution varies with the level of wealth. The hypothesis that the saving rate, and its sensitivity to the interest rate, are a rising function of income finds strong empirical support. The rationale here is that only after the households achieve a subsistence consumption level consider saving the portion of their budget left after subsistence has been satisfied.

Bayoumi (1993) studied the relationship between financial deregulation and household savings for 11 regions in the UK over the period 1971-1988. The findings suggest that the effects of deregulation shown that savings become significantly more sensitive to changes in wealth, current income, real interest rates, and demographic factors. Finally, saving is also estimated to have become more sensitive to predicted changes in real disposable income, which is consistent with a fall in the importance of liquidity constraints on consumption. In particular, the author concluded that an autonomous fall in the personal saving rate might be attributed to deregulation alone.

Jappelli and Pagano (1994) investigated the role of capital market imperfections on aggregate saving and growth for 30 OECD and non-OECD countries over the period 1960-

1987. The results showed that liquidity constraints on households raise the saving rate, strengthen the effect of growth on savings, and increase the growth rate if productivity growth is endogenous, which in turn may increase welfare. The overall results suggest that financial deregulation in the 1980s contributed to the decline in national savings and growth rates in the OECD countries.

Bandiera et al. (2000) examined if financial reforms raise or reduce savings for developing countries over the period 1970-1994. The authors constructed an index of financial liberalization based on eight different components: interest rates; reserve requirements; directed credit; bank ownership; prudential regulation; securities markets deregulation; and capital account liberalization. The findings suggest a negative relationship between the real interest rate and savings, while the effect of the financial liberalization index on savings is found positive and significant.

Reinhart and Tokatlidis (2005) used data of 50 countries consisting of 14 developed and 36 developing ones over the period 1970-1998 and found that in the majority of cases, higher real interest rates were associated with reduced savings. Similarly, Schmidt-H. and Servén (2002) argued that the sign of the interest rate elasticity of savings was ambiguous, both theoretically and empirically. Higher interest rates increased savings through the substitution effect, but could ultimately reduce the savings rate if the associated income and wealth effects were sufficiently strong.

Liberalisation and financial reforms

Stulz et al. (1999), Claessens et al. (2001), and Mishkin (2011) confirmed through their findings that the financial liberalisation process increases the efficiency of the financial system by weeding out inefficient financial institutions promoting transparency and accountability and creating higher pressure for a reform of the financial sector. The same authors argued that the development of the international capital markets helped policy-makers to discipline, who might be led to a temptation to exploit an otherwise captive domestic capital market. Also, liberalisation is beneficial in the short and long run for developed markets, while in emerging markets revealed more massive booms and crashes in the short run (Kaminsky et al., 1998).

However, the empirical literature on financial liberalisation does not strongly support the hypothesis that interest rates lead to higher savings. On the other hand, it is recognised that a well-behaved financial system is a success of financial reforms throughout the liberalisation process. Nevertheless, financial repression is an expensive way for a government to purchase this credibility due to collateral constraints. Banks can raise only a limited amount of funds from depositors. Forcing banks to allocate a higher percentage of these funds to government securities instead of productive investments lowers the total amount of funding new investments, which is a driving force in a national economy. In this sense, financial repression is crowding-out costs and reduces aggregate output by driving down private investing. Thus, policymakers need to balance moral hazard concerns against debt-financing concerns.

Table 2.1: Empirical literature of financial liberalisation

Authors	sample	period	model	variables	results
Giovannini 1985	18	1962-1972	OLS	Real income growth, real interest rate, domestic savings to GDP	The traditional savings equations cannot detect significant responses of aggregate savings to the rate of interest
Ostry and Reinhart 1992	13	1968-1983	GMM	Gross domestic product (GDP), private consumption, exports, imports, interest rate, exchange rate, population	Only when the disaggregated commodity structure for traded and non-traded goods is assumed, interest rates lead to higher consumption growth
Bayoumi 1993	11	1971-1988	OLS	Saving, disposable income, real house prices, real interest rate	The effects of deregulation shown that saving becomes significantly more sensitive to changes in wealth, current income, real interest rates and demographic factors. Also, an autonomous fall in the personal saving rate may be attributed to deregulation alone
Jappelli and Pagano 1994	30	1960-1987	OLS	GDP, Labour force growth, saving, productivity growth, loan to value ratio, real interest rate	Liquidity constraints on households raise the saving rate, strengthen the effect of growth on saving, and increase the growth rate if productivity growth is endogenous. The overall results suggest that financial deregulation in the 1980s contributed to the decline in national saving and growth rates in the OECD countries.
Ogaki et al. 1996	82	1985-1993	OLS GMM	Real interest rates, saving, and growth	Intertemporal elasticity of substitution varies with the level of wealth. The hypothesis that the saving rate, and its sensitivity to the interest rate, are a rising function of income finds strong empirical support
Bandiera et al. 2000	8	1970-1994	OLS GMM	Interest rates, reserve requirements, directed credit, bank ownership, prudential regulation, securities markets deregulation, and capital account liberalization	There is no evidence of any positive effect of the real interest rate on saving. In most cases, the relationship is negative and statistically significant. Furthermore, the effects of the financial liberalization index on saving are mixed: negative and significant in Korea and Mexico, positive and significant in Turkey and Ghana
Stulz 1999, Claessens et al. 2001, Mishkin 2011					Confirmed through their findings that the financial liberalisation process increases the efficiency of the financial system by weeding out inefficient financial institutions promoting transparency and accountability and creating higher pressure for a reform of the financial sector
Reinhart and Tokatlidis 2005	50	1970-1998	ARDL	GDP, interest rates, investment, savings	Positive effects in terms of foreign direct investment and capital flows. Also, the results are not conclusive for savings, while the effect in countries with low income seems to have little benefits
Kaminsky et al. 1998	28	1973-1986		Capital flows, interest rates,reserves, stock market capitalisation	Liberalisation is not continuous process in emerging economies and leads to booms and busts in short run. Also, the quality of governance is crucial

2.3 Empirical literature

After reviewing the theoretical framework, it is essential to examine and critically evaluate the empirical research conducted in the field to determine if the theory reflects reality. As mentioned in the introduction of the chapter, the analysis focuses on three different types of data sets to assess the role of the financial sector in stimulating economic growth. Notably, the review begins with the cross-sectional studies, continuous with the time series and ends with the panel data studies.

2.3.1 Cross-Sectional studies

In early studies, especially for those conducted before 2000, the most common econometric method used was the cross-sectional regression and focused on developed and developing countries. However, the studies are old regarding the period covered, since the most part is from 1960 to 1990. Cross-sectional studies were also conducted after 2000, included a more recent period (1970-2009), and they have mainly investigated the structural characteristics of the financial system for developing countries. Apart from cross-sectional regression model, the studies used other models, namely pooled cross-sectional[1] regression and Generalized Methods of Moment (GMM)[2]. The majority of the studies have used one indicator of economic growth, which represents the dependent variable, and various measures of financial development, which represent the independent variables. Regarding the proxy of economic growth, the most widely used was real per capita gross domestic product (GDP) growth or growth of GDP. As for the indicators of financial development, the most commonly used are liquid liabilities to GDP, credit to private sector to GDP, the ratio of total banks assets, stock market capitalisation to GDP, stocks traded or total value traded to GDP, and the liquidity of the stock market or turnover ratio.

Table 2.2 provides a summary of these empirical studies that investigated the impact of financial development on economic growth, and the channel by which the former affects the latter. The data used in these studies are obtained from various sources, namely the Global Financial Development Database published by the World Bank Data and the IMF World Economic Outlook (WEO) Database (October 2017). However, in some cases, data were obtained from the central banks, and commercial banks of countries studied. They also used large samples of countries which are higher than 41 ($n \geq 41$) and in some studies the sample is greater than 90, focusing on either developing or developed countries, but nor both of them.

[1] Pooled data occurs when a time series of cross-sections, but the observations in each cross-section do not refer to the same unit.

[2] GMM is the best suited econometric model to deal with potential endogeneity issues, which cause inconsistent and biased estimators

In brief, the results from cross-sectional empirical studies that investigated the importance of financial intermediaries and financial markets in the process of economic activity confirmed the positive relationship between financial development and economic growth. Also, it became widely acknowledged by these studies that economic growth without well-developed financial sector would be detrimental to the long run sector prospects in developing countries and reform programs led to the higher financial development, which in turn contributed to economic growth. Finally, the studies provide substantial evidence that the primary channel through which financial development is positively related to economic growth is the efficiency of investments.

2.3.1.1 Empirical findings that support the hypothesis of positive relationship between financial development and economic growth

Employing OLS and GMM methodologies, studies below provide consistent results. They found strong and significant evidence that all indicators of financial development are positively related to economic growth. Other studies reveal that there is a significant relationship between financial reforms and financial development, and support that the main mechanism of finance to cause growth is an investment.

Using the cross-sectional regression models in three different studies over a sample period from 1960 to 1989, King and Levine (1993b) found that all the indicators of financial development were significant and positively related to economic growth. All findings are consistent with the Schumpeterian view that the financial system can promote economic growth. In particular, they investigated whether higher levels of financial development were significantly and robustly correlated with faster rates of economic growth for 100 developed and developing countries. They used as proxies of financial development indicators that are designed to measure the depth of financial intermediaries. These were bank deposits relative to central banks and credit issued to private firms, which is more directly linked to investment.

Also, in a new study which was a refinement of the previous one, the same authors examined 92 developing and developed countries and found that the financial sector reforms lead to a higher level of financial development (King and Levine, 1993c). Finally, the same results are obtained when 64-88 wealthy, rich, poor and impoverished countries are investigated, confirming that the financial sector reforms are significant for the financial development (King and Levine, 1993c).

The findings from King and Levine (1993), were also supported by Gregorio and Guidotti (1995), who examined the finance-growth for 100 countries over the period 1960-1985. Financial development was proxied by the ratio of bank credit to the private sector. However, the positive relationship between financial development and economic growth in the whole cross country sample changes across subsamples and is negative in panel data for Latin America. Specifically, the same authors applied the six-year average panel data method for 12 Latin American countries from 1950 to 1985, with findings suggesting that financial development improves growth performance. This effect, however, varies across countries and over time. Authors pointed out that there may be instances such as the Latin American experience, where deregulation of financial system and bailouts can lead to a negative relationship between the degree of financial intermediation and growth and they insist that the removal of financial repression requires a regulatory framework to avoid a costly financial crisis. Their findings also strongly indicate that the main channel of transmission from financial development to growth is the impact on the efficiency of investment rather than its level.

The conceptual basis that was provided by some theories of the belief that larger, more efficient stock markets boost economic growth, was investigated by Levine and Zervos (1996). The authors examined whether there is substantial empirical evidence that the stock market development is essential for the economic growth for 47 countries and a sample period from 1976 to 1993. Using as proxies of stock market development indicators that are designed to measure the size and liquidity of the stock market such as the average of market capitalisation, the turnover ratio and total value traded, the results suggest that stock market liquidity positively predict growth in the long-run. The relationship, between stock market development and long-run growth, remains robust even after controlling for initial conditions, inflation, the size of the government, the black market exchange premium and the financial depth measured by the ratio of liquid liabilities. Also, the findings confirm the views that financial markets provide essential services for growth and that equity markets provide different services from banks. Finally, the findings suggest a negative relationship between the size of the stock exchange and volatility with economic growth.

During the same period, some economists declared different views regarding the relationship between financial development and economic growth. According to these views, economic development creates demands for financial system development. Saint-Paul (1996) presented a model which explains financial development as being triggered by an unusual increase of demands for financial services. The increase of financial services demand was a result of higher public debt or from technological innovations associated with increasing returns of scale, only funded by large amounts of savings. He related this model to the empirical findings from the historical experiences of financial development in England.

In a different study, Levine (1997) analyzed the existing theory of the finance-growth nexus to shed light on different views by economists. The author organized the literature on finance and economic activity by breaking the financial functions into five essential functions: the mobilizing of savings, the allocating of resources, the facilitating the risk management (trading, hedging, diversifying), the facilitating of the exchange of goods and services and the monitoring and exerting corporate control. He used two channels through which each financial function may affect economic growth: capital accumulation and technological innovation. However, considering the cross-country empirical studies, there is persistent evidence consistent with the view that the level of financial development affects economic growth. Similarly, the body of country-studies suggests that the well-functioning the financial system has, in some cases, during some periods, considerably boost the economic growth. Finally, there is no sufficient understanding of the long-run economic growth because there was not full evolution of the financial system.

Throughout another important study, the investigation of the legal, regulatory systems and financial reforms, and how these, in turn, are linked to long-run economic growth were investigated using cross-country data. In particular, Levine (1999) studied the effect of the legal and regulatory environment on intermediary financial development as well as the causal link between intermediary financial development and economic growth employing Generalised Methods of Moment (GMM). He used the legal and regulatory indicators of creditor rights, as instrumental variables for financial development, contract enforcement, and information disclosure. Also, he placed a sample of 49 countries into four legal families, English, French, German, or Scandinavian. First, the findings indicated that the legal and regulatory environment matters for financial development. Specifically, the results are consistent with the argument that cross-country differences in legal systems affect the relationship between entrepreneurs and creditors (Shleifer and Vishny, 1997). Second, the findings indicate that the exogenous component of intermediary financial development (the legal and regulatory environment defined the element) has a positive relationship with economic growth. Also, the results show that countries with regulatory systems that give a high priority to creditors had a better functioning of financial intermediaries.

Later studies that employed cross-sectional data investigated the primary mechanism through which financial development has a positive and significant impact on economic growth. According to these studies reviewed, the former affects the latter by increasing the productivity of investments and not by savings and physical capital accumulation. However, the results showed substantial evidence that investment is an important channel through which financial development positively affects economic activity. Trabelsi et al. (2002), when conducting his study for 69 developing countries and sample period from 1960-1990, employing cross-country and pooled cross-section regressions, found that financial development is a significant determinant of economic growth and the channel of the effectiveness is mainly through an increase in investment efficiency. In a related study for the relationship between investment and economic growth, there is new evidence on the concept of threshold effects. Azman-Saini et al. (2010) employed a threshold regression model using cross-country data set from 91 countries over the period from 1975 to 2005. The findings suggest that the positive impact of foreign direct investment (FDI) on growth is activated after financial market development exceeds a threshold level. Until then, the benefit of FDI is non-existent.

According to the aforementioned theoretical background, Rajan and Zingales (2003) confirmed that greater financial development accelerates the growth of financial dependent industries, but the financial structure does not matter. In a later study, Vlachos and Waldenström (2005) examined the growth effects of financial liberalisation employing the OLS and instrumental variables (IV) methods, and examined 42 countries over the period 1980-1990. The authors used as a proxy for financial development the total capitalisation measured as the sum of domestic credits and stock market capitalisation over GDP. Capital account liberalisation, equity market liberalisation, actual flows, and international capital flows were used as indicators of financial liberalisation. The main result is that firms highly dependent on external financing, do not present high value-added in countries with the liberalised financial system. However, liberalization increases the growth rates of both output and firm creation among externally dependent industriesgiven that the countries have reached a relatively high level of financial development.

In a more recent study, Allen et al. (2012) studied the link between the structural characteristics of the financial system of countries that experienced banking and market crises in the years 1970-2009. They employed a cross-country regression, covering 75 banking crises and 17 market crashes. Their results show that there is a significant short-term reversal in the bank sector development and stock market development, with the bond market moving to the same direction as bank credit. Also, their results are insignificant for bank-based economies but statistically and economically significant for market-based economies during the banking crises. This can explain why emerging markets take more time for them to recover from an economic downturn after a crisis because they are mainly bank-based. Moreover, findings suggest that financial reform did not make many contributions to alleviating the crises. Policy implications that emerge from their results are that regulators need to pay more attention to the financial system structure, and they should not only focus on the banking sector.

2.3.1.2 Empirical findings that do not support the hypothesis of positive relationship between financial development and economic growth

Contrary to the conclusions of several previous studies based on cross-country data that have been used in most research on the subject, there are some studies that suggest different results. However, when the regression model varies across subgroups, a parametric heterogeneity is observed and the results do not support the hypothesis of positive relationship between financial development and economic growth.

Ram (1999) studied the relationship between financial development and economic growth for 95 countries over the period 1960-1989. He used as indicator of financial development the ratio of liquid liabilities to GDP. The findings reveal that out of the entire set of 95 countries, the finance-growth relationship is significantly positive in 9 countries, while in 16 countries if found significantly negative. However, the preponderance of evidence suggests a negligible or weakly negative association between economic growth and a prime proxy for financial development. Finally, when the regression model is permitted to vary across three subgroups, a parametric heterogeneity is observed, and the overall result is that of a negligible or negative association between financial development and growth.

Similarly to the results of a negligible association between financial development and growth, in a meta-analysis study, Bumann et al. (2013) studied the empirical literature on the relationship between financial liberalization and economic growth to explain the reported heterogeneity of results. The authors in the meta-analysis method explored 441 t-statistics reports from 60 empirical studies. The results suggest that there is a positive effect of financial deregulation on growth, and the significance of this effect is only weak. In contrast to the conclusions reached in several recent studies through a cross-sectional regression, investigations for individual countries suggest different results. Also, for most of the variables that may help explain the heterogeneity of results, the findings do not indicate any significant effects. These results remain valid after employing several robustness tests including a test for publication selection bias.

2.3.1.3 Evaluative summary for cross-sectional studies

In summary, having review the cross-sectional studies in Table 2.2, the seminal papers of King and Levine (1993a,b,c), Levine and Zervos (1996), Levine (1997, 1999) as well as Allen et al. (2012), have provided a comprehensive analysis and bring together e major contributions to the study of finance and growth relationship. They consider conceptual and empirical studies to discover the link between financial systems-including indicators from financial intermediaries, financial markets and the functioning of the economy-including economic growth. However, when considering some qualitative indicators, such that of legal, institutional, and policy determinants of financial development, marginal contribution to the study is provided.

However, in terms of bank sector development or stock market sector development, there is still no consistent view on whether the former is better than the later for the real economy. So much more research was needed to be conducted on determinants of stock market development together with indicators of the bank sector. Nevertheless, Levine and Zervos (1996) conducted this research, finding that equity markets provide different services from banks being positively related to economic growth, but on the other hand, there is a negative relationship between the size of the stock exchange and volatility with economic growth.

The main conclusion of the cross-sectional studies is that the finance-growth relationship is positive, but their methodological approach failed in explaining the real direction of causality as well as to analyze the behavior over time. Also, the timing of collecting data is not guaranteed to be representative, and this potentially can lead to selective bias.

The current study uses a panel data set consisting of a homogeneous group of countries that implement the same regulations, thus capturing differences due to legal, institutional, and other qualitative determinants. More accurate inference of model parameters are obtained than this of cross-sectional studies, and the dynamic relationship is uncovered, as the economic behavior is inherently dynamic, and most econometrical interesting relationship is explicitly or implicitly dynamic.

Table 2.2: Cross-sectional data studies

Authors	sample	period	model	variables	results
King and Levine 1993a	64-100	1960-1989	OLS	GDP per capita, productivity growth, investment, liquid liabilities, bank deposits, credit to private sector, total bank assets	All indicators of financial development were significant and positively related to economic growth.
King and Levine 1993b	92	1960-1989	OLS	The same variables as above	Refinement of King-Levine 1993a: Financial sector reforms lead to higher level of financial development
King and Levine 1993c	64-88	1960-1989	OLS	The same variables as above	Refinement of King-Levine 1993b. A different sample of countries. Financial sector reforms lead to higher level of financial development
De Gregorio Guidoti 1995	100	1960-1985	OLS	GDP per capita, credit to private sector to GDP	The whole sample: positive and significant impact on economic growth, through increased efficiency of investment. The subsamples: the impact of financial development on growth changes across countries. Latin American panel presents negative finance-growth relationship
Levine and Zervos 1996	64-88	1960-1989	OLS	As King and Levine 1993a	Stock market indicators were significant and positively related to economic growth and remain robust when examined with the size of governments and proxies for bank sector
Saint-Paul 1996					Presented a macroeconomic model and found that the increase of financial services demand was a result of higher public debt or from technological innovations associated with increasing returns of scale, only funded by large amounts of savings.
Levine 1997	-	-		Examined the literature on five functions:mobilizing of savings allocating of resources facilitating the risk management exchange of goods and services monitoring and exerting corporate control	Persistent evidence consistent with the view that the level of financial development affects the economic growth. Also, the well functioning financial system has, in some cases, during some time periods, considerably boost the economic growth
Levine 1999	49	1960-1995	GMM	GDP per capita, productivity growth, credit to private sector, legal indicators	Countries with legal systems that rigorously enforce laws and contracts have better developed banks than countries where enforcement is more lax
Shleifer and Vishny 1997	49	1960-1990	OLS	GDP per capita, rule of law, creditor rights	The results show that commonlaw countries generally have the strongest, and French civil law countries the weakest, legal protections of investors, with Germanand scandinaviancivillaw countries located in the middle
Trabelsi 2002	69	1960-1990	OLS	GDP per capita, the ratio of money stock to nominal GDP	The cross country and pooled cross section regressions showed that financial development is significant determinant of economic growth and the channel of the effectiveness is mainly through an increase in investment efficiency
Azman-Saini et al., 2010	91	1975-2005	OLS	GDP , FDI to GDP, initial income, population growth, government spending to GDP	The positive impact of FDI on growth is activated after financial development exceeds a threshold level
Rajan and Zingales, 2003	41	1975-2005	OLS GMM	GDP per capita, per capita industrialization, openness, equity market capital to GDP,	Confirmed that financial development contributes to productivity through providing necessary financial support to the development and expansion of industries
Vlachos and Waldenstrom 2005	42	1980-1990	OLS IV	GDP growth, domestic credits, stock market capitalisation, capital account liberalisation, equity market liberalisation, actual flows, international capital flows	The main result is that industries highly dependent on external financing, do not present high value added in countries with liberalised financial markets. Liberalization does, however, increase the growth rates of both output and firm creation among externally dependent industries-given that the countries have reached a relatively high level of financial development
Allen et al. 2012	69	1970-2009	OLS	GDP per capita, stock market capitalisation, credit to private sector, total value traded, bank assets, bond market indicators	The results are insignificant for bank-based economies but statistically and economically significant for market-based economies during the banking and market crises
Ram 1999	95	1960-1989	OLS	GDP per capita, liquid liabilities	The finance-growth relationship is significantly positive in 9 countries, while in 16 countries if found significantly negative. The preponderance of evidence suggests a negligible or weakly negative association
Bamann et al. 2013	Meta-analysis of 60 studies			441 t-statistics reports	The results suggest that there is a positive effect of financial deregulation on growth, and the significance of this effect is only weak.

2.3.2 Time series studies

In time series studies the econometric models use data that contain information about their past value. There are two-time series models namely linear and non-linear. The linear models for time series data can have many forms, and the one of major importance is the autoregressive (AR) model. In particular, when a regression model includes one or more lagged values of the dependent variable among its explanatory variables, it is called an autoregressive model. It is also known as a dynamic model since it portrays the time path of the dependent variable about its past value. An extension of this model is the vector autoregressive model (VAR) model which can be considered as time series method. A restricted VAR model is the vector error correction model (VECM), which is designed to estimate if the underlying variables have a long-run stochastic trend, also known as cointegration. The VECM has the advantage of including both long-run and short-run information. However, for the analysis of both short and long run, the autoregressive distributed lag (ARDL) approach is employed. The ARDL model is being used to model the relationship between variables in a single-equation time-series setup. Furthermore, another popular method in time series is the causality analysis which tests the direction of causality between two variables (Granger causality tests). Causality in economics is tested for by measuring the ability to predict the future values of a time series using prior values of another time series. Finally, the non-linear time series models estimate the changes of variance over time, which is called heteroscedasticity. These models represent autoregressive conditional heteroscedasticity (ARCH), and a wide variety of the extension of ARCH model are the generalised (GARCH), threshold (TARCH), exponential (EGARCH), and power (PGARCH) autoregressive conditional heteroscedasticity models respectively.

Table 2.3 provides a summary of the empirical time series studies of the relationship between financial development and economic growth. These studies were conducted after 2000 and the most common econometric methods used were Granger causality, VAR, VECM and ARDL models, focusing on developed and developing countries. The covered period is similar compared to cross-sectional studies, except those conducted by Odhiambo (2013) and Phiri (2015), who extended the time period until 2011 and 2013 accordingly. The majority of studies have used one indicator for economic growth which represents the dependent variable and various measures of financial development are used as independent variables. Regarding the proxy of economic growth, the most widely used was GDP per capita, while proxies for financial development are similar to those used in cross-sectional studies. Various sources provide the data used in these studies, namely International Financial Statistics (2002), World Bank Development (2002), Global Financial Development Database published by the World Bank and the IMF World Economic

Outlook (WEO) Database (October 2017). However, in some cases, data were obtained from the central banks, and commercial banks of countries studied (National bank of Poland). They also used samples of countries which are no higher than 39 ($n \leq 39$). The period examined was no less 10 years ($n \leq 10$) and no higher than 44 years ($n \leq 44$).

In brief, studies that investigated one country, either developed or developing, concluded in unidirectional causality results, where finance-led growth. On the other hand, in studies that investigated more than one country the results do not provide conclusive evidence of unidirectional causality hypothesis. On balance, the findings of these studies support the bidirectional or two-way causality hypothesis. Studies that employed VAR and VECM models examined the dynamic relationship between financial development and economic growth and concluded that the former has a positive and statistically significant relationship with the latter. Finally, the mechanism linking the financial development and economic growth is investment.

2.3.2.1 Empirical findings that support the hypothesis of positive relationship between financial development and economic growth

Some studies examined the direction of causality between the two variables and concluded that there is a unidirectional causality or one-way causality between finance and growth. Particularly, the finance-led growth hypothesis suggests that financial development is the leading factor in economic growth. From the literature, one can conclude that most of these studies that they have focused on developing countries suggest that the relationship between financial development and economic growth follows a supply-leading pattern. Specifically, Ghali (1999) and Darrat et al. (2006) employed in their studies the Granger causality test, and the results show a one-way causality from financial development to economic growth.

Asteriou and Price (2000) investigated the effects of financial and stock market development on the process of economic growth in the UK. They first presented two competing alternative hypotheses related to the financial development and economic growth in terms of their causal relationships, in the context of supply-leading and demand-following hypothesis. The results obtained from the cointegration and causality test support the supply-leading hypothesis, which suggests that the causal directions run from the development of the financial sector to the real sector (measured by real GDP per capita).

In another study, Andriesz et al. (2005) explored the linkage between financial liberalization and economic growth in Poland. They used monthly empirical data covering the period 1990-2002, and the results indicate that not only there is evidence of a long-run positive linkage between financial development and economic growth but also causation which runs from the former to the latter and not vice-versa.

Yang and Yi (2008) examined the causal relationship between financial development and economic growth for Korea from 1971 to 2002, when Korea has experienced both economic growth and a variety of financial liberalisation and reforms. Financial development was measured by the ratio of the sum of loans and trading value of securities (stocks and bonds) to nominal GDP. The authors employed a causality methodology, and the results suggest that financial development causes economic growth, but the reverse is not true. Also, the stability tests show that there are structural breaks, and since parameters for financial development are not stable, it is obvious that there is no evidence for causality from economic growth to financial development. The conclusion is that there exists a unidirectional causality from financial development to economic growth. The main policy implication is that Korea should give priority to financial reforms rather than any other factors that lead to economic growth.

In several studies, the VAR model was employed to identify the dynamic interactions between financial development and economic growth. All variables in a VAR enter in the model in the same way and are based on its own lagged values and the lagged values of the other model variables. Arestis et al. (2001) examined the relationship between stock market development and economic growth for five developed economies, such as Germany covering the period from 1973-1997, the United States during the period 1972-1998, Japan, the United Kingdom over the time 1968-1997, and France over the period 1974-1998. The authors used quarterly data of the indicators for banking system development proxied by the domestic credit as a percentage of GDP, stock market development proxied by the stock market capitalization as a percentage of GDP, and stock market volatility proxied by the standard deviation of stock market prices. Employing a VAR method and based on a VECM model, the results show that financial development has an essential contribution to output in France, Germany, and Japan. In the United States and the United Kingdom, the link between financial development and growth is found to be statistically weak. Also, the findings suggest that both a bank-based financial system and a capital-market-based promote long-run economic growth. However, the effects of the former are more powerful. Finally, the stock market volatility hurts growth across all countries, except Germany, where is found to be insignificant.

Federici and Caprioli (2009) studied the dynamic relationship between financial development and economic growth in a period of very high degree of international financial integration after 1990. The sample includes 39 countries over the period from 1990 to 2000. A set of measures was used that adequately capture the relevant aspects of financial development. In particular, the primary indicators were the ratio of deposit-money bank assets, the credit to the private sector, the liquid liabilities, the market capitalisation, the total value of shares traded to GDP, and the turnover ratio. The authors employed a VAR model hand their results show that more financially developed countries can avoid currency crises. On the opposite side countries with deficient financial development are immunized by crises.

Ang (2008) investigated the mechanisms linking the two variables of financial development and economic growth for a developing country such as Malaysia using annual data for the period 1960-2003. He adopted a six-equation model to provide some insight into the multiple channels that link financial development and economic growth. The author also used the method of the principal component to measure the deregulation of the financial sector, consisted of six series, such as maximum and minimum lending and deposit rates, liquidity ratio, and policy controls translated into dummy taking the value one if control is present and zero otherwise. Employing the ARDL bound tests, the results show that financial development has a significant positive impact on economic growth throughout both private saving and private investment. Also, findings provide evidence that finance leads to higher growth through improved efficiency of investment. A key policy implication that emerges from the results is that it is critical for the government to develop the financial sector since financial deepening facilitates mobilisation of saving, private capital formation, and long-term economic growth. A sound financial system instills confidence among savers so that resources can be mobilised efficiently to increase productivity in the economy.

In a different study, the complementarity effects between bank development and stock market development were investigated. Odhiambo (2013) studied the relationship between banks, stock markets, and economic growth in South Africa using annual time series data over the period 1994-2011. Three determinants of stock market development were utilised namely market capitalisation, total traded market value, and stock market turnover ratio. The proxy for bank-based financial development was the ratio of credit to the private sector and the real GDP per capita for economic growth. The authors employed the ARDL-Bounds testing method, and the results show that when stock market capitalisation is used as a proxy for stock market development, complementarity between bank-based financial development and stock market development exists both in the long-run and in the short-run. On the other hand, when the stock market traded value is used as a proxy for stock market development; the complementarity is rejected both in the short-run and in the long-run. Finally, when the stock market turnover ratio is used as a proxy, the complementarity is rejected only in the short run, and not in the long-run. The overall empirical results show that the complementarity between bank development and stock market development is weak and sensitive to the determinants used to measure stock market development.

2.3.2.2 Empirical findings that do not support the hypothesis of positive relationship between financial development and economic growth

The bi-directional causality suggests a two-way causal relationship between financial development and economic growth. A country with a well-developed financial system could promote high economic activity, which in turn will create a high demand for financial services. As the financial sector responds to these demands, it will stimulate increased economic development. Thus, financial development can affect economic growth at a certain stage of development, and the reverse will be found later on. This is how the idea of a bi-directional relationship comes in.

Demetriades and Hussein (1996) investigated the issue of causality between financial development and economic growth for 16 developing countries. The selected countries in the data set were not highly developed in 1960, including at least 27 continuous annual observations. In the study were used two measures as proxies for financial development, namely the ratio of bank deposits to GDP and the ratio of bank claims on the private sector to GDP. The authors employed cointegration and causality tests between financial development and real GDP. The evidence provides very little support to the view that finance is a leading sector in the process of economic development. On the contrary, there is evidence that in some countries, the direction of causality is from economic growth to financial development. However, on balance, most of the evidence seems to favour the view that the relationship between financial development and economic growth is bi-directional. The countries that belong to this latter group are considered some of the most successful examples of financial reform. What is also evident from their causality tests is that the results are very much country-specific. That highlights the dangers of statistical inference based on cross-section countries studies, which implicitly treat different economies as similar entities.

Shan and Morris (2002) investigated the relationships between financial development and economic growth for 19 OECD countries, China, and South Korea. They used quarterly data over the period from 1985 to 1998 and as proxies of financial development the ratio of total credit to GDP and the spread between borrowing and lending rates of interest as an indicator of the level of efficiency. Also, the authors employed the Granger causality test for the presence of causality relationships between financial development and economic growth. The results show that the causality between total credit, financial efficiency, and economic growth seems to be weak. Moreover, employing causality tests between financial development productivity and investment do not support the hypothesis that financial development has a significant impact on economic growth. Overall, the findings give little evidence to support the hypothesis that financial development leads to economic growth. The few countries in which there is evidence of one-way causality from financial development to economic growth is insufficient to draw any general conclusions. On the other hand, there are signs of reverse causality and bi-directional causality in others. Abu-Bader and Abu-Qarn (2008) examined the causal relationship between financial development and economic growth in five Middle Eastern and North African (MENA) countries for different periods ranging from 1960 to 2004, within a vector autoregressive (VAR) framework and applying Granger causality tests. The empirical results show weak support for a long-run relationship between financial development and economic growth, and for the hypothesis that finance leads to growth. In cases where cointegration was detected, Granger causality either was bidirectional, or it ran from output to financial development.

Phiri (2015) investigated the asymmetric cointegration and causality effects between financial development and economic growth in South Africa throughout 1992-2013. The authors used the momentum threshold autoregressive (M-TAR) approach, which allows for threshold error-correction (TEC) modeling and Granger causality analysis between variables. The results indicate an abrupt asymmetric cointegration relationship between banking activity and economic growth, on the one hand, and a smooth cointegration relationship between stock market activity and economic growth, on the other hand. Moreover, causality analysis reveals that while banking activity tends to cause economic growth, stock market activity is, however, caused by economic growth increase.

In a recent study, the relationship between, on the one hand, financial institutions, political institutions, inflation, public deficit and trade openness and, on the other hand, economic growth and growth volatility was explored. Campos et al. (2016) employed a P-ARCH framework and used data for Argentina from 1890 to 2000. The findings suggest that the primary explanatory factors, regarding their direct effects on economic growth, turn out to be financial efficiency, informal political instability (either guerrilla warfare or strikes), formal political instability and trade openness. Further, they found robust evidence that both formal political instability (constitutional changes) and trade openness affect growth negatively, indirectly by way of its volatility.

2.3.2.3 Evaluative summary of time-series studies

In summary, having review the time-series studies in Table 2.3, the research of Arestis et al. (2001), Federici and Caprioli (2009), Odhiambo (2013) as well as Demetriades and Hussein (1996) provide major contributions to the study of the finance-growth relationship considering the causality effects from financial development to economic growth by investigating more than one countries in a period of very high degree of international integration after 1990. Additionally, little contribution to the knowledge is provided by empirical studies examining one country. They also investigated the direction of causality from economic growth to financial development, thus capturing both, the unidirectional and bi-directional effects of the finance-growth relationship.

However, the results from the time-series studies that bring together major contribution are mixed. In general, the view that in developing countries, finance causes growth in the earlier stages of economic development, and that in developed countries, growth causes financial development, prevailed. Also, the results are country-specific-as the observations are collected for one country only-but when looking at many countries, there is a risk in concluding that they treat different economies as similar entities. Additionally, it is worth noticing that Odhiambo (2013) found that the complementarity between bank sector and stock market sector is weak and sensitive to the determinants used to measure stock market development. This also highlights that further research has to be conducted on determinants of stock market development together with indicators of the bank sector.

Nevertheless, as the main advantage of time series analysis is that can be used to understand the past as well as to predict the future, the main disadvantage of this methodological approach is that the effects of many countries cannot be considered simultaneously, since basically in time-series data this is the case for one country. Also, the observations are not mutually independent and the probability of finding a high correlation is higher than is suggested by other econometric techniques, but not impossible to be solved. However, one of the main disadvantages is that the effects of many countries can not be considered simultaneously, since basically in time-series data this is the case for one country.

The current study uses a panel data, which are multi-dimensional data involving measurements over time. In particular, panel data contain observations obtained over multiple time periods for the same entities (countries). Time series and cross-sectional data can be thought of as special cases of panel data that are in one dimension only (one panel member or individual for the former, one time point for the latter).

Table 2.3: Time-series data studies

Authors	sample	period	model	variables	results
Ghali (1999)	Tunisia	1963-1993	Granger causality	GDP per capita, ratio of bank deposits to GDP, ratio of bank claims to private sector to GDP	The results suggest that improving the structure and operation of the financial sector in emerging markets does stimulate real growth, but only if such improvement persists over a prolonged period
Darrat (2006)	5-MENA	1970-2003	Granger causality	GDP per capita, broad money stock (M2) and deposits in the narrow money stock (M1)	Existence of a long-run relationship between financial development and financial sector and the evolution of economic growth consistent with the view that the causal directions run from financial development to economic growth
Asteriou and Price 2000	UK	1960-1989	Granger causality	GDP per capita, productivity growth, investment, liquid liabilities, bank deposits, credit to private sector, ratio of deposit money bank assets to deposit money bank assets plus central bank assets	The causality test strongly supports the supply-leading hypothesis, which suggests that the causal directions run from the development of the financial sector to the real sector
Andriesz and Asteriou 2005	Poland	1990-2002	Granger causality cointegration	GDP per capita, liquid liabilities, market capitalisation, turnover ratio, depth and share prices	Evidence indicating that the direction of causation runs from financial development to economic growth and not vice-versa
Yang and Yi 2008	Korea	1971-2002	Granger causality	GDP per capita, ratio of the sum of loans and trading value of securities (stocks and bonds) to nominal GDP	Financial development causes economic growth, but the reverse is not true
Arestis et al. 2001	5	1973-1997	VAR Cointegration	GDP per capita, domestic credit as a percentage of GDP, stock market capitalization, stock market volatility proxied by the standard deviation of stock market prices	Financial development has an essential contribution to output in France, Germany, and Japan. In the United States and the United Kingdom, the link between financial development and growth is found to be statistically weak
Federici and Caprioli 2009	39	1990-2000	VAR	GDP , ratio of deposit-money bank assets, credit to private sector, liquid liabilities, market capitalisation, total value of shares traded, turnover ratio	Countries more financially developed can avoid currency crises. Crises immunise countries with very little financial development
Ang, 2008	Malaysia	1960-2003	ARDL	GDP , lending and deposit interest rates, liquidity ratio, dummies for policy control	Financial development has a significant positive impact on economic growth throughout both private saving and private investment. Also, the channel through which finance leads to higher growth is investment
Odhiambo 2013	South-Africa	1994-2011	ARDL	GDP per capita, market capitalisation, total traded market value, stock market turnover ratio, the ratio of bank credit to the private sector	Complementarity between bank development and stock market development is weak and sensitive to the determinants used to measure stock market development
Demetriades 1996	16	1960-1987	Granger causality	GDP per capita, ratio of bank deposits to GDP and the ratio of bank claims on the private sector to GDP	The relationship between financial development and economic growth is bi-directional. Also, the results are very much country-specific
Shan and Morris 2002	21	1985-1998	ARDL	ratio of total credit to GDP and the spread between borrowing and lending rates of interest as an indicator of the level of efficiency	The few countries in which there is evidence of one-way causality from financial development to economic growth is insufficient to draw any general conclusions. On the other hand, there are signs of reverse causality (from growth to finance) and bi-directional causality in others.
Abu-Bader (2008)	6-MENA	1960-2004	Granger causality-VEC	GDP per capita, broad money stock (M2) and credit to private sector	The empirical results show weak support for a long-run finance-growth relationship and for the hypothesis that finance leads growth. In cases where cointegration was detected, Granger causality either was bidirectional, or it ran from output to financial development
Phiri 2015	South Africa	1992-2013	M-TAR	GDP per capita, productivity, credit to private sector, legal indicators	Asymmetric cointegration relationship between banking activity and economic growth and smooth cointegration relationship relationship between stock market activity and economic growth. Causality analysis reveals bi-directional effects
Campos et al. 2016	Argentina	1890-2000	P-ARCH	GDP per capita, financial institutions, political institutions indices, inflation, public deficit, trade openness, economic growth volatility	Both formal political instability (constitutional changes) and trade openness affect economic growth negatively, indirectly by way of its volatility

2.3.3 Panel data studies

In panel data studies, the econometric models use data where the same cross-sectional unit is surveyed over time. By combining time-series and cross-section observations, panel data give more observations and are better suited to study the dynamics of change. In particular, the panel data regression models, namely fixed effects and random effects are considered as standard panel methods and static models, while a regression analysis of panel data that includes one or more lags for the values of the dependent variable among its explanatory variables, is considered as a dynamic panel data model. Similarly to the time-series data, the extension of the dynamic panel data models is the panel vector autoregressive model, the panel vector error-correction model, the panel cointegration, all designed to estimate if the underlying variables have a long-run relationship. Also, the Pooled Mean Group and Mean Group models are being used to model the relationship between variables in the short and long run. Furthermore, in many studies, the direction of causality is explored throughout the Granger causality test.

Panel data methods employed for the relationship between financial development and economic growth have been increasingly used in empirical research, especially for those conducted after 2000. Tables 2.4a to 2.4c provide a summary of these empirical studies. Although cross-sectional studies concluded that financial development positively affects economic growth, the studies that employed the panel data models arrived at a less uniform conclusion. Similarly to the cross-sectional and time-series studies, the same indicators were used for economic growth and financial development. Various sources provide the data used in these studies, namely UNESCO, Penn World Table (PWT), International Financial Statistics (2002), World Bank Development (2002), Global Financial Development Database published by the World Bank and the IMF World Economic Outlook (WEO) Database (October 2017). However, in some cases, data were obtained from the central bank, and commercial bank of countries studied. Finally, approximately more than 60% of the studies have samples of countries superior or equal at 52 ($n \geq 52$), sample much higher than the equivalent in empirical studies on time-series.

On balance, studies that investigated the direction of causality do not provide substantial evidence supporting the view that financial development is a significant factor for economic growth. Also, the less uniform conclusions seem to be due to the specific characteristics of the countries, which can be estimated by employing the variety of econometric panel methods. More specifically, the extent of government intervention and the legal environment of each country are important factors for financial development and hence, economic growth. It is worth noticing that some studies which employed dynamic panel models reveal insignificant or adverse effects in the short-run, while in the long-run there is a threshold point after which the finance-growth relationship is negative.

2.3.3.1 Empirical findings that support the hypothesis of positive relationship between financial development and economic growth

Exploiting the dynamic nature of panel data methods, panel unit root test, panel cointegration analysis, VECM model, and panel Granger causality, were applied to examine the long-run relationship between financial development and economic growth. The use of these models, give results with substantial evidence in respect to the hypothesis that long-run causality runs from financial development to economic growth.

Christopoulos and Tsionas (2004) studied the long-run relationship between the financial sector and economic growth for ten developing countries over the period 1970-2000. The authors used as a proxy of financial development the ratio of total bank deposits to nominal GDP. They employed threshold cointegration test for stationarity as well as threshold effects, and cointegration test for the existence of a long-run relationship among output, financial depth, and the control variables (investment and inflation). It is found from the tests that the long-run equilibrium relationship exists among these variables, and this relationship is estimated using fully modified OLS. The findings confirm that there is a single equilibrium relation between financial depth, growth and ancillary variables, and unidirectional causality from financial depth to economic growth. Also, the results from the dynamic panel data estimation for a panel-based VECM model suggest that there is no short-run causality between financial deepening and output, and the effect is in the long-run.

Apergis and Fillipidis (2007) studied whether a long-run relationship between financial development and economic growth exists in a group of 15 OECD and 50 non-OECD countries over the period 1975 to 2000. They examined as measures of financial development, liquid liabilities, and credit to the private sector by banks and other financial institutions all as a percentage of GDP. The authors employed a panel cointegration estimation, and the findings support the existence of a positive and statistically significant long-run relationship between financial deepening, economic activity, and a set of macroeconomic variables. The results also suggest that the auxiliary variables, human capital, investment share, and international trade, have a significantly positive impact on growth, while government spending exhibits a positive effect for the OECD countries, but an adverse effect on the group of non-OECD countries. However, the results indicate a bi-directional causality between financial development and economic growth and the implication is that policies aiming at improving capital markets and their functions will have, in the long run, a significant impact on economic growth.

Hassan et al. (2011) studied the role of financial development in accounting for economic growth in low-middle and high-income countries classified by geographic regions for a panel dataset of 98 states and sample period from 1980 to 2007. As proxies for financial development were used domestic credit provided to the private sector, domestic credit from the banking sector, liquid liabilities and gross domestic saving all as a percentage of GDP. The authors employed both panel regressions method and variance decompositions of annual GDP per capita growth rates to investigate what measures of financial development have a significant impact on economic development over time and their contribution to economic growth across geographic regions and income groups. Their results show a positive relationship between financial development and economic growth in developing countries. Moreover, other variables from the real sector, such as trade and government expenditure, play a significant role in explaining economic growth. Finally, their results provided strong long-run linkages between financial development and economic growth.

Hsueh et al. (2013) investigated the causal relationship between financial development and economic growth for 10 Asian countries during the period 1989 to 2007. Based on previous studies they used four financial development indicators such as the ratio of private claims and the ratio of money supply (M1) as well as (M2) and (M3), all as a percentage to GDP. The authors employed a panel Granger causality analysis, and the results show that the causal direction is sensitive to the financial development measures used in each of the countries. Specifically, the results revealed that domestic claims cause economic growth in six countries, while it does not exist for the others. Granger causality from M1 to growth can be found only in two countries (China and Taiwan), while for the rest countries the null hypothesis of no Granger causality can not be rejected. The causality from the indicators M2 and M3 to economic growth exists in three and one countries, respectively. On the other hand, the findings suggest that the causality from economic growth to financial development is very weak in the ten Asian countries. The overall findings support the supply-leading hypothesis and suggest that the causal directions are from financial development to economic growth.

Pradhan et al. (2016) examined the interactions between innovation, financial development, and economic growth in 18 European countries that are members of the monetary union, covering the period from 1961 to 2013. They used eight different indicators for financial development to construct a composite index of financial development (CFD) applying a principal component analysis. These indicators were domestic credit to the private sector provided by banks, domestic credit provided by the financial sector, market capitalization, turnover ratio, and the total value of traded stocks. The authors employed a VECM model and focused on whether causality run between innovation, financial development, and economic growth in both ways, the one way, the other way or not at all.

The results reveal that all variables are cointegrated, and there is clear evidence that the enhanced innovative capacity and development of the financial sector in the Eurozone contributes to long-term economic growth in the countries of the region. A country with a well-developed financial system could promote high economic growth through technological change, as well as product and services innovations, which in turn will create high, demand for financial services.

Love and Zicchino (2006) studied the dynamic relationship between financial development and investment for 8000 firms of 36 countries and a sample period from 1988 to 1998. The authors constructed a financial development index by combining measures of five indicators, namely stock market capitalization, the total value of shares traded, stock market turnover ratio, liquid liabilities, and credit to the private sector. Also, they split the countries into two groups based on the median of its indicator and referred to these two groups as high (high financial development) and low (low financial development). Employing a VAR analysis of panel data and impulse response, the results suggest that the availability of internal funds is more important for investment in countries with less developed financial systems. More specifically, the impact of a positive shock to cash flow on investment is significantly higher in countries where the level of financial development is lower than in countries with a higher level of financial development. Symmetrically, it is found that a positive shock to marginal productivity has less impact on investment of firms in countries with a low level of financial development. Overall, both of these effects imply that financial under-development adversely affect the dynamic investment behavior, thus leading to inefficient allocation of capital.

Based on the panel datasets, the studies that employed Two-Stage Least Square (TSLS) method or GMM method also support findings of a positive link between financial development and economic growth. However, the GMM dynamic panel estimation ignores the integration and cointegration properties of the data. In this way, the estimated panel models of GMM do not characterize a long-run equilibrium relationship between finance and growth.

Benhabib and Spiegel (2000) examined the role of financial development in economic growth and investment on a balanced panel group of four countries covering the period from 1965 to 1985. Similarly to King and Levine (1993c) study, the authors used as indicators of financial development the liquid liabilities, the credit to the private sector and the money bank deposits, all as share to GDP. Employing the GMM estimation on panel groups for five-year periods for the whole sample period, the results indicate that two measures of financial development, liquid liabilities, and credit to private sector lead to economic growth, while only money bank deposits positively influence investment. Also, the proxies of financial development are quite sensitive when fixed effects are employed. This sensitivity might be as a result of broader characteristics of the countries. However, the results indicate that the depth of financial and the private sector both have a positive effect on economic growth through total factor productivity, while the size of banking sector influences investment through both physical and human capital accumulation rates.

Rioja and Valev (2004) investigated the channels through which financial development influences the economic growth in a panel of 74 countries and sample period from 1961 to 1995. The data were averaged over five-year intervals, starting creating seven observations for each state, and countries were grouped into low-medium and high income according to their income per capita. To investigate the sources of growth, the authors used three dependent variables, such as economic growth, capital growth, and productivity growth. Following the empirical literature, they used three common financial development measures, namely credit to the private sector, commercial bank assets, and liquid liabilities. Employing the GMM dynamic panel estimation, the findings suggest that financial development has a significant impact on economic growth in the middle and high-income regions and for low-income countries; finance may have an unwanted effect on growth. Their results confirm that finance has a positive impact on production function growth and primarily in well-developed economies. In less-developed economies, the effect of financial development on economic growth occurs mainly through capital accumulation.

Anwar and Cooray (2012) examined the impact of the interaction of the quality of the governance, financial development, foreign direct investments, and economic growth in South Asia over the period 1970 to 2009. They used as measures of the quality of governance the political rights and civil liberties indices, while money supply was the proxy of financial development. Also, government size proxied by government expenditures and foreign direct investments were estimated in the model. Employing panel fixed effects, and GMM system estimation, the results suggest that financial development has contributed to economic growth and enhanced the benefits of foreign direct investments. Moreover, some control variables and interaction terms were added to the model, and additional tests were employed to control for the robustness of the results above, and the main findings of the study do not change. Finally, improvements in political rights and civil liberties, through their interaction with financial development, have made a significant contribution to economic growth.

Muhammad et al. (2016) studied the impact of financial development on the economic growth of the six Gulf Cooperation Countries (GCC) using a panel dataset over the period from 1975 to 2012. The study used two indicators that measure financial development, which is the total domestic credit to the private sector and the money supply (M2), all as a percentage of GDP. The authors employed four estimation methods, pooled OLS, fixed effect estimation, random effect estimation, and the system GMM estimation. The pooled OLS and the random effect regression models show that financial development plays an essential role in economic growth because both demonstrate a positive and statistically significant impact on growth. The results from the fixed effect estimation show that financial development does not contribute to economic growth even though their signs are positive. Though the fixed effect is more appropriate than random effects after the Hausman test, the system GMM shows that there is a positive effect of financial sector development on the economic growth of GCC region and support the results of pooled OLS and random effect regressions. Also, the results indicate that foreign direct investment (FDI), fixed capital formation, and oil production promote the economic growth of this region. However, the findings suggest that there is substantial evidence that financial development promotes growth in these countries.

Durusu-Ciftci et al. (2017) studied the role of financial development on economic growth theoretically and empirically. In the theoretical part of the study, by developing a Solow-Swan growth model augmented with financial markets, they show that debt from credit markets and equity from stock markets are two long-run proxies for GDP per capita. Turning to the empirical part, the long-run relationship is estimated for a panel of 40 countries over the period 1989-2011, and employing the augmented mean group (AMG)[3] and common-correlated effects (CCE)[4], both of which allow for cross-sectional dependencies. The cross-sectional findings vary across countries, while the panel data analyses show that both proxies have a positive long-run impact on steady-state level of GDP per capita, and the contribution of the credit markets is substantially greater. As a policy implication, they recommend that policymakers need to emphasize on implementing policies that can lead in the deepening of financial markets, including institutional and legal measures to strengthen the rights for creditors and investors as well as contract enforcement. Hence, by fostering the development of a countrys financial sector, economic growth will be accelerated.

2.3.3.2 Empirical findings that do not support the hypothesis of positive relationship between financial development and economic growth

In more recent studies, panel causality tests are employed to investigate the direction of causality between financial development and economic growth, and the findings do not support the hypothesis of their positive relationship. Kar et al. (2011) examined the di-

[3]AMG estimates the panel time series models and allows for heterogeneous slope coefficients across group members and are also concerned with cross-section dependence.

[4]CCE estimates panel time series models and allows heterogeneous or homogeneous coefficients and supports instrumental-variable regressions and unbalanced panels. The cross-sectional dependence test is automatically calculated and presented in the estimation output.

rection of causality between financial development and economic growth over the period 1980-2007 for fifteen the Middle East and North African (MENA) countries. Also, the study used as indicators of financial development, the ratio of narrow money to income, the ratio of deposit money bank liabilities to income, and the ratio of private sector credit to income. They employed panel causality testing approach, and their results do not provide substantial evidence supporting the view that financial development is a significant factor in economic growth. In particular, out of six financial development indicators, only for two countries the findings have strong evidence that financial development causes growth, while none or one or two of financial development indicators causes economic growth for the rest 13 countries. This effect can be attributed to the main features of the MENA region that the implementation of the financial reforms has been delayed and the high information and transaction costs have hindered development in the financial sector. Furthermore, in many of the MENA countries, the critical features of the financial system were that banks were dominated by the state-owned. As a result, government intervention in credit allocation and financing losses of public sector enterprises are which, in turn, constrain to the role of the financial system in economic growth in these countries.

Menyah et al. (2014) examined the causal relationship between financial development and economic growth for 21 African countries over the period 1980-2008. The authors used a comprehensive index of financial development based on principal component analysis and constructed from four commonly used indicators such as broad money (M2), liquid liabilities (M3), domestic credit provided by the banking sector, and domestic credit to the private sector all as a percentage of GDP. Employing a panel Granger causality analysis the findings suggest that for fifteen countries or almost three-quarters of the sample, there was no causality in any direction between financial development and economic growth, while for four countries there was a unidirectional causality running from financial development to growth, one country with the opposite direction and one county with bi-directional causality. The results from panel causality between financial development and trade openness indicate that for sixteen countries or almost three-quarters of the sample, there was no causality in any direction between financial development and trade openness, while for four countries there was a unidirectional causality running from financial development to openness, and one country with the opposite direction. Overall, there is substantial evidence that financial development has no predictive power on economic growth and trade openness.

Swamy and Dharani (2018) used an alternate approach in exploring the causal link between financial development and economic growth for advanced economies as these countries experience significantly higher levels of financial development. The authors employed a fully balanced panel of 24 economies from 1983 to 2013, and the results indicate a negative association of the finance-growth nexus in the long-run when imposing a linear relationship. The panel Granger causality tests examine the bi-directional causality between the financial development variables and economic growth. Employing an alternative approach of moderated mediation effect framework, they noticed that the relationship between financial development and economic growth is moderated by the negative impacts of inflation, interest rate, and population dependency; and the positive mediation effect of trade openness. The policy implication is that there is a need to rein in inflation and real interest rates and enhance trade openness to optimise the benefits of growing financial development on economic growth.

In many studies the researchers employed GMM estimator methods, and the results do not confirm the positive relationship between financial development and economic growth. Narayan and Narayan (2013) examined the finance-growth relationship for 65 developing countries grouped in four regional panels, (Asian, European, African, South American, and Middle Eastern) and sample period from 1995 to 2011. The banking sector is proxied by domestic credit to the private sector, and the financial sector is proxied by the market capitalization of listed companies and the total value of stocks market traded, all as a percentage to GDP. The authors employed a system-GMM estimator, and their findings suggest that financial sector has a positive and statistically significant effect on economic growth, while the banking sector has a negative and statistically significant impact on economic growth. At the regional level, the Asian panel has similar results. In the Middle Eastern group, none of the financial development measures is found to be statistically significant. In the European and African panels, only market capitalization has presented a positive and significant impact on their economy, while the banking sector development is found to have a statistically significant and adverse effect on economic growth. Finally, in the South American panel, only the banking sector presented significant negative results.

Ductor and Grechyna (2014) investigated whether the effect of financial development on economic growth depends on the relative speed of the financial and real sector development for 101 developed and developing countries over the period 1970-2010. Financial development is proxied by the amount of private credit by banks, private credit by banks and other financial institutions, and liquid liabilities. Accordingly, the real sector is proxied by the industrial production growth. The authors employed OLS and GMM methods using cross-sectional and panel data. The results from the OLS method show that financial development and economic growth have an inverted U-shaped relationship because the acceleration of credit growth is not accompanied by growth in the real sector. The results from GMM show that an increase in credit growth leads to an increase in economic growth if private credit and real output grow at the same rate. Finally, the findings suggest that one of the leading channels through which financial development may harm economic growth is an unbalanced growth between private credit and real output. For example, the expansion of credit is not followed by the expansion of the demand for funds by the productive sector of the economy, thus increasing the likelihood of funding risky investments and leading to lower economic growth.

A different study provides new evidence on the relationship between finance and economic growth using an innovative, dynamic panel threshold technique. Law and Singh (2014) investigated this issue throughout a sample of 87 developed and developing countries over the period 1980 to 2010. The measures of financial development were liquid liabilities and credit to the private sector. The authors employed a GMM estimator based on threshold regression, and the empirical results indicate that there is a threshold impact on the finance growth relationship. In particular, they found that the level of financial development is beneficial for growth only up to a threshold; beyond the threshold level, further development of finance tends to affect growth adversely. These results show that more finance is not always good for economic growth and highlight that an optimal level of financial development is more crucial in facilitating growth.

Cojocaru et al. (2015) studied the impact of financial development on economic activity in the transition economies of Central and Eastern European countries and the independent states, every one of which is a former Soviet republic, during the transition years from 1990 through 2008. The interest rate spread, the overhead costs, and the bank concentration measure the efficiency of financial sector development, while the amount of private sector credit provided by the banking system measures the size or the depth of the financial sector. Employing a GMM panel data in their estimation, and including both, the amount of private sector credit and the efficiency of the banking system, the findings suggest that measurement of the financial efficiency, is more important and statistically significant, while the impact of private credit is quantitatively smaller and statistically insignificant, regarding promoting economic growth. Furthermore, problems unique to the transition period in these countries, such as soft budget constraints and small bank competition, could have weakened the potential positive effects of financial development on economic growth.

Caporale et al. (2015) investigated the relationship between financial development and economic growth for new European Union members which were centrally planned economies. The panel consisted of data for ten transition countries from Central and Eastern Europe over the period from 1994 to 2007. The proxies for financial development are domestic credit to private sector, liquid liabilities, and stock market capitalization. Additionally, the interest rate margin is used to measure the efficiency of the banking sector and the reform index for financial institutional development. The authors employed the system-

GMM estimator, and the results suggest that credit to the private sector is insignificant, possibly as a result of many banking crises caused by a large number of non-performing loans at the beginning of the transition process. Further, the stock market capitalization has a positive but minor effect on economic growth, mainly because of the small size of their stock markets, and liquid liabilities has a positive and significant effect on economic growth, which is consistent with the idea that money supply helps growth by facilitating the economic activity. Finally, the margin of interest rates and reform index appear to be highly significant.

Ayadi et al. (2015) explored the impact of financial development on economic growth, using a group of north and south Mediterranean countries for the years 1985-2009. The authors employed a GMM method and included variables to measure the financial sector to account for the quantity and quality effects. The results show that credit to the private sector and bank deposits are negatively related to growth, which confirms deficiencies in credit allocation in the region and suggests the weaknesses of financial regulations and supervision. On the other hand, the results for the stock market, indicate that stock market size and liquidity play an essential role in growth, specifically when estimating the quality of an institution. Investment, whether domestic or in the form of foreign direct investment, contributes significantly to economic growth. Stronger institutions and low inflation are key growth factors.

A new method to estimate the dynamic impact of financial development on economic growth was the error correction based pooled mean group (PMG), mean group (MG), dynamic fixed effect (DFE) model for analysing dynamic heterogeneous panel data. Demetriades and Hook Law (2006) examined the impact of financial development and financial institutions on economic growth for 72 countries over the period 1978-2000. The authors used a panel data set and employed PMG and MG models. The financial development indicators were from the bank sector (liquid liabilities and credit to the private sector) and the main indicators to measure the overall institutional quality, were corruption, bureaucratic quality, and the rule of law. The findings suggest that financial development has highly significant effects on GDP per capita when the financial system follows a sound institutional framework. Moreover, financial development is most potent in middle-income countries, where its effects are particularly large when institutional quality is high. Importantly, the findings suggest that in low-income countries the influence of financial development is at its weakest; in these countries, more finance without sound institutions may not succeed in delivering long-run economic benefits.

Loayza and Rancière (2006) studied two opposing aspects of the literature on the of the financial system on economic activity. In particular, they investigated the impact of financial development and financial fragility on economic growth for 75 countries using annual data during the period from 1960 to 2000. The measure of financial development was the credit to the private sector as a percentage of GDP, and for the financial fragility is proxied by the number of banking crises and the financial volatility measured from the standard deviation of the growth rate of private domestic credit to GDP. They employed a PMG and MG estimator through a panel of cross-country and time-series observations. The results suggest different effects of financial development and credit expansion on economic growth. In particular, there is a positive impact of financial size on economic activity in the long-run and co-exists with a mostly negative effect in the short-run.In order to explain the short-run finance-growth relationship, the study estimated the relationship between the short-run coefficients and financial fragility (banking crises and financial volatility). The results confirm that for financially fragile countries, namely those that experience banking crises or suffer high volatility, present significantly negative short-run effects of financial development on economic growth.

Samargandi et al. (2015) revisited the relationship between financial development and economic growth for a panel of 52 middle-income countries in a sample period from 1980 to 2008. The variables for financial development are widely used in the literature, such as the ratio of liabilities and the ratio of total bank assets. The authors combined these three variables into a single indicator by using the principal component analysis (PCA). Also, the employed the dynamic model of Pooled Mean Group (PMG) and the quadratic form of financial development series to consider the short and long-run equilibrium as well as the nonlinear relationship between the financial development and economic growth. The findings suggest that there is an insignificant impact of financial development on economic growth in the short-run and an inverted U-shaped relationship between finance and growth in the long-run. Thus there is a threshold point after which the impact of financial development on economic growth is negative, demonstrating that the financial development and economic growth are not linearly related. Overall, the impact varies across the countries due to the heterogeneous nature of economic structures, institutional quality, and financial markets.

Sohag et al. (2015) examined whether there is any significant impact in the short run or long run, of financial development on economic growth from nine island economies over 30 years (1980 to 2009). Using a panel data set the authors employed error correction based PMG, MG, and dynamic fixed effect (DFE) model for analysing dynamic heterogeneous of their data. The results from the PMG estimates demonstrate that financial development has a negative short-run impact on economic growth. , in the long run, there is a positive and a homogenous effect of financial development on growth across the island economy.

2.3.3.3 Evaluative summary of panel-data studies

In summary, having review the panel data studies in Table 2.4, Pradhan et al. (2016), Anwar and Cooray (2012), Narayan and Narayan (2013), and Samargandi et al. (2015) bring together significant contribution to the knowledge, considering the dynamic properties of panel data and reducing the country heterogeneity effects, since they investigated more homogeneous group of countries. Additionally, the periods examined include the year 2008, thus capturing the stress time when the crisis erupted. However, studies that include the period of crisis, provide little contribution to the knowledge, since the number of countries examined is either too small (Muhammad et al., 2016), or too big and heterogeneous, thus failing to reduce the panel heterogeneities (Ductor and Grechyna, 2014; Durusu-Ciftci et al., 2017). Furthermore, the study of Swamy and Dharani (2018) which covers the longest examined period (1983-2013), provides substantial evidence of bidirectional effect of financial development on growth, but has marginal contribution, since it examines causality effects, a research that has been largely conducted in previous studies.

However, the results from the panel data studies that have a major contribution are mixed. In general, the view that the well-developed financial system, technological changes (innovation) and the quality of governance contribute to economic growth across all panel of countries whether developed or developing. Nevertheless, as panel data studies enable a researcher to analyze over a long period for the same countries a number of important financial issues that cannot be addressed using cross-sectional or time series data sets, there are still issues to be considered. In particular, Pradhan et al. (2016), Narayan and Narayan (2013) and Samargandi et al. (2015) do not examine simultaneously the impact of the bank and stock market sector on economic growth. Instead, they used either bank or stock market indicators as proxies of financial development and the interaction of both was never the case. Also, their prime objective was to investigate the finance-growth relationship by employing a new panel econometric technique, thus not capturing any structural change because of the crisis period. This highlights the need for further research to be considered as the results for the studies covering periods tend to be more negative.

What merits in the current study, is that using a panel data set examined two new aggregate indices to investigate the effect of the financial bank and stock market sector development on economic growth, through a comparative approach before/after the crisis, which leads to more accurate results and clarifies the queries arising from the mixed results of the abovementioned studies.

2.4 Conclusions of empirical literature

To summarise, the cross-sectional studies provide conclusive evidence that financial development positively affects economic growth, but failed in explaining the direction of causality between finance and growth. The time-series studies focused more on the causality direction and the characteristics of each country, arriving at a less uniform conclusion. In particular, when one country was investigated, concluded in unidirectional causality results, where finance-led growth, while for studies that more than one country was examined, the results do not provide conclusive evidence of unidirectional causality hypothesis. Nevertheless, the dynamic relationship (VAR-VECM models) is found significantly positive. The results from the panel data studies, in turn, are not conclusive due to the specific characteristics of the countries, while there is substantial evidence of a significantly positive long-run relationship.

A general view obtained from the review of the empirical research is that the finance-growth relationship differs across developing and developed countries. In developing countries, finance causes growth in the earlier stages of economic development, while on the contrary, in developed countries, growth causes financial development. Additionally, the causal relationship between financial development and economic growth depends on which measures of financial development were used as well as the level of development of the financial sector. Furthermore, the main channels through which financial development lead to a higher level of economic growth is the efficiency of investment and increased productivity through the capital accumulation of savings. Finally, the level of government intervention, the quality of financial institutions, and the financial reforms might be the main reasons for country-specific results or in other words, country heterogeneity.

Table 2.4a: Panel-data studies

Authors	sample	period	model	variables	results
Christopoulos and Tsionas 2004	10	1970-2000	VECM FMOLS	GDP per capita, the ratio of total bank deposits liabilities to nominal GDP	Confirm that there is a single equilibrium relationship between financial depth, growth, and ancillary variables, and unidirectional causality from financial depth to economic growth. There is no short-run causality between financial deepening and output, and the effect is in the long-run
Apergis and Fillipidis 2007	65	1975-2000	Panel cointegration	Liquid liabilities, credit to the private sector by banks and other financial institutions	Findings support the existence of a significantly positive long-run relationship. The existence of a bi-directional causality implies that policies aiming at improving capital markets will have in the long run a significant impact on economic growth
Hassan et al. 2011	98	1980-2007	Fixed effects VAR Decomposition	GDP per capita, domestic credit provided to the private sector, liquid liabilities and gross domestic saving	Positive relationship between financial development and economic growth in developing countries. Also, results provided strong long-run linkages between financial development and economic growth
Hsueh et al. 2013	10	1989-2007	Granger causality	GDP per capita, ratio of private claims, ratio of money supply (M1), (M2) and (M3)	Overall, the findings support the supply-leading hypothesis that the causal directions are from financial development to economic growth
Pradhan et al. 2016	18	1961-2013	VECM	GDP per capita, domestic credit to private sector, domestic credit from banks, domestic credit from the financial sector, market capitalization, turnover ratio, total value of traded stocks and the total number of listed domestic companies	All variables are cointegrated and there is clear evidence that the enhanced innovative capacity and development of the financial sector in contributes to long-term economic growth. A country with a well-developed financial system could promote high economic growth through technological change
Love and Zicchino (2006)	36	1988-1998	VAR impulse response	Investment, stock market capitalization, the total value of shares traded, turnover ratio, liquid liabilities and credit to private sector	Positive shock to cash flow on investment is significantly higher in countries which have a lower level of financial development than in countries with a higher level of financial development. Symmetrically, a positive shock to marginal productivity has less impact on investment of firms in countries with a low level of financial development
Benhabib and Spiegel 2000	4	1965-1985	GMM	GDP per capita, liquid liabilities, the credit to private sector, money bank deposits	The depth of financial sector and the private's sector both have a positive effect on economic growth through total factor productivity, while the size of banking sector in influences investment through both physical and human capital accumulation rates
Rioja and Valev 2004	74	1961-1995	GMM	GDP growth, capital growth, productivity growth, credit to private sector, commercial bank assets, liquid liabilities	Financial development has a significant impact on growth in the middle and high-income regions, but not for low-income countries

Table 2.4b: continued panel-data studies

Authors	sample	period	model	variables	results
Anwar and Cooray 2012	South Asia	1970-2009	GMM	GDP growth, government expenditures, foreign direct investment, political rights, civil liberties indices, money supply	Financial development has contributed to economic growth and enhanced the benefits of foreign direct investment. Moreover, improvements in political rights and civil liberties, through their interaction with financial development, have made a significant contribution to economic growth.
Muhammad et al. 2016	6	1975-2012	OLS FE,RE GMM	GDP growth, foreign direct investment, total domestic credit to the private sector, and the money supply (M2)	Findings suggest that there is substantial evidence that financial development promotes growth in these countries
Durusu-Ciftci 2017	40	1989-2011	AMG-CCE	GDP per capita, market capitalisation, credit to private sector, total value traded	While the cross-sectional findings vary across countries, the panel data analyses reveal that both channels have positive long-run effects on steady-state level of GDP per capita, and the contribution of the credit markets is substantially greater.
Kar et al. 2011	15	1980-2007	Granger causality	GDP growth, the ratio of narrow money, ratio of deposit money bank liabilities, ratio of private sector credit	Findings do not provide substantial evidence supporting the view that financial development is a significant factor in economic growth. Government intervention in credit allocation and financing losses of public sector enterprises are which, in turn, constrain to the role of the financial system in economic growth in these countries
Menyah et al. 2014	21	1980-2008	Granger causality	GDP growth, index constructed from four indicators: broad money (M2), liquid liabilities (M3), domestic credit provided by the banking sector, domestic credit to the private sector	Overall, there is substantial evidence that financial development has no predictive power on economic growth and trade openness
Swamy and Dharani 2018	24	1983-2013	Granger causality	GDP growth, index constructed from four indicators: broad money (M2), liquid liabilities (M3), domestic credit provided by the banking sector, domestic credit to the private sector	Financial development and economic growth are negatively associated in the long run. Bi-directional causality between the financial development variables and economic growth. When employing an alternative method, the finance-growth nexus is moderated by the negative impacts of inflation, interest rate, and population dependency; and the positive mediation effect of trade openness
Narayan and Narayan 2013	65	1995-2011	GMM	GDP growth, stock market capitalisation, total value traded	For Asian, South American, European and African panels, only market capitalization have presented positive and significant impact on their economy, while the effect of the banking sector development is significantly negative. In the Middle Eastern group, none of the financial development measures is found to be statistically significant
Ductor and Grechyna 2014	101	1970-2010	GMM	GDP growth, private credit by banks, private credit by banks and other financial institutions, and liquid liabilities	Financial development and economic growth have an inverted U-shaped relationship because the acceleration of credit growth is not accompanied by growth in the real sector
Cojocaru et al. 2015	30	1990-2008	GMM	GDP growth, interest rate spread, overhead costs, bank concentration, amount of private sector credit provided by the banking system	Findings suggest that measurement of the financial efficiency, is more important and statistically significant, while the impact of private credit is quantitatively smaller and statistically insignificant, regarding promoting economic growth

Table 2.4c: continued panel-data studies

Authors	sample	period	model	variables	results
Caporale et al. 2015	10-EU	1994-2007	GMM	GDP growth, domestic credit to private sector, liquid liabilities and stock market capitalization	Credit to private sector is insignificant, and the stock market capitalization has a minor effect on economic growth. Liquid liabilities has a positive and significant effect on economic growth
Ayadi et al. 2015	11	1985-2009	GMM	GDP per capita, domestic credit to private sector, bank deposits, turnover ratio, financial openness index, financial reform index, stock market capitalization	The results indicate that credit to the private sector and bank deposits are negatively associated with growth, implying weak financial regulation and supervision. Stock market size and liquidity play an essential role in growth, especially when estimating the quality of an institution. Investments contribute significantly to economic growth. Also, stronger institutions and low inflation are key growth factors
Demetriades and Hook Law 2006	72	1978-2000		GDP growth, liquid liabilities, credit to private sector, and the overall institutional quality, were corruption, bureaucratic quality, and the rule of law	Findings suggest that financial development has significant positive impact on GDP per capita for a financial system follows a sound institutional framework. In low-income countries, the influence of financial development is weak
Loayza and Ranciere 2006	75	1960-2000	PMG MG	GDP growth, credit to private sector, number of banking crises, and the financial volatility measured from the standard deviation of growth rate of private domestic credit to GDP	Positive impact of financial size on economic activity in the long-run and co-exists with a mostly negative effect in the short-run. The results confirm that for financially fragile countries, namely those that experience banking crises or suffer high volatility, present significantly negative short-run effects of financial development on economic growth
Law and Singh 2014	87	1980-2010	GMM	GDP per capita, liquid liabilities, credit to private sector, government expenditures, trade openness, population growth	The empirical results show that there is a threshold effect in the finance growth relationship. These findings show that more finance is not always good for economic growth and highlight the optimal level of finance is more crucial in facilitating growth
Samargandi et al. 2015	52	1980-2008	PMG MG	GDP growth, ratio of liabilities, the ratio of commercial bank assets to the sum of commercial bank assets plus central bank assets and the ratio of bank credit to the private sector	Findings suggest that there is an insignificant impact of financial development on economic growth in the short-run and an inverted U-shaped relationship between finance and growth in the long-run. Thus there is a threshold point after which the impact of financial development on economic growth is negative
Sohag et al. 2015	9	1980-2009	PMG MG		Financial development has a negative short-run impact on economic growth. While in the long run, there is a positive and a homogenous effect of financial development on growth

Chapter Three

Data

3.1 Introduction

The chapter describes the dataset in detail. The decision on the type of data collected depends on the nature of the analysis of this survey. In particular, the study is based on panel data analysis. This statistical method is widely used in econometrics to analyze two-dimensional data over time for the same entities, such as countries. Datasets come in various forms, and the most commonly used in empirical research for the relationship between economic growth and financial development are cross-sectional, time series, pooled cross-sectional and panel data. Before proceeding with the description of the dataset, it is worth analyzing more profound the nature of the data as follows:

(1) First, the cross-section data is a set of observations collected at the same point of time for subjects, such as individuals, firms, countries or regions. This type of data has applications when analysing differences among subjects.

(2) Second, the time-series data that is a set of observations on values collected at different points of time. They are usually collected at fixed intervals, such as daily, weekly, monthly, quarterly, annually basis. This type of data has applications in macroeconomics, primarily in financial economics.

(3) Third, the pooled cross-sectional data is a set of observations that is a combination of time series and cross-section data. What is remarkable in this type of data is that they do not refer to the same unit. They are randomly collected from a large population independently of each other at different points in time.

(4) Fourth, panel data or longitudinal data is a type of pooled data in their nature. The difference between pooled data and panel data is that panel data are repeated ob-

servations on the same cross-section, observed for several periods. In other words, it is randomly selected the cross-section only once, and once that is done, it is followed by each statistical unit within this cross-section over time.

An additional distinction to be made is that of a balanced and an unbalanced panel. A balanced panel has the same number of time-series observations for each cross-section unit and viewed the other way around, the same number of cross-sectional units at each time point. An unbalanced panel has some cross-sections with fewer observations or observations at different times to others. In both cases, the same techniques are used to estimate the model, and the software package automatically calculates the missing observations.

This thesis follows the most relevant and recent literature in selecting an appropriate framework of data for the estimation and uses a dataset consisted of an unbalanced panel. Panel estimation techniques include both time series and cross-sectional elements of data (Wooldridge, 1999; Pesaran et al., 1999; Arellano, 2003; Hsiao, 2014) and a considerable number of studies in the literature discussed in this study used the panel data estimation. For the relationship between financial development and economic growth, King and Levine (1993c) used in his research four different bank development measures. The four measures were the bank credit plus central bank domestic assets to *GDP*, the ratio of credit allocation to private business to total domestic credit, liquid liabilities of banks and non-banks, and the ratio of credit to private business to *GDP*. Since then, many studies have applied panel data estimation in its empirical work. However, it is important that much literature has found that the power of finance weakens when estimation is changed from pure cross-section data to annual data (Favara, 2003; Beck and Demirguc-Kunt, 2009).

Apart from the analysis of the types of datasets being used within the empirical literature, advantages or disadvantages and any limitations that are relevant for the analysis, it is crucial to becoming familiar with the data. The following section provides the list of countries and describes the data as well as the sources from where are obtained. Section 3 provides all graphs of the variables used in this study.

3.2 The sample

This study employs annual data for 26 EU countries over the period 1990 to 2016. The list of countries is provided in Table 3.1 below. The economies with a population of less than 500,000 in 1990 are excluded from the sample. Also, the sample period is intentionally selected to include the transition economies when changing from a centrally planned economy to a market economy. If all data were available, theoretically, it could give strongly balanced panels with 702 observations *(26 cross-sectional observations times 27 time-series observations)*, but there are some missing observations and make the dataset unbalanced.

However, in the present study, the missing observations for the dependent variable and for the variables that are proxies for the banking sector are approximately from 1% to 2%, while for the financial market sector do not exceed 10%. Regarding the macroeconomic variables, the lack of observations is approximately 4%. The precise number of observations is described in Table 5.1 (Descriptive statistics) of chapter five, in the last row in each group of countries examined. All variables are expressed either as the share of GDP (%) or as a ratio in percentage. The data for the financial development measures and macroeconomic variables are collected from the Global Financial Development Database (2017), the World Bank Data, International Monetary Fund (IMF) and Eurostat Database.

3.2.1 List of countries

The research also explores three regional panels of countries to capture the heterogeneity in the EU. The advantage of regional panels is that the finance-growth relationship can be investigated for a more homogeneous panel of countries and compare the results for different regions. Also, the countries Luxembourg and Malta have a population less than 500,000 in 1990 and are excluded from the sample (World Bank Global Development Network Database). The full sample of EU countries is divided into three regional groups according to the background of their economy and geography and are displayed in Table 3.1 below.

Table 3.1: Regional panels list of countries

Panel A	Panel B	Panel C
Austria	Bulgaria	Cyprus
Belgium	Croatia	Greece
Denmark	Czech Republic	Italy
Finland	Estonia	Spain
France	Hungary	Portugal
Germany	Latvia	
Ireland	Lithuania	
Netherlands	Poland	
Sweden	Romania	
United Kingdom	Slovak Republic	
	Slovenia	

Note: PANEL A : North-West EU countries. PANEL B: Central Eastern EU countries or transition economies. PANEL C: South EU countries.

3.2.2 List of variables

Table 3.2 below provides a brief description of all variables used in the study.

Table 3.2: List of variables

variables	Description of variables	Sources
GGDP	Annual growth rate of GDP (%)	World Bank
LLY	Liquid liabilities to GDP(%)	World Bank-IMF
PRIVY	Credit to private sector to GDP(%)	World Bank-IMF
BTOT	Total banks assets ratio (%)	World Bank-IMF
MCAP	Stock market capitalization to GDP (%)	World Bank-IMF
TVT	Stock market total value traded to GDP(%)	World Bank-IMF
TOR	Stock market turnover ratio (%)	World Bank-IMF
INFL	Inflation rate (%)	World Bank
CPI	Consumer Price Index	World Bank
FDI	Net inflows of foreign direct investments to GDP(%)	World Bank
OPEN	Trade openness to GDP(%)	World Bank
DEBT	Central government debt to GDP(%)	World Bank
TAX	Tax revenue to GDP(%)	World Bank
Cr0809	Dummy variable for the sub-prime crisis (2008-2009)	
Cr0816	Dummy variable for the ongoing crisis (2008-2016)	

3.2.3 Description of data

3.2.3.1 Dependent variable

Annual GDP growth rate (GGDP %) is the annual percentage growth rate of Gross Domestic Product at market prices based on constant local currency (aggregates are based on constant 2010 U.S. dollars). GDP is the sum of gross value added by all resident producers in the economy plus any product taxes. The GDP growth rate measures the change in the volume of its output or the real incomes of its residents. In other words, it estimates how fast the economy is growing, where GDP is the economic output of a nation and is the primary indicator of economic health. The data are obtained from World Bank national accounts data, and OECD National Accounts data files.

3.2.3.2 Measures of financial development

Cihak et al. (2012) introduced the Global Financial Development Database that is an extensive dataset of financial system characteristics and includes the following categories of measures: First, the size of financial institutions and markets (financial depth); second, the degree to which individuals can and do use financial services (access); third, the efficiency of financial intermediaries and markets in intermediating resources and facilitating financial transactions (efficiency); four, the stability of financial intermediaries and markets (stability).

The conventional measures of financial development on which the research is based are divided into two groups. The first group measures the financial banking sector development, while the second measure the stock market development. The ratio of liquid liabilities to GDP, credit to the private sector by deposit money banks and other financial institutions to GDP and the ratio of commercial bank assets to the sum of the commercial bank plus central bank assets to GDP-comprise the banking sector. The stock market capitalization to GDP, the stock market turnover ratio to GDP, and the total value of all traded shares-comprise the market sector. The variables have received much attention in the empirical literature, but the stock market indicators are available for a smaller number of countries.

Measures of bank sector

Liquid liabilities (LLY to GDP %) is the ratio of liquid liabilities to GDP, which is widely known as broad money to GDP (M3). They are calculated as the sum of currency and deposits in central banks (M0), adding the transferable deposits and electronic currency (M1), as well as time and saving deposits, foreign currency transferable deposits, certificates of deposits and securities of purchase agreements (M2), plus travelers checks, foreign currency time deposits, and shares of mutual funds or market funds held by residents. Liquid liabilities is one of the primary indicators used to measure the size, relative to the economy, financial intermediaries, including three types of financial institutions: the central bank, deposit money banks and other financial institutions. It is calculated as the liquid liabilities of banks and non-bank financial intermediaries over GDP.

Credit to the private sector (PRIVY to GDP %) is the ratio of credit to the private sector by deposit money of banks and other financial institutions to GDP. Credit to private sector refers to financial resources provided to the private sector by financial corporations and other financial intermediaries divided to GDP, excluding credit issued to the government and public enterprises. Private credit also excludes credit issued by central banks. The higher this measure results in, the larger financial resources provided to the private sector of a country and so the greater space for the private sector to develop and grow. The better the private sector gets and the more extensive the role it has in the national economy, the better is generally the health and development of the economy of a country. It measures the general financial intermediary activities provided to the private sector.

Total banks assets (BTOT %) is the ratio of commercial bank assets to the sum of the commercial bank plus central bank assets. Commercial bank assets are the total assets held by deposit money banks and include the deposit money banks and other financial institutions that accept transferable deposits, such as demand deposits. It proxies the advantage of financial intermediaries in channeling savings to investments, monitoring firms, influencing corporate governance, and undertaking risk management relative to the central bank. It is a comprehensive measure of the size of the banks and indicates the capital adequacy for protecting depositors according to the Guarantee Deposit Scheme. However, it is available for a smaller number of countries and has been used less.

Measures of the stock market sector

Stock market capitalization (MCAP to GDP %) is the ratio of the total value of listed domestic shares in a stock market as an indicator of market size, namely stock market capitalization to GDP. Stock market capitalization (also known as market value) is the share price times the number of shares outstanding for listed domestic companies. Investment funds, unit trusts, and companies whose only business goal is to hold shares of other listed companies are excluded. The rationale behind this measurement is the size of the stock market of the economy.

Total value traded (TVT to GDP %) is the ratio of the total value of all traded shares, which is calculated by multiplying the number of domestic shares traded by their respective matching prices in a stock market exchange as a percentage of GDP and can be used to gauge market liquidity on an economy-wide basis. According to the World Data basis, the figures are single estimated (one side of the transaction is counted). Companies which are admitted to listing and admitted to trading are also included in the data. Data are the end of year values. This measure is an indicator to measure market activity, namely stock market total value traded.

Turnover ratio (TOR %) is the ratio of domestic shares traded on domestic exchanges for a period divided by the average of the stock market capitalisation for this period, namely stock market turnover ratio. It also indicates how easy, or difficult; it is to sell shares of a particular stock on the market. Furthermore, the more active the market, the higher the trading volume and the higher the share turnover ratio will be. This measure is an indicator to measure market liquidity and efficiency. A high value of the turnover ratio will indicate a more liquid and potentially more efficient equity market.

3.2.3.3 Control variables

Inflation rate (INFL %) is a proxy for macroeconomic stability. It is measured by the consumer price index and reflects the annual rate at which prices increase over time, resulting in a fall of the purchasing value of money.

Foreign direct investments (FDI to GDP %) is the net inflows of foreign direct investments to GDP, which is the main channel of transmission from financial development to economic growth. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors and is divided by *GDP*.

Trade openness (OPEN to GDP %) is the trade openness to GDP, which is the sum of exports plus imports and is an indicator of the relative importance of international trade in the economy of a country.

3.2.3.4 Measures for Fiscal policy

Debt (Debt to GDP %) is the total stock of government contractual obligations to others expiring on a particular date. It also includes domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans. It is the gross amount of government liabilities reduced by the amount of equity and financial derivatives held by the government. Because debt is a stock rather than a flow, it is measured as of a given date, usually the last day of the fiscal year.

Government expenses (EXP to GDP %) is the cash payments for operating activities of the government to provide goods and services. It includes compensation of employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends.

Taxrevenues (TAX to GDP %) is the cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent, and income from property or sales.

3.2.3.5 Dummy variables for crisis periods

In the study, the dummy variables take the value **1** to capture the sub-prime crisis period or the ongoing crisis period; and take the value **0** to capture the remaining regular/normal periods.

Cr0809 covers the sub-prime crisis period from 2008 and 2009, when the financial crisis unfolded.

Cr0816 covers the ongoing crisis period from 2008 to 2016, which corresponds to the whole period after the crisis.

3.3 The Figures of data

3.3.1 Figures of the dependent variable

Figure 3.1: The mean of GDP growth rate over the period 1990-2016.

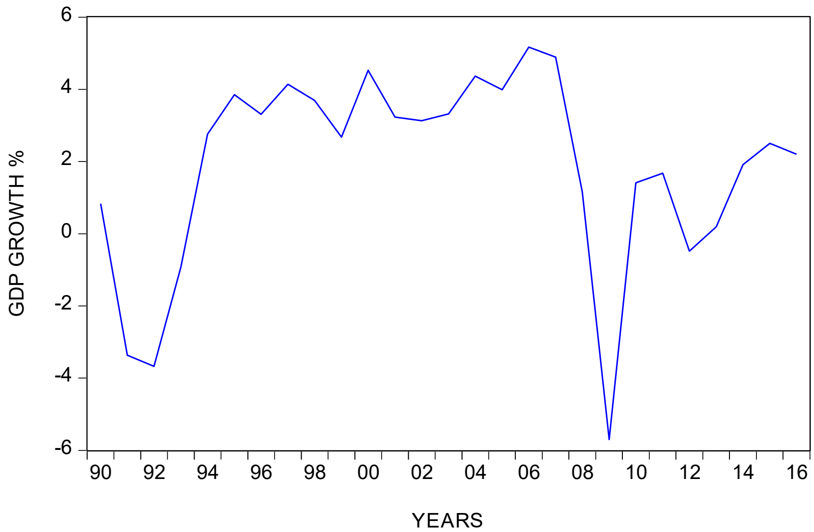
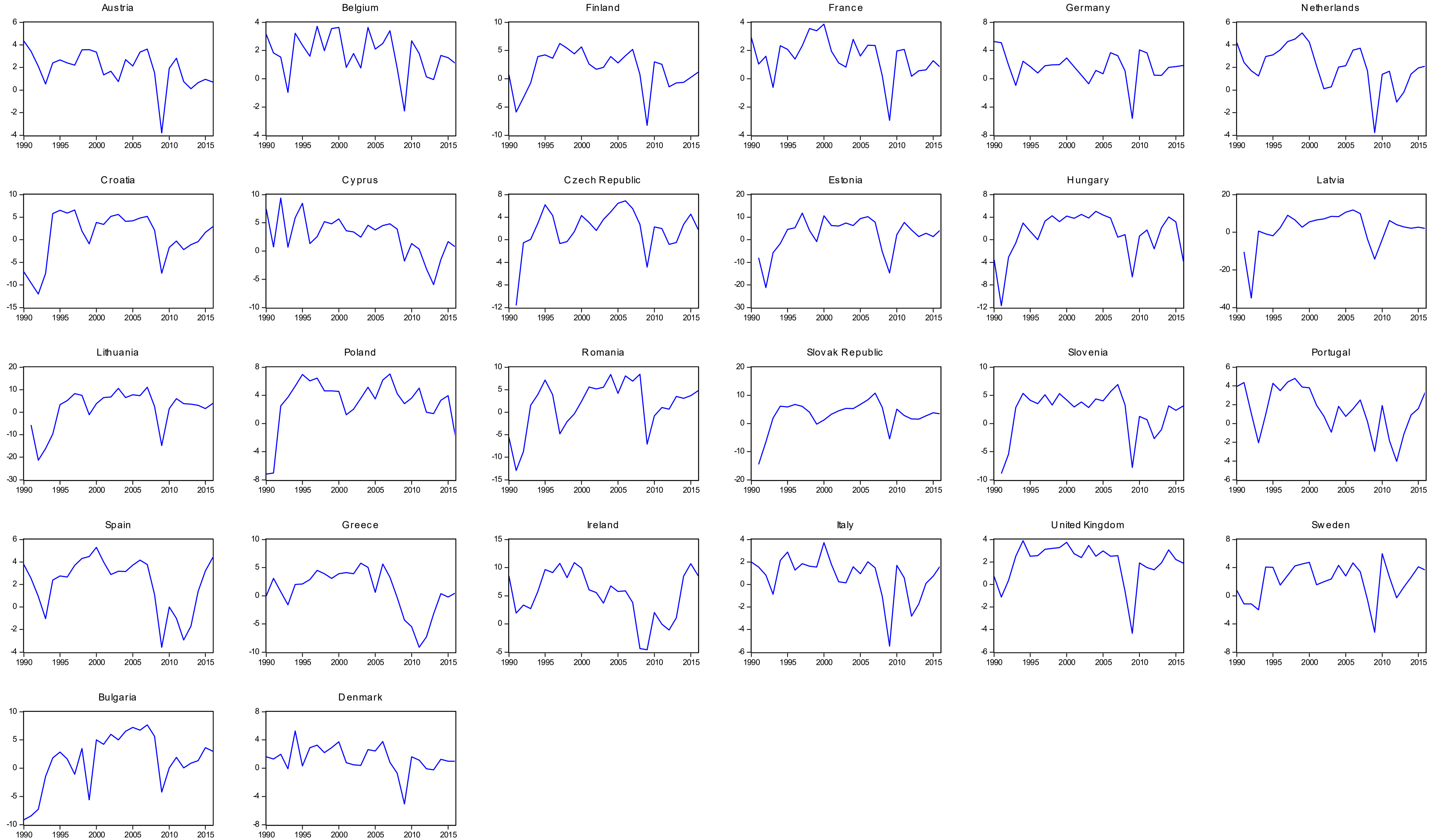


Figure 3.1 above illustrates the mean of *GDP* growth rate of 26 EU countries over the period 1990-2016. As the figure demonstrates, there is a sharp fall in 1991 and 1992, where the average declines from 1.9% to -1.4% (approximately -3.3%). Turning to figure 3.1, it can be easily observed that the growth rate from 1994 to 2007 is moving slightly over 4% and in 2007 it is slightly less than 5%. In the years 2008 and 2009, when the great recession broke out, the economic growth shrunk by around 6%. After 2009, the growth rate is close to 1.3%. Due to the continued recession and subsiding domestic demand, in 2012, growth drops (-0.4%) and remains slow until 2013 (0.3%). After 2014, even though signs of improvement have appeared and growth moves close to 2%, it seems that recovery remains uncertain and fragile and is not approaching the pre-crisis levels.

As seen in the individual cross-sectional graph (figure 3.2), the decrease in growth rate in the years 1991-1992 is from the transition economies. After their liberalization from the centralised socialist economic system, all these countries experienced budget deficits and hyperinflation, which in turn led-drastic falls in output and economic collapse. In particular, in 1991, the Czech Republic, Hungary, and Romania had approximately -12%, while in 1992, the outliers were from Latvia 35%, Lithuania -21.3% and Estonia -21%. After 1992, there is an upward trend, and Central-Eastern Europe and the Baltic states succeed in their early stabilization effects. Also, it is worth noticing that Estonia, Latvia, and Lithuania faced the most profound economic decline across all EU countries and reached approximately -14.7% in 2009.

Figure 3.2: The cross-section individual graphs for the mean of growth rate.



3.3.2 Figures of financial development measures

Figures of the Bank sector measures

Figure 3.3: The mean of liquid liabilities (LLY) as shared of GDP (%)

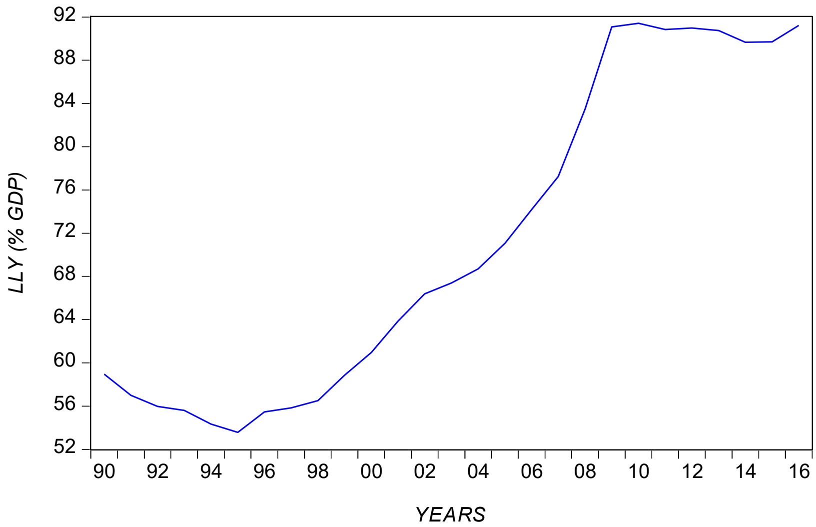


Figure 3.3 above shows the liquid liabilities shared to GDP of 26 EU countries. The degree of liquid liabilities had increased steadily over fourteen years (1995-2009), and the average value of 53.6% reached more than 91%. After the financial crisis, the average value did not exceed 91% and had been moving steadily at this level.

Figure 3.4 illustrates the individual cross-section of liquid liabilities in 26 EU countries. Aside from Cyprus, which have the highest share, UK, Germany, Netherlands, and Spain also have high ratios to GDP that are much more than 100%, while other countries have less than 100%. Transition economies have a lower ratio of liquid liabilities than the rest of European countries. Furthermore, the graph shows that Romania, Lithuania, and Slovenia are the countries with the smallest ratios.

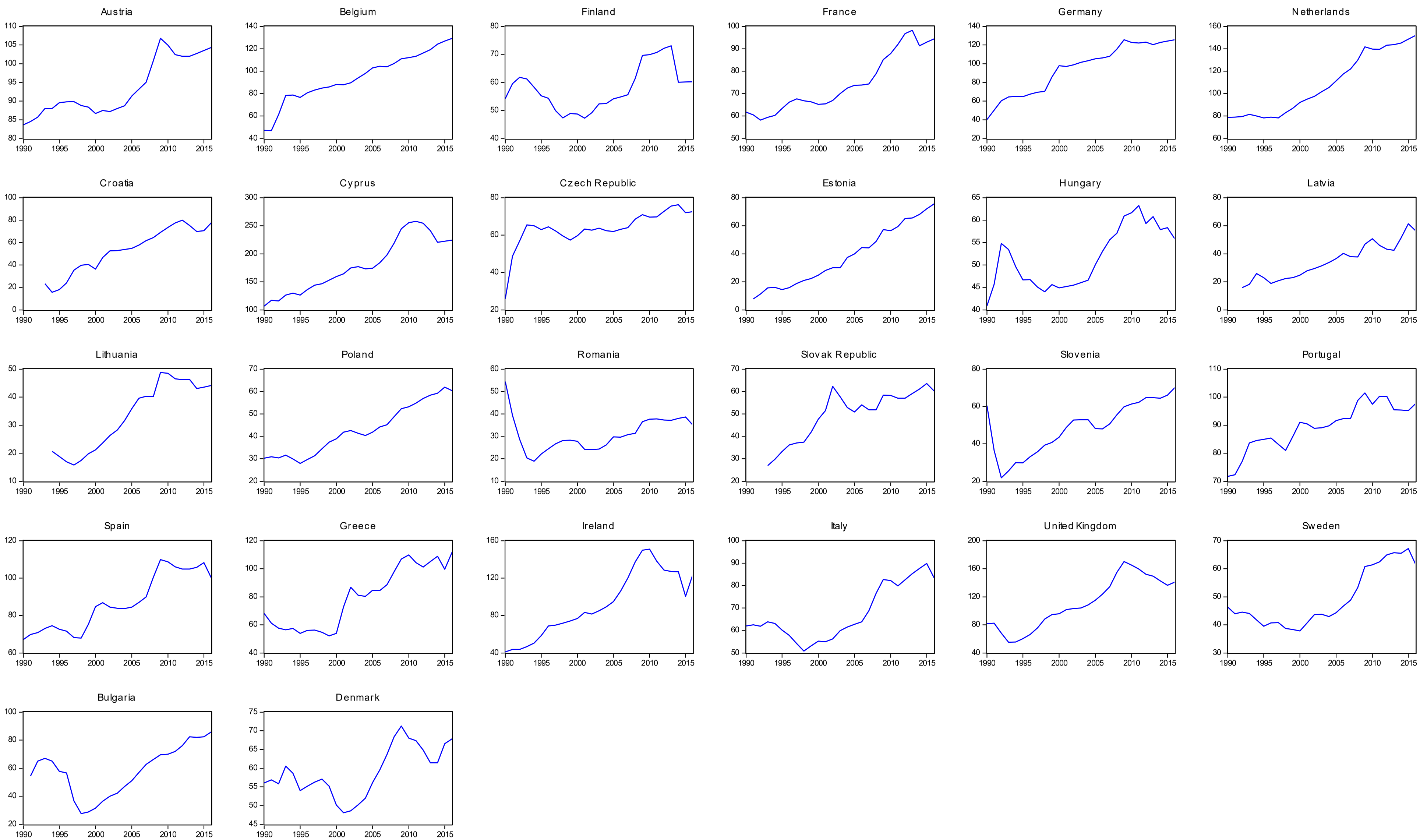


Figure 3.4: The cross-section individual graphs for the mean of LLY.

Figure 3.5: The mean of credit to private sector (PRIVY) as shared of GDP (%)

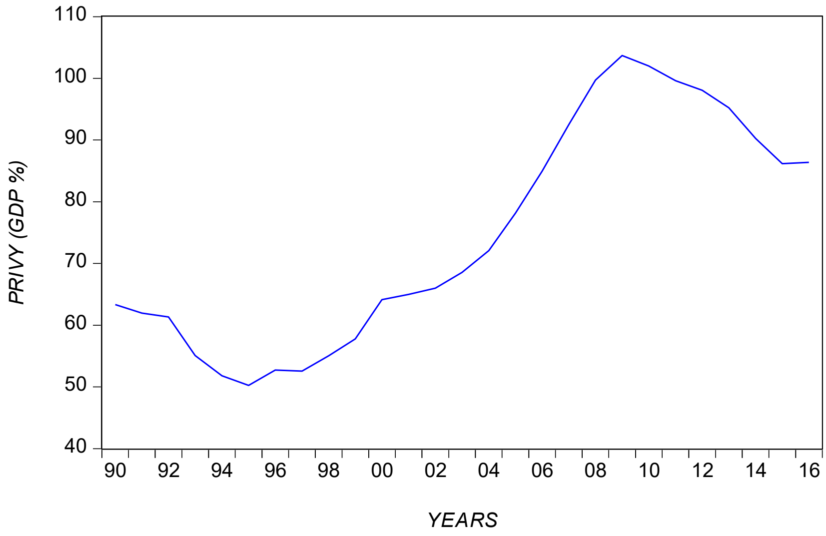


Figure 3.5 above shows the mean of credit to the private sector of 26 EU countries. A rapid expansion since 1995, reaching from 50% to 105% by end-2008, implies that bank credit was growing on an average annual rate of about 4 percent. Bank credit to the private sector slowed and by the end of 2009 turned negative, reaching from 105% by-end of 2016 to 86%. The average rate dropped at an annual rate of about 3%, slightly less than the rapid expansion in fourteen years.

Figure 3.6 illustrates the individual cross-section of credit to the private sector in 26 EU countries. Similarly to liquid liabilities, Cyprus presents the highest share, reaching from 213% in 2008 to 261% in 2013. UK, Spain, and the Netherlands also have high ratios to GDP that are much more than 100%, reaching 194%, 172% and 124% in 2009 respectively, while other countries have less than 100%. Transition economies have a lower ratio of liquid liabilities than the rest of European countries. Furthermore, the graph shows that Romania, Lithuania, and Slovenia are the countries with the smallest ratios Bank credit.

Figure 3.6: The cross-section individual graphs for the mean of PRIVY.

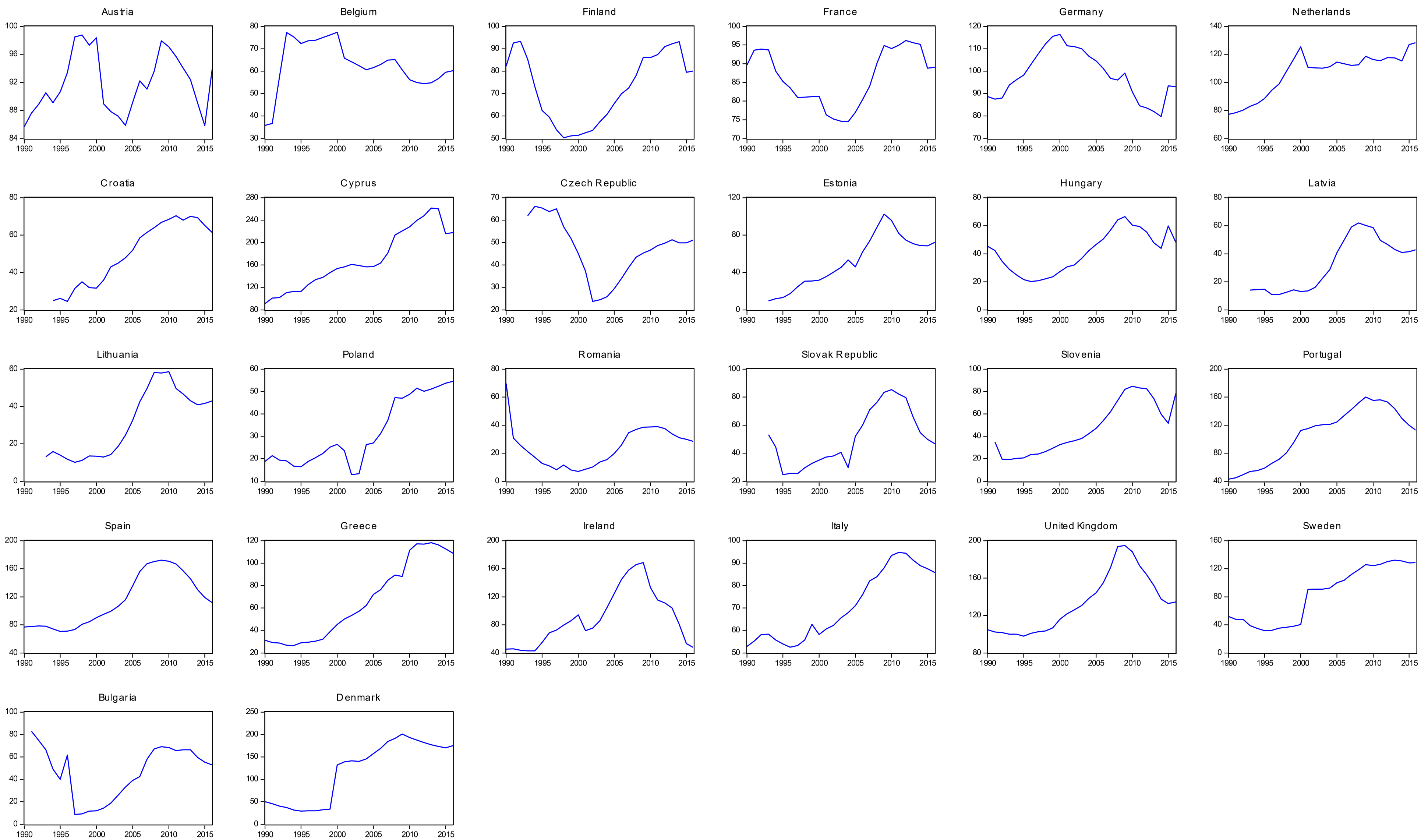


Figure 3.7: The mean of the total bank assets (BTOT %)

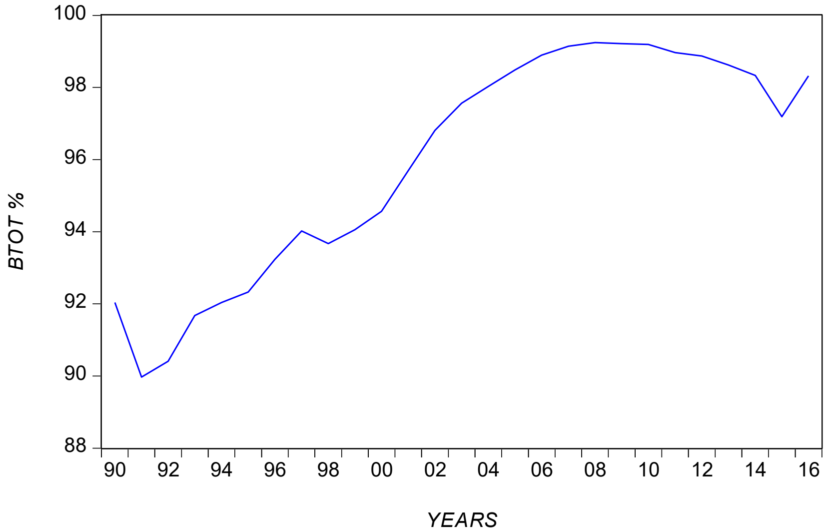


Figure 3.7 above shows the mean of the total commercial bank assets of 26 EU countries. Since 1992, the mean from 90% reached to 99% by -2006, and then the average moves slightly more than 99%. From 2010 slowed, reaching by-end of 2015 to 97.2%, and 98.3% in 2016. A directive of the European Parliament on deposit guarantee schemes requires all members to create deposit insurance for at least 90% of the deposited amount. The purpose was to prevent the bank runs from an insolvent bank.

Figure 3.8 illustrates the individual cross-section of commercial bank assets in 26 EU countries. Over the period 1991-1994, some of the transition economies presented low ratios. In particular, Hungary had the lowest ratio of 43% and Estonia 44% in 1991. Also, Poland had 68% in 1994. Other outliers of low ratios were from Greece in 1994, with a ratio by about 68%, Bulgaria by about 64% in 2000, and Ireland by about 81% in 2015.

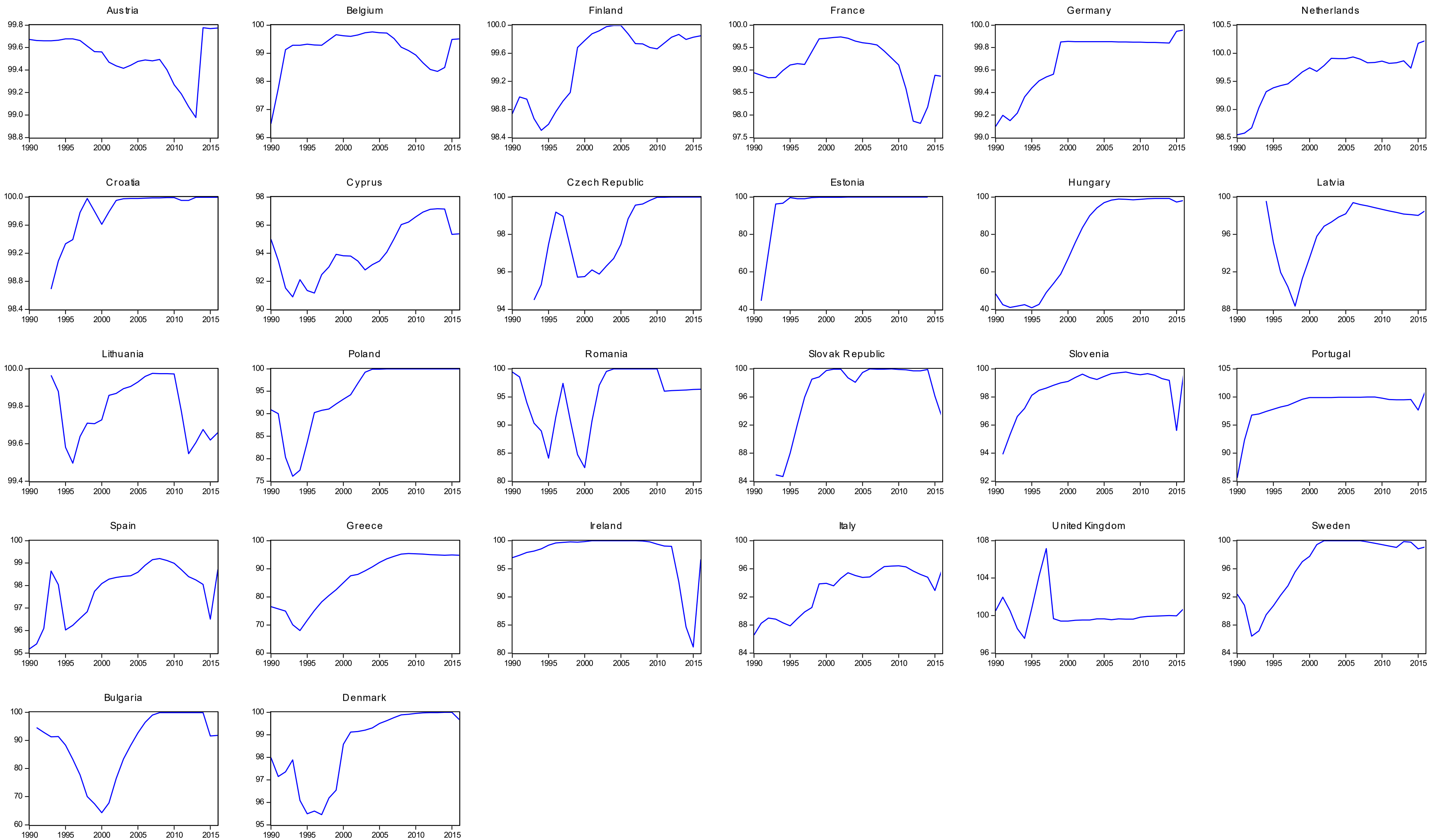


Figure 3.8: The cross-section individual graphs for the mean of BTOT.

Figures of the stock market sector measures

Figure 3.9: The mean of the stock market capitalisation (MCAP) as shared of GDP (%)

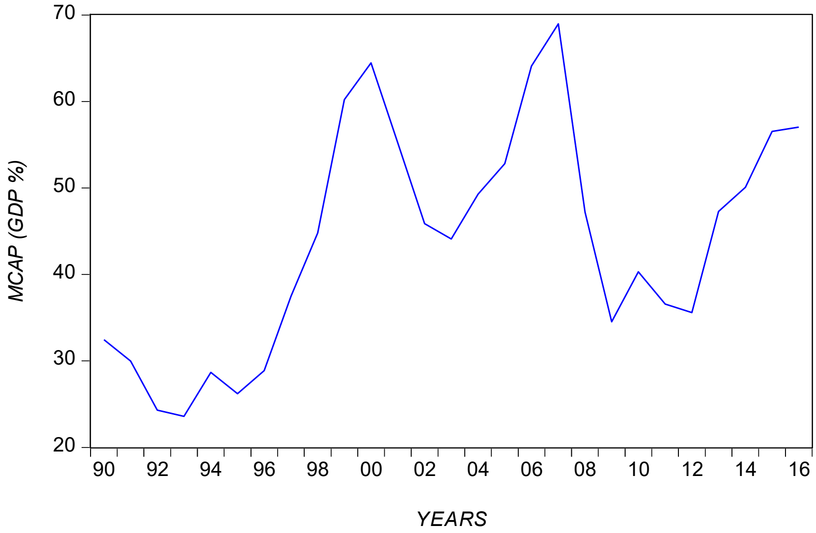


Figure 3.9 above illustrates the stock market capitalisation of 26 EU countries. As it is evident, in the years 1992 and 1993 the average is slightly more than 20% and by the end of 2000 reached 65%, and the main reason for the rapid growth might be the information technology bubble that was a period of extreme growth in the usage and adaptation of the Internet by businesses and consumers. Some other reasons might be the sharp fall in exchange rates in some Asian countries (1997-1999), the growth stimulus that was provided by the reductions in interest rates across European countries, and restrictive policies designed to reduce fiscal deficits to ensure compliance with economic and monetary union (EMU) entry criteria of 3% of GDP. In 2001, stock market prices took a sharp downturn, and many internet-based companies, commonly referred to as dot-coms, failed, and the bubble collapsed. Also, after the terrorist attack on the 11th of September on 2001, the market fell by about 20%, and the average of stock market capitalisation across European countries in 2003 reached 44%. Then the newly created currency area of the twelve participating European Union Member States created a rapid growth from 2002 until 2007 and reached to 69%. During the crisis, the stock market activity sharply declined to reach 35% in 2009 and moving by around the same level until 2012 reached 57% in 2016.

Figure 3.10 illustrates the cross-section individual *MCAP* and the majority of transition economies move around 40%, with the lower rate in Latvia, where the ratio does not exceed 14%. The higher ratio becomes from North-west countries, where the ratio exceeds 40%. The outliers as shown from the graph, are from Spain in 1999 (198%), Finland and UK in 2000 (238%, 171% respectively), and the Slovak Republic in 2006 (210%).

Figure 3.10: The cross-section individual graphs for the mean of MCAP.

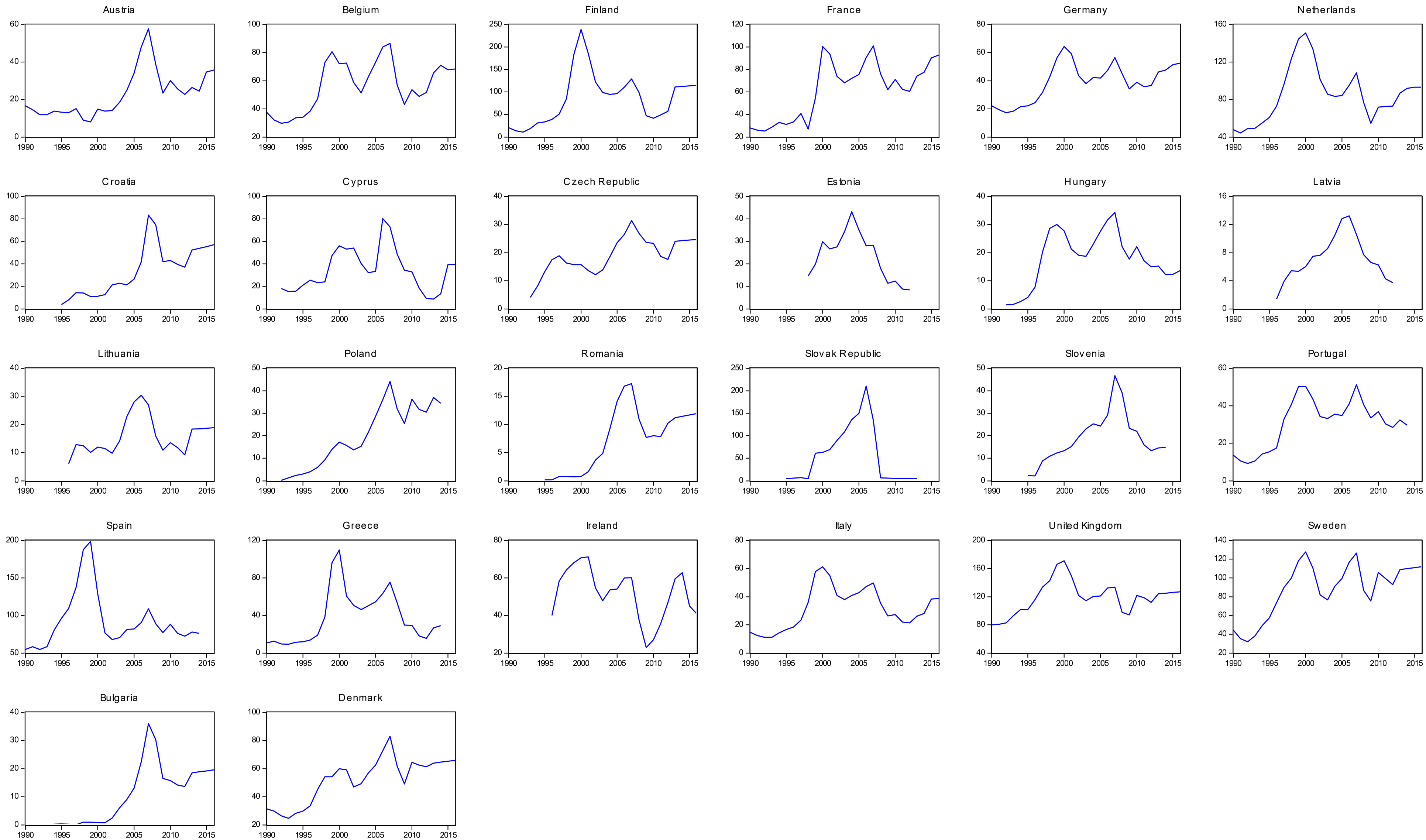


Figure 3.11: The mean of the total value traded (TVT) as shared of GDP (%)

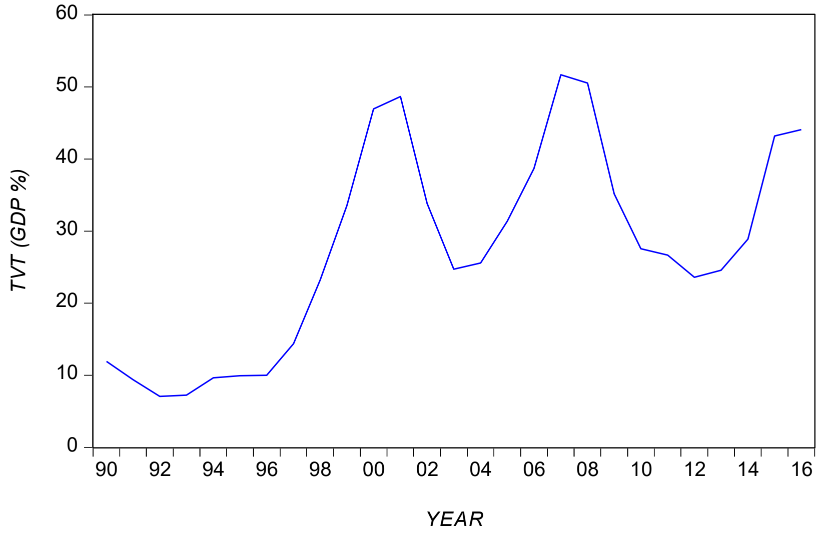


Figure 3.11 above illustrates the total value traded of 26 EU countries. As it is demonstrated in the years 1992 and 1993 the average is 7%, while in 1994 and 1995 is 10%. The reasons are the same as those of the stock market capitalisation. Then, by the end of 2001, an expansion of reached 49%. After 2001, the total value traded fell by about 24%, and the average across European countries in 2003 reached 25%. Then it was increased until 2007 and reached to 52%. From 2007 and after the crisis, the stock market activity sharply declined to reach 35% in 2009, and 24% in 2012. After 2012, there is a recovery, and the recent ratio of total value traded reached 48% in 2016, which is 4% less than the 2007 level.

Figure 3.12 illustrates the cross-section individual of total value traded and the majority of transition economies move around 40%, with the lower rate in Latvia, where the ratio does not exceed 12%. The higher ratio becomes from North-west countries and Spain, where the ratio exceeds 40%. The outliers as shown from the graph, are from Spain in 1999 (198%), Finland and UK in 2000 (238%, 171% respectively), and the Slovak Republic in 2006 (210%).

Figure 3.12: The cross-section individual graphs for the mean of TVT.

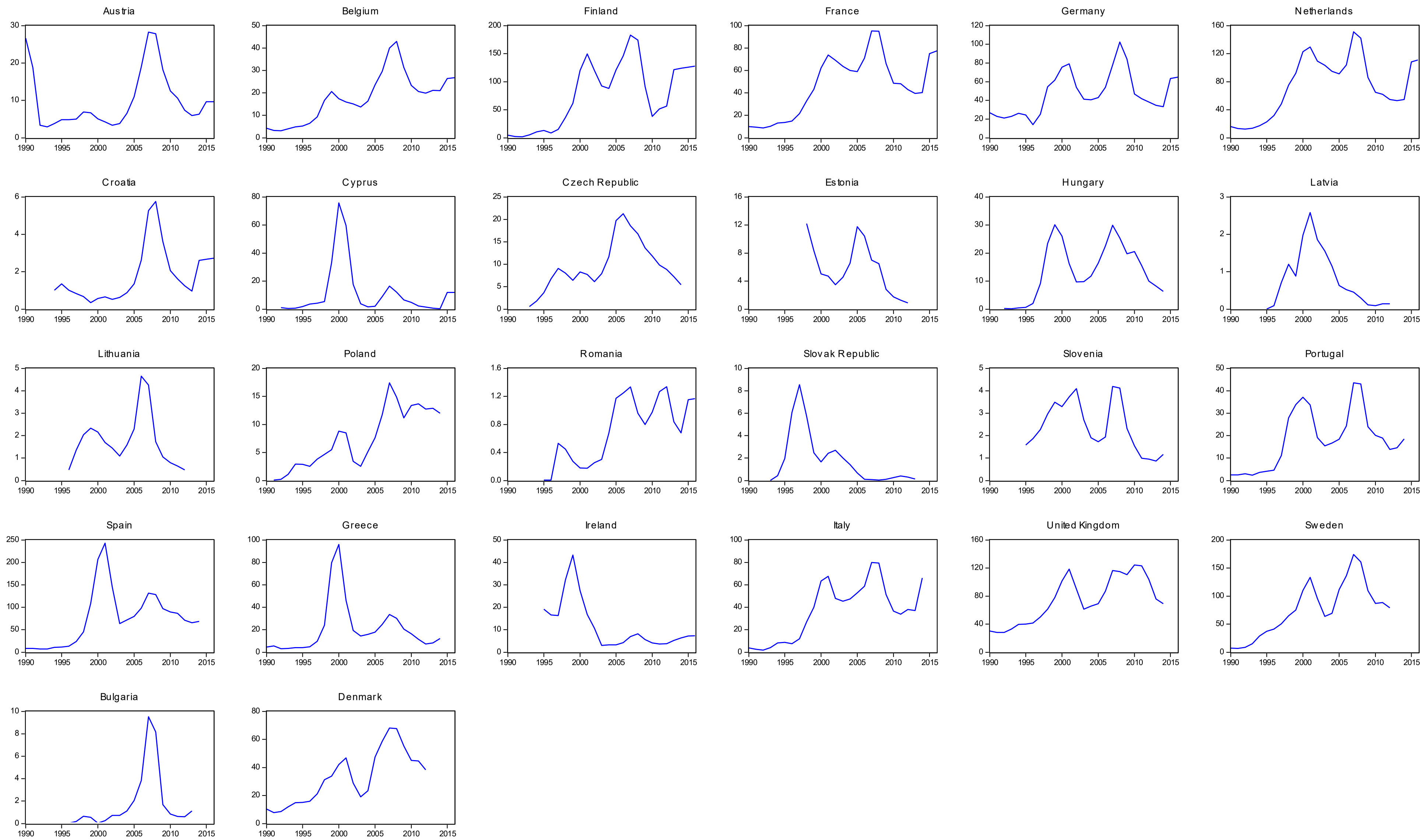


Figure 3.13: The mean of the turnover ratio (TOR%)

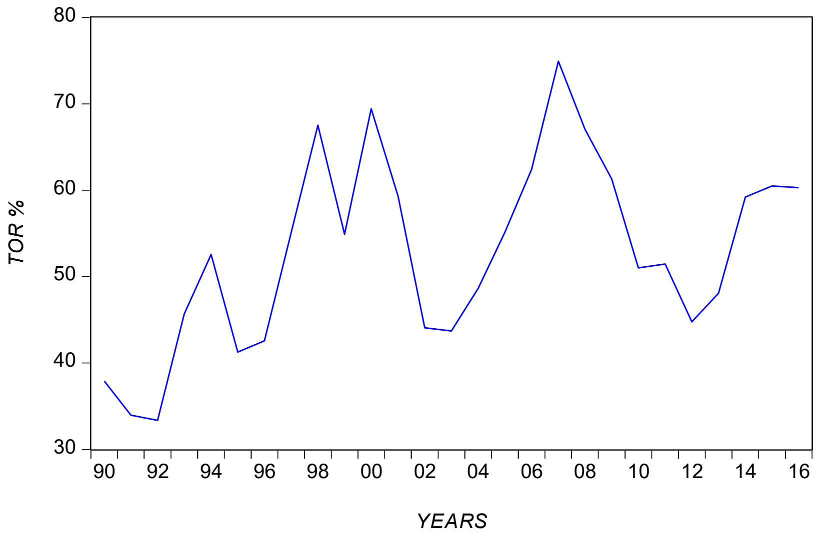
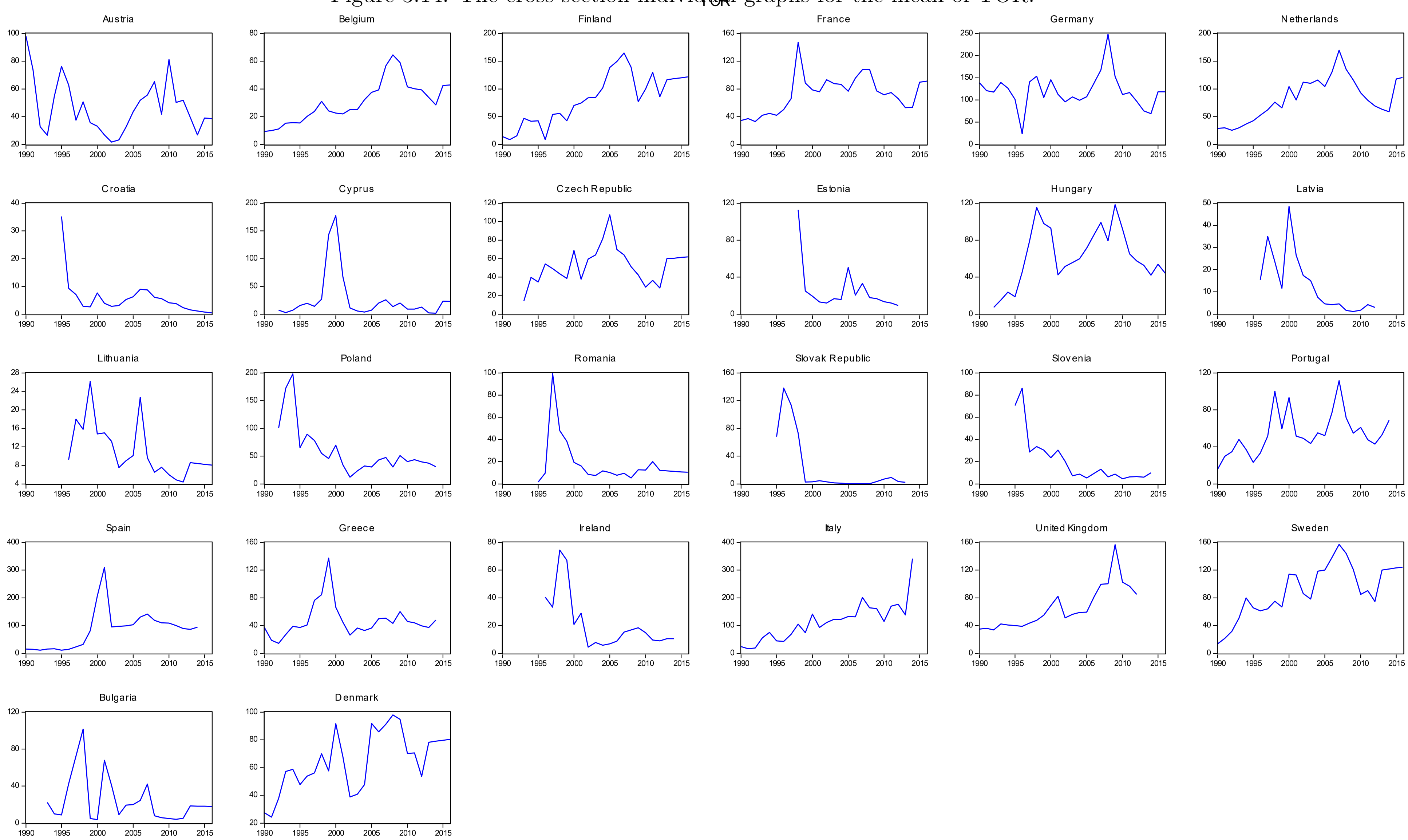


Figure 3.13 above shows the stock market turnover ratio of 26 EU countries. It is evident that from 1992, where the ratio was 33%, in 2000 reached 69%. After 2000, the ratio fell by about 25%, and the average across European countries in 2002 reached 44%. Then a rapid growth achieved until 2007 and reached to 75%. From 2007 and after the crisis, the stock market liquidity declined to reach 45% in 2012. After 2012, there is rapid growth, and the recent ratio of stock market turnover ratio reached 60% in 2016.

Figure 3.14 illustrates the individual cross-section of stock market turnover ratio. As previous stock market development variables, the majority of transition economies move at the lower level. The outliers as shown from the graph, are from Poland in 1994 (198%), Slovakia in 1996 (138%), Germany in 1997 (141%), France in 1998 (147%), Cyprus in 2000 (177%), Spain in 2001 (310%), Finland, Netherland, UK, Sweden in 2007 (around 160% to 170%), Germany in 2008 (248%), and Italy in 2014 (341%).

Figure 3.14: The cross-section individual graphs for the mean of TOR.



3.3.3 Figures of the control-macroeconomic variables

Figure 3.15: The mean of the inflation rate (INFL%)

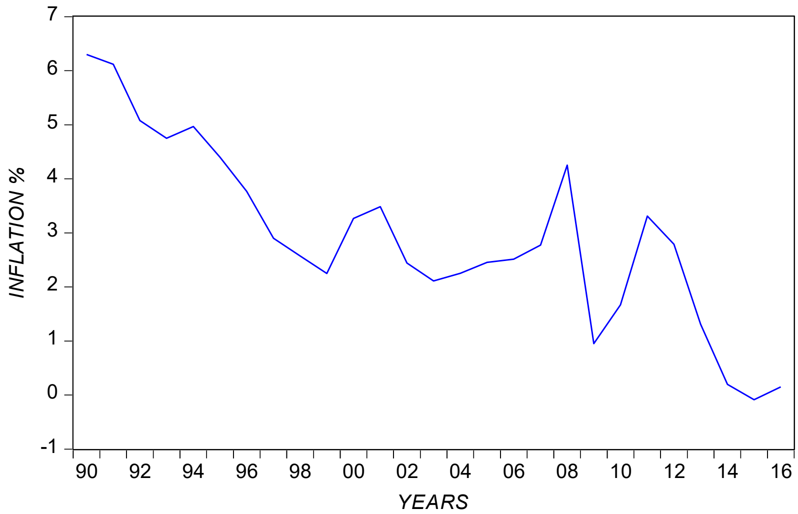


Figure 3.15 illustrates the mean of the inflation rate of 26 EU countries. As can be seen it is obvious that inflation rate declines from approximately 7% in 1990 to 2.1% in 2003. Apparently, there are some fluctuations before and after 2001 where the rate arrived 3.5%, and before after 2008, where it reached 4.3%. Between 2009 and end-2011, inflation rate was expected to be lower (around 1%), given the severity and length of the recession. After 2012, it has been persistently low despite the progressive economic recovery, and this might be mostly related to the fall in the price of oil since 2011. Since mid-2014, the fall of inflation rate has become even more severe and is moving around 0.2%.

Turning now to the cross-sections individual graph (3.16) the most extreme observations (outliers) are in Central-Eastern and Baltic countries and specifically in Poland (600% in 1990) and Bulgaria (1200% in 1997). Indeed, excessively high inflation rates in a large number of countries in the sample is a useful information and deletion of outliers is controversial.

Figure 3.16: The cross-section individual graphs for the mean of inflation rate (INFL).

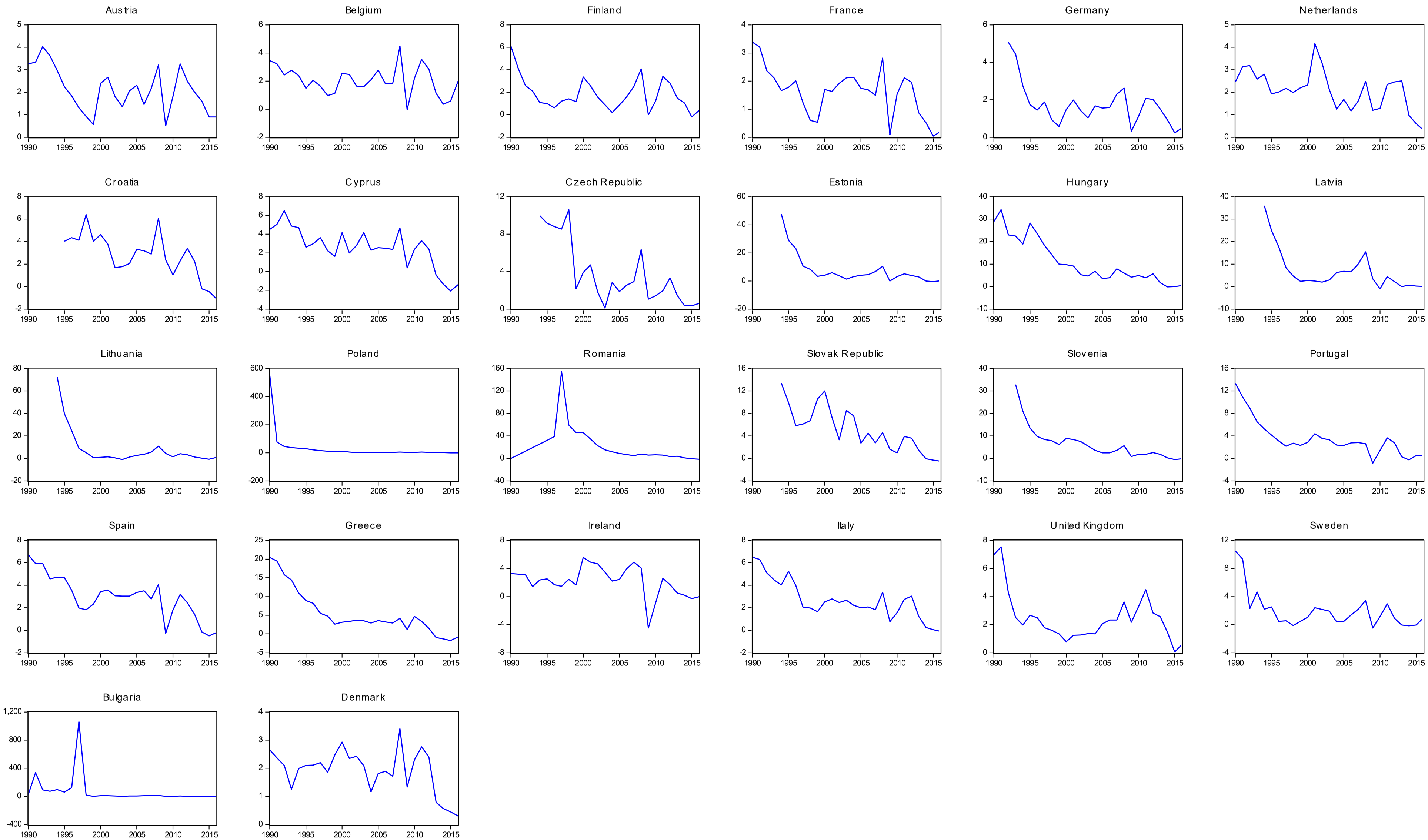


Figure 3.17: The mean of the net foreign direct investments (FDI) as shared to GDP (%)

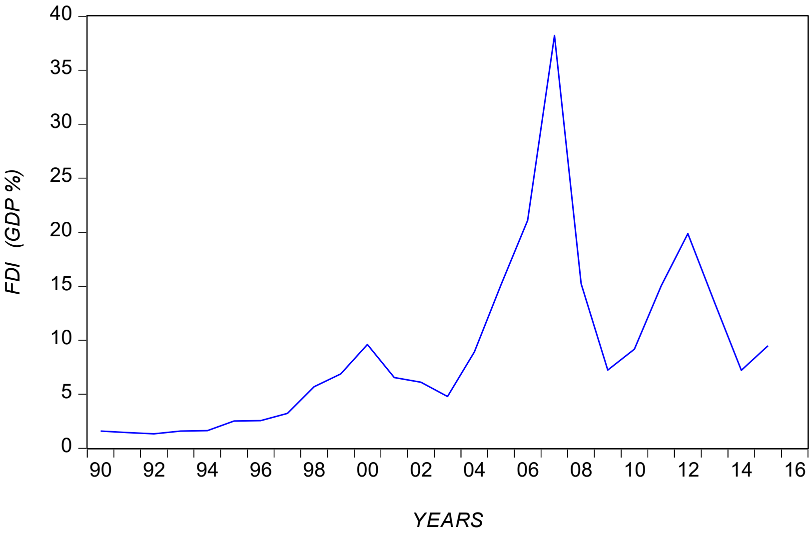


Figure 3.17 above shows the mean net foreign direct investments of 26 EU countries. As demonstrated from the graph, *FDI* presents an upward trend from 1990 (1.6%) to 2000 (9.6%), and as evidenced in figure 3.18, the increase may be partly due to higher investments in transition economies. Also, in the cross-section individual graphs (3.18), can easily be observed an extreme observation in Netherlands (approximately 700%) in 2007. This occurred due to the takeover of ABN AMRO (Algemene Bank Nederland-Amsterdam Rotterdam Bank) bank from the consortium (Royal Bank of Scotland Group PLC and Banco Santander) of foreign banks, which boosted *FDI* inflows into the Netherlands. By 2007, ABN AMRO was the second-largest bank in the Netherlands and the eighth-largest in Europe by assets.

Figure 3.18: The cross-section individual graphs for foreign direct investments for the mean of (FDI).

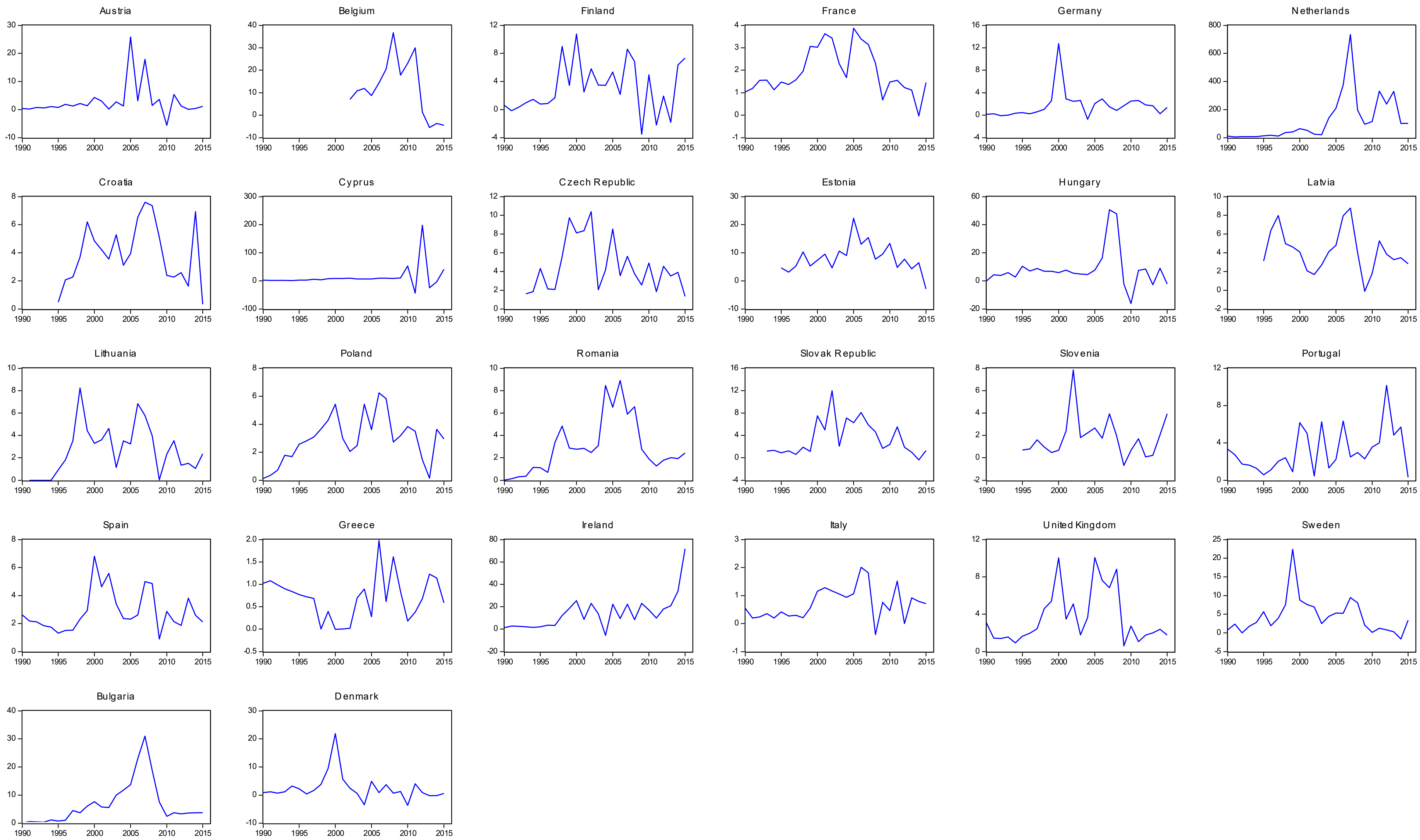


Figure 3.19: The mean of the trade openness (OPEN) as shared to GDP (%)

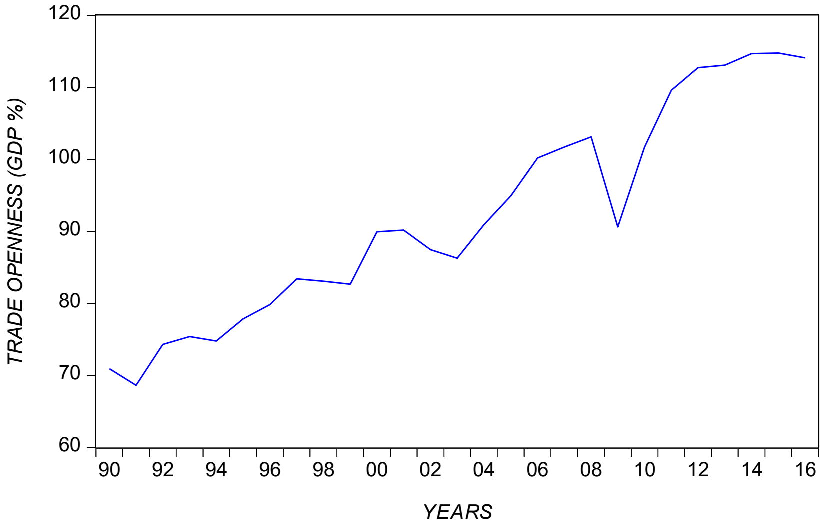
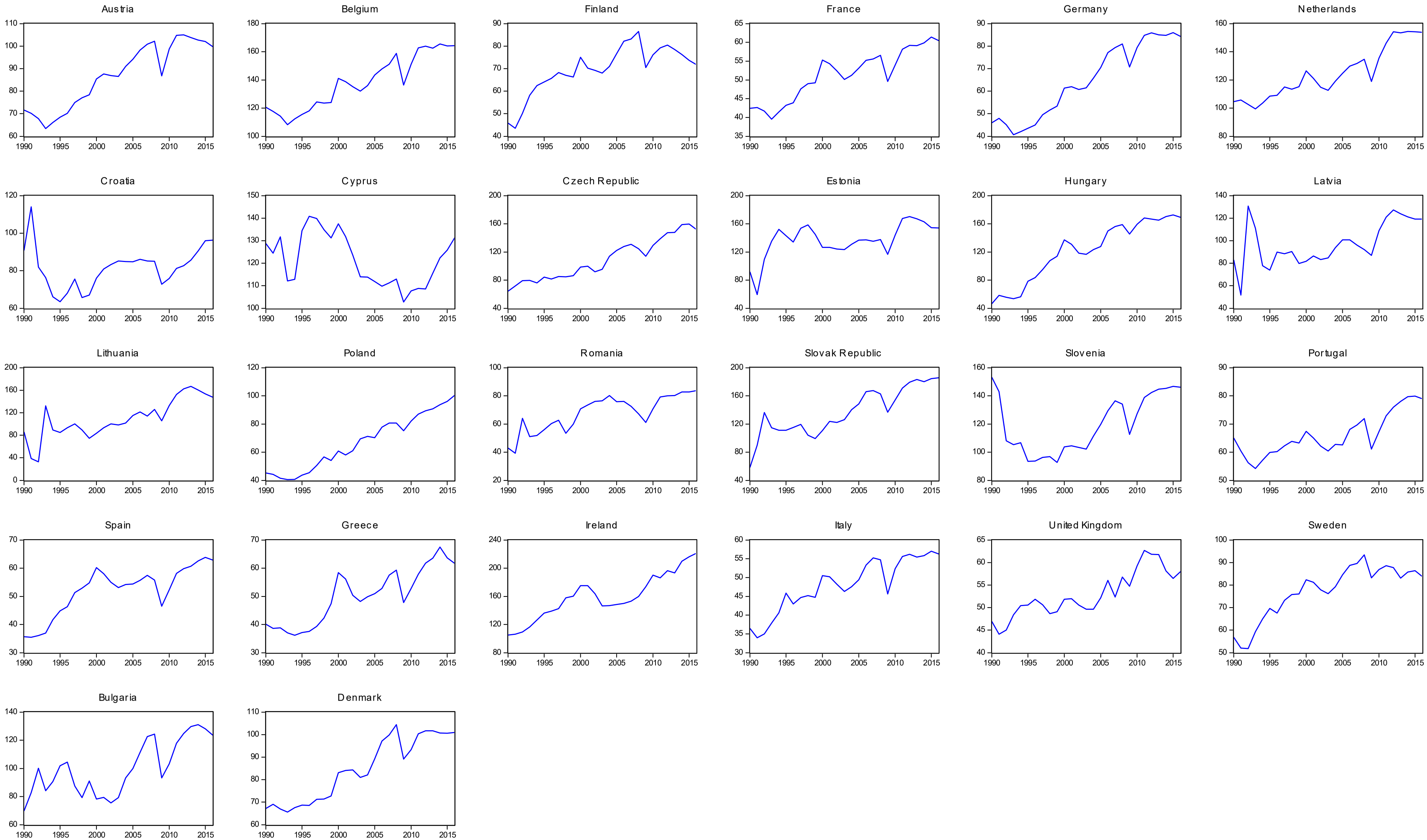


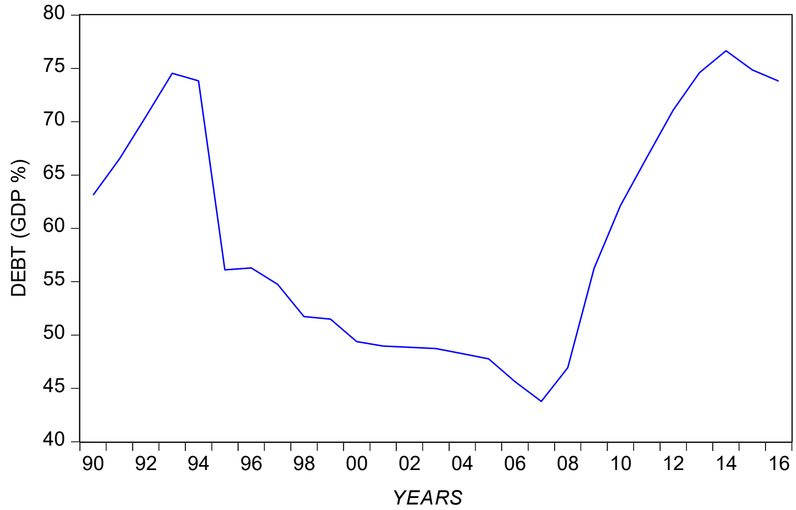
Figure 3.19 above shows the trade openness (OPEN) as shared to *GDP (%)* of 26 EU countries. As shown by the upward trend, 70% in 1990 and 103% in 2008, the ratio of trade to *GDP*, has grown for most EU countries as a result of globalisation and trade liberalisation. Also, transition economies that have become members of the EU have encouraged the role of the private sector through strong privatization programs and opened up their economy to international trade. Moreover, as was expected, there is a sharp drop in 2009 by 12%, as the trade to *GDP* reached to 91%, but shortly after the full recovery took place and the international trade reached to 114% of *GDP* in 2016.

Figure 3.20: The cross-section individual graphs for the mean of trade openness (OPEN).



3.3.4 Figures of the fiscal policy measures

Figure 3.21: The mean of the government debt as shared to GDP (%)



The graph above illustrates the government debt of 26 EU countries. As it is evident, in the years 1990 to 1993 the average from 63% raised to 75%, while two years after sharply declined to 56% and in the early of 2000 reached 49.5%. In 1992, the countries-members of the European Union signed the Maastricht Treaty in 1992, under which they pledged to reduce their budget deficit and debt levels. However, in the early 2000s, some EU member states were failing to stay within the confines of the Maastricht criteria and turned to securitizing future government revenues to reduce their debts to the lowest average level of 44% in 2007. After the financial crisis, several European countries experienced the collapse of financial institutions, high government debts, and rapidly rising bond yield spreads in government securities. The sovereign debt crisis peaked between 2008 and 2014, where the average reached 76.6%. After 2014 the average is slightly less than 74%, and the main reason of this reduction of public debt might be the policy of buying government bonds and other public assets designed to boost the economy for the Eurozone countries, which are 19 countries out of 26 in the sample.

Figure 3.21 illustrates the cross-section individual *DEBT* and the lowest average of debt is displayed in transition economies moving around 40%, with the lower rate in Estonia not exceeding 10% in 2016. The higher ratio becomes from South countries, where the ratio exceeds 87%, while for North-West countries, the average debt is approximately 63%. The outliers, as shown from the graphs, are from Greece in 2016 (181%), followed by Italy 133% and Portugal 130% in 2016 as well. It is worth noticing that Ireland reduced the debt from 120% in 2012 to 75% in 2016.

Figure 3.22: The cross-section individual graphs for the mean of government debt.

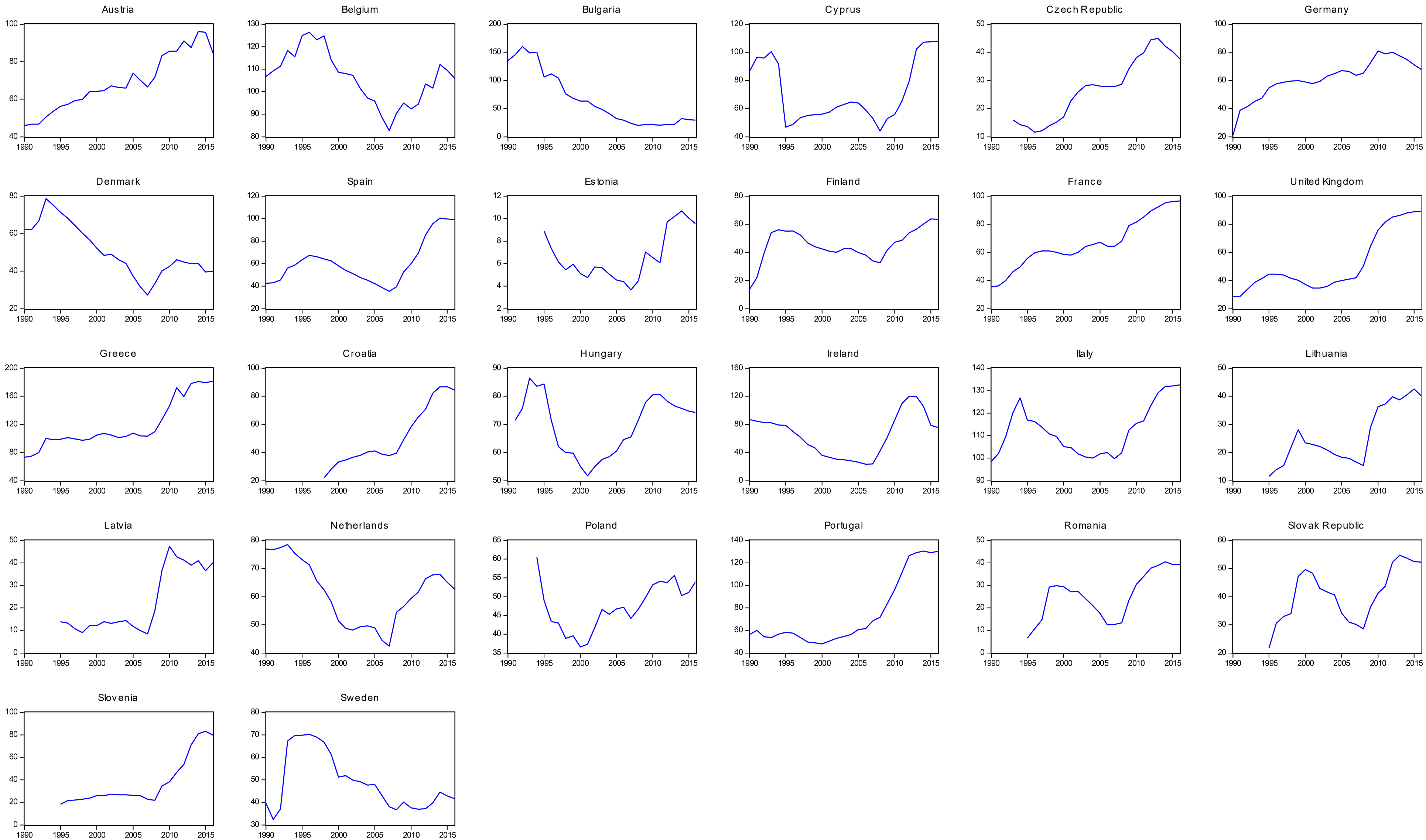


Figure 3.23: The mean of the government expenditures as shared to GDP (%)

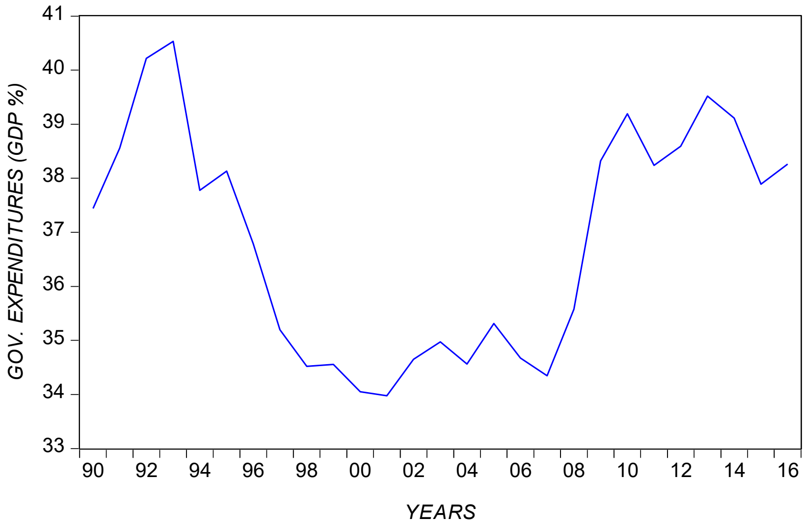


Figure 3.23 above illustrates the mean of government expenditures of 26 EU countries. Similarly to public debt, in the years 1990 to 1993 the average from 37.5% raised to 40.5%, while in the early of 2000 reached 34%. As described in the previous graph, the main reason is the implementation of the Maastricht Treaty criteria (also known as the convergence criteria), under which they pledged to limit their deficit spending as well as the private funding of a significant part of social services influence the structure and the amount of government spending. However, after the financial crisis, public expenditures peaked between 2008 and 2013, where the average reached approximately 40%. After 2014 the average is 38.3%, and the main reason for this reduction of public expenditures might be the priority of governments to reduce the budget deficits and in turn the public debt.

Figure 3.24 illustrates the cross-section individual *Government expenditures* and the lowest average is illustrated in transition economies moving around 32%, with the lower rate in Estonia and the ratio did not exceed 3% in 2016. The higher ratio becomes from South countries, where the ratio is approximately 40%, while for North-West countries the average public spending is slightly less than 39%. The outliers, as shown from the graphs, are from Croatia in 2014 (87%), followed by Greece 60% in 2013, and Ireland 62% in 2010.

Figure 3.24: The cross-section individual graphs for the mean of government expenditures.

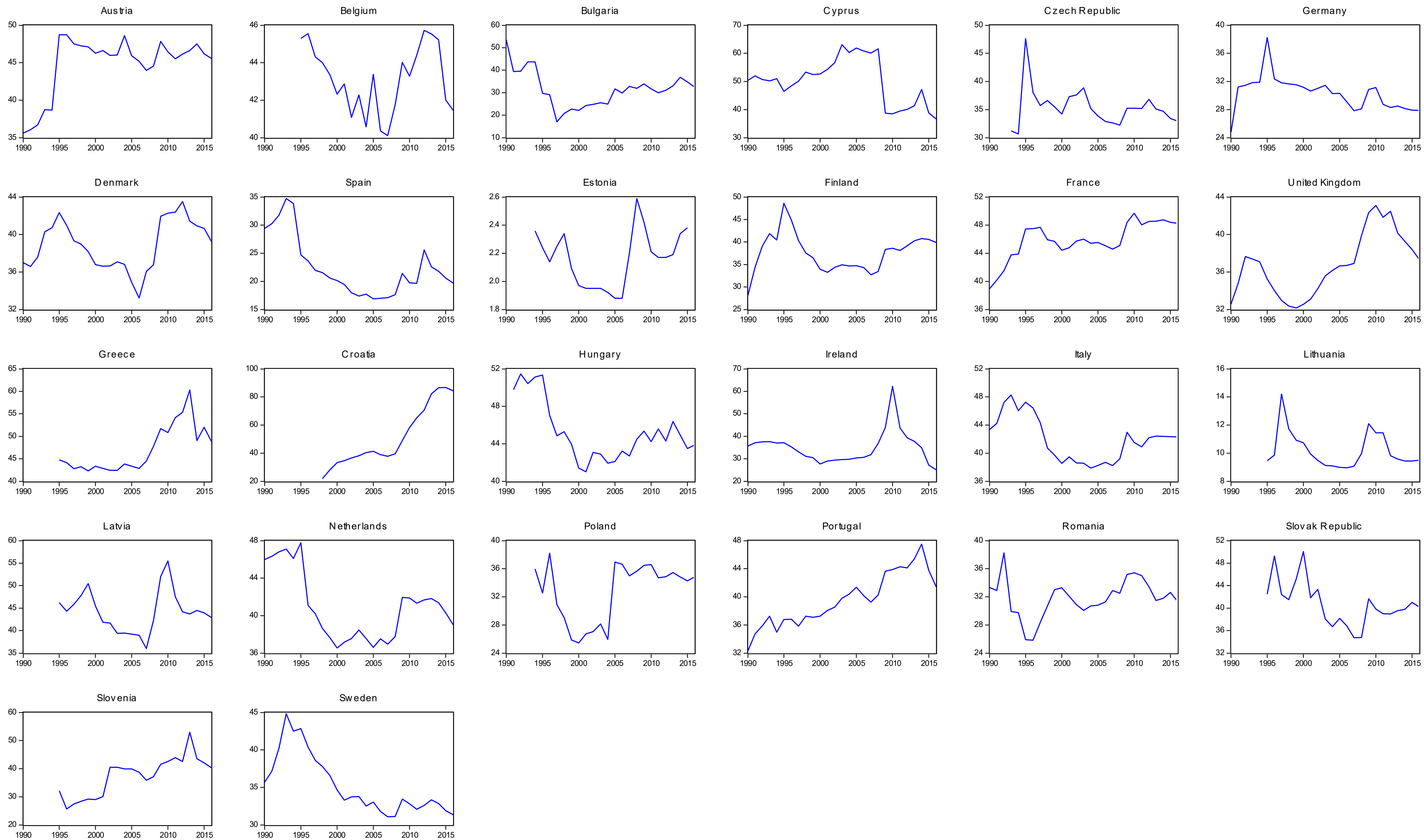


Figure 3.25: The mean of the taxrevenues as shared to GDP (%)

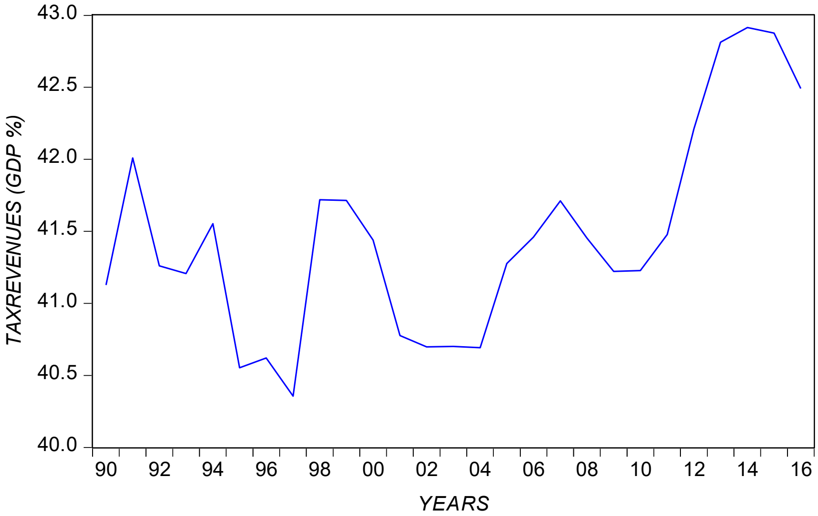
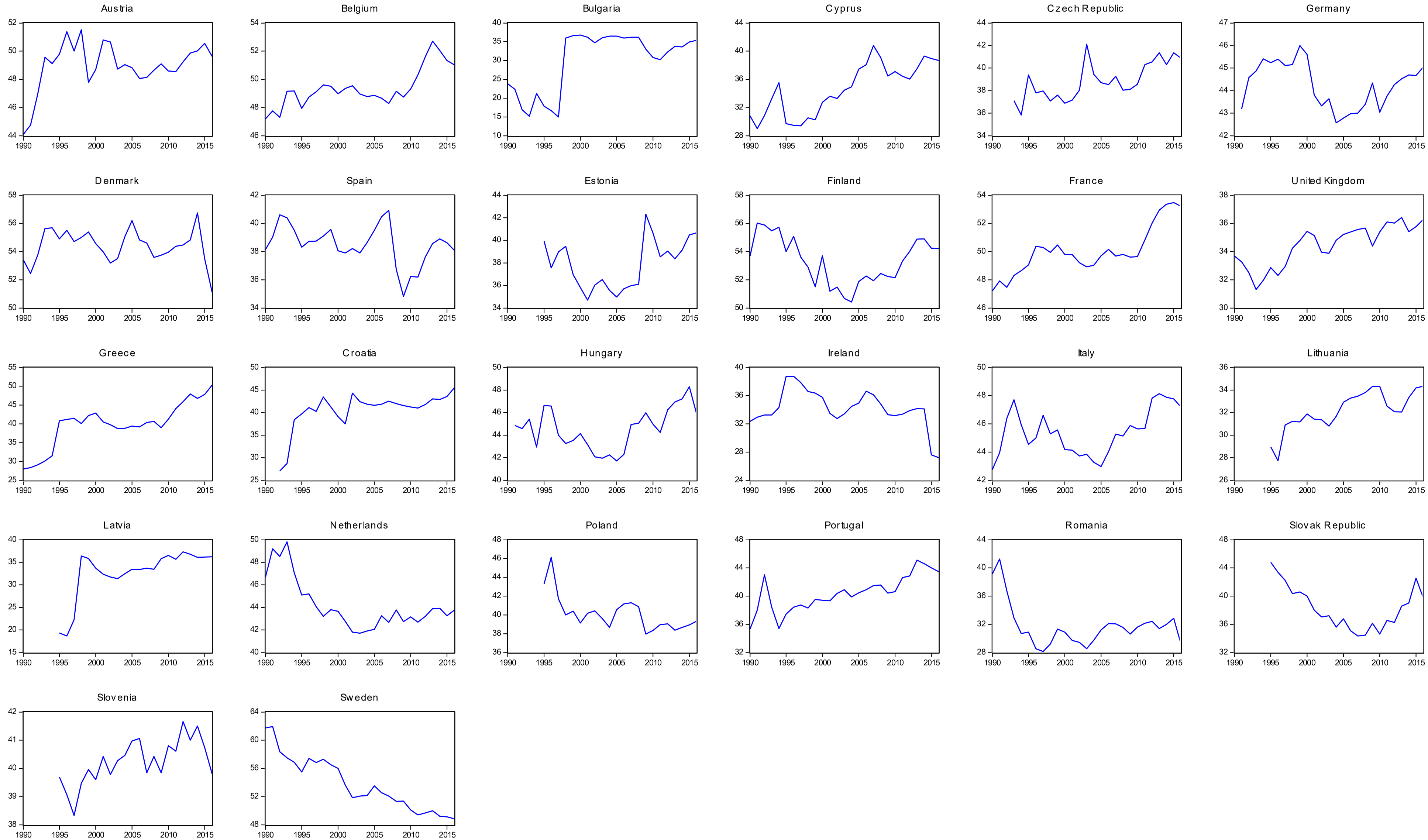


Figure 3.25 above illustrates the mean of tax revenues of 26 EU countries. It is evident, in the years 1990 to 2011, the average moves around 40% to 42% and reached in 2016 42.5%. The diagram 3.26 illustrates the cross-section individual *Taxrevenues*, and the lower average is presented in transition economies moving around 37%. The higher average becomes from North-West countries, which is around 77.6%, while for South countries the average tax revenues are approximately 40%. The outliers, as shown from the graphs, are from Finland 54% in 2016, followed by Denmark 51%, Greece 50%, Sweden 49%, and Italy 48% in 2016 as well. It is worth noticing that Ireland has the lowest ratio of tax revenues, 27% and Romania 29% both in 2016.

Figure 3.26: The cross-section individual graphs for the mean of taxrevenues.



Chapter Four

Methodology

4.1 Introduction

This chapter describes the estimation techniques that will be employed to compute the estimates of the parameters of the econometric models. The models are outlined and explained using equations, noting any weaknesses in the approach. In particular, it describes important features of panel analysis and the advantages and disadvantages of working with panels.

The simplest way to deal with panel data is to estimate a pooled regression, which involves estimation of a single equation on all data together as described in details in section 4.2 below. Pooling the data, it is implicitly assumed that the average values of the variables and the relationship between them are constant over time and across all cross-sectional units in the sample. While this is a simple way to proceed and requires as few parameters as possible, it has some severe limitations. Indeed, it can be estimated separately by employing time-series regressions of each country, but this may be a sub-optimal way to proceed since this approach does not take into account any common structure present in the series of interest. Alternatively, it can be estimated separately by employing cross-sectional regressions for each of the periods, but again this may be not wise if there is common variation in the series over time.

According to Baltagi (1997) and Hsiao (2014), the important advantages of making full use of panel data structure are:

- First, the techniques of panel data estimation can take into account the individual heterogeneity by allowing subject-specific variables.
- Second, it can be addressed a broader range of issues and deal with more complex problems with panel data than would be possible with pure time series or pure cross-sectional data alone.

- Third, it is often of interest to explore how variables change over time. Thus, using pure time-series data would usually require a long run of data to get a sufficient number of observations to conduct meaningful hypothesis tests. By combining time-series and cross-sectional data, the number of degrees of freedom can be increased, and thus the power of tests.

- Four, employing the dynamic behaviour of a large number of countries at the same time, introduces additional variation which can help to mitigate problems of multi-collinearity that may arise if time series are modelled individually.

- Five, by appropriately structuring the model, the impact of certain forms of omitted variables bias in regression results can be removed.

Asteriou and Price (2001) argue that the basic idea behind panel data analysis is that the individual relationships will all have the same parameters, which is known as pooling assumption. Then, if the pooling assumption is correct, panel data estimation can offer the following considerable advantages:

- First, an increase in the number of observations.

- Second, pooling several periods of data increases the precision in estimation.

- Third, the problem of omitted variables, which may cause biased estimates in a single individual regression, might not occur in a panel context.

The disadvantage of panel estimation is that if the pooling assumption is not correct, there may be problems, which are often referred to a heterogeneous panel (because the parameters are different across the cross-sections), and usually the panel data estimator would be expected to give a representative average estimate of the individual parameters. Also, in the case of pooled data, the residuals are not assumed as serially correlated when we apply a regression analysis. In the case of panel data, it cannot be assumed that the observations are independently distributed across time, and the serial correlation of regression residuals becomes an issue. Thus, panel data studies must be prepared that unobserved factors while acting differently on different cross-sectional units, may affect the same statistical unit when followed through time. This makes the statistical analysis of panel data more difficult. However, panel data provide useful information on individual behavior both across time and across individuals and this major advantage is analyzed more detailed in the linear panel data models.

The remainder of this chapter presents the methodological approaches employed for the empirical investigation of the data. Section 2 of this chapter describes the panel data estimation methods, including the linear panel models, pooled OLS models as well as the fixed and random effects methods. Section 3 describes the diagnostic test used for panel data methods, namely the Hausman test and section 4 presents the correlation analysis including multicollinearity test. In section 5 is analysed the cross-sectional dependence tests, while section 6 describes the testing for stationarity, including panel unit root tests in order to examine which of the variables are stationary or non-stationary. Section 7 presents the panel cointegration tests to examine if the series has a long-run equilibrium. In section 8, the dynamic panel models are described including the pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE). Finally, section 9 presents the multivariate factor analysis, including the principal component analysis (PCA).

4.2 Panel data models

4.2.1 Linear panel models

The panel data set is formulated from a sample that contains N cross-sectional units (for example, countries) that are observed at different T time periods. A simple panel linear model with one explanatory variable is given as below:

$$Y_{it} = \alpha + \beta X_{it} + \boldsymbol{u_{it}} \tag{4.1}$$

where α is the constant and β is the coefficient of the independent variable X. The dependent variable Y and the independent variable X have both i and t subscriptions for $i = 1, ...N$ and $t = 1, ...T$; time periods. If the same sample set consists of a constant T for all cross-sectional units, then the data set is called balanced. Otherwise, when observations are missing for the periods of some of the cross-sectional units, then the panel is called unbalanced. In this simple panel, the coefficients α and β do not have any subscripts, suggesting that are same across all units and for all years. By relaxing the rule that the constant α is identical for all cross-sections, it is introduced some degree of heterogeneity. For better understanding, consider a case where the sample includes different subgroups of countries, and that differences are expected in their behaviour. Thus, the model becomes:

$$Y_{it} = \alpha_i + \beta X_{it} + \boldsymbol{u_{it}} \tag{4.2}$$

where α_i can now differ for each country in the sample. There are different methods of the panel data models estimation. In general, linear panel data models can be estimated using three different methods.

1. Pooled OLS method of estimation (also called with common constant)

2. Allowing for fixed effects

3. allowing for random effects

4.2.2 Pooled OLS model

The pooled OLS model, also known as the common coefficient model, has a common constant and implies that there are no differences between the estimated cross-sections. The principal assumption of the pooled OLS method is that the model estimates a common constant for all cross-sections. This assumption is useful under the hypothesis that the data set is a priori homogeneous. Thus a *pooled model* is the most restrictive model because it specifies constant coefficients, and is given as below:

$$Y_{it} = \alpha + \boldsymbol{\beta}' \boldsymbol{X_{it}} + \boldsymbol{u_{it}} \tag{4.3}$$

where Y_{it} is the dependent variable, α is the intercept term, $\boldsymbol{\beta}$ is a $\kappa \times 1$ vector of parameters to be estimated on the explanatory variables, and $\boldsymbol{X_{it}}$ is a $1 \times \kappa$ vector of observations on the explanatory variables, $t = 1, ...T$; $i = 1, ...N$. The way to deal with such data would be to estimate a pooled regression, which involves the estimation of a single equation on all the data together. Thus, the data set for y is stacked up to a single column containing all cross-sectional and time-series observations, and similarly, all the observations on each explanatory variable are stacked up to single columns in the X matrix. Then this equation would be estimated employing the usual OLS method. In this simple panel, the coefficients α and $\boldsymbol{\beta}$ do not include any subscripts, denoting that they are same across all units and all years.

Aditionally, if this model is correctly specified and the assumption that regressors are uncorrelated with error term $E[X_{it}|u_{it}] = 0$, then it can be consistently estimated by pooled OLS. If the assumption above is violated, and the error term is correlated over time for a given individual, then the reported standard errors should not be used as they can be significantly downward biased. In particular, the usual formula for OLS standard errors in a pooled OLS regression leads to underestimated standard errors and t-statistics can be greatly inflated. For valid statistical inference, it is necessary to control for possible correlation of regression model errors over time for a given individual. An efficient solution to the problem is to pool the data into a panel of time series from different cross-sectional units.

The pooling of the data generates differences among the different cross-sectional or time-series observations, and there are broadly two cases of panel estimator approaches that can be employed in the research, the *fixed effects* models and *the random effects* models. In particular, the first model uses dummy variables to capture the systematic differences among panel observations results and then removes the unobserved effect before estimation. The second model, where the unobserved effect is thought to be uncorrelated with all explanatory variables and any neglected leftover heterogeneity only induce serial correlation in the composite error term, but it does not cause a correlation between the composite errors and the explanatory variables.

4.2.3 Fixed effects method

In the fixed effects method, the constant is treated as group-specific. This means that the model allows for different constants for each group. The fixed effects estimator is also known as the least square dummy variable (LSDV) estimator because it includes a dummy variable for each group allowing for different constants for each group. A very general linear model for panel data is as below:

$$Y_{it} = \alpha_i + \boldsymbol{\beta}' \boldsymbol{X_{it}} + \boldsymbol{u_{it}} \tag{4.4}$$

where y is the dependent variable, the dependent and independent variables have both i and t subscripts for i=*1,2,...,*N countries and t=*1,2,...,*T time periods. Then, α_i that can differ for each country in the sample; $\boldsymbol{\beta}$ is the vector of coefficients; $\boldsymbol{X_{it}}$ is a vector of independent variables and $\boldsymbol{u_{it}}$ reflects an error term. The equation above can be written as below:

$$Y_{it} = \beta_1 X_{1it} + \beta_2 X_{2it} + ... + \beta_k X_{kit} + \nu_{it} \tag{4.5}$$

In the generic panel data model, the error term is considered as a composite error term: $\boldsymbol{\nu_{it} = \alpha_i + u_{it}}$, where α_i is the unobserved individual-specific time-invariant effects (for example in EU countries this could include geography, climate, culture etc.) which are fixed over time and u_{it} is time-varying random component effects that are not constant over time. This model is too general and is not estimable as there are more parameters to estimate than observations.[1]To understand this better consider the following model:

$$Y_{it} = \beta_1 X_{1it} + \beta_2 X_{2it} + ... + \beta_k X_{kit} + \overbrace{\alpha_1 D_{1i} + \alpha_2 D_{2i} + ...\alpha_N DN_i}^{D_N} + u_{it} \tag{4.6}$$

where Y_{it} is the dependent variable, β_s are the coefficients of the independent variables X_s, α_s are the coefficients of cross-sectional dummy variables D_s. D_{1i} takes the value 1 for all observations on the first entity (e.g the first country) in the sample and zero otherwise. D_{2i} takes the value 1 for all observations on the second entity (e.g the second country) and zero otherwise, and so on. The matrix notation of the model can be rewritten as:

$$\boldsymbol{Y} = \boldsymbol{D\alpha} + \boldsymbol{X\beta}' + \boldsymbol{u} \tag{4.7}$$

[1]The number of dummies for panel observations plus the observations for independent variables

where,

$$\boldsymbol{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ . \\ . \\ . \\ Y_N \end{bmatrix}_{NTX1}, \quad \boldsymbol{D} = \begin{bmatrix} i_T & 0 & . & . & . & 0 \\ 0 & i_T & & & . & 0 \\ . & . & & & & \\ . & . & & & & \\ . & . & & & & \\ 0 & 0 & & & & i_T \end{bmatrix}_{NTXN}, \quad \boldsymbol{X} = \begin{bmatrix} X_{11} & X_{12} & . & . & . & X_{1k} \\ X_{21} & X_{22} & . & . & . & X_{2k} \\ . & . & & & & \\ . & . & & & & \\ . & . & & & & \\ X_{N1} & X_{N2} & . & . & . & X_{Nk} \end{bmatrix}_{NTXk},$$

,

$$\boldsymbol{a} = \begin{bmatrix} a_1 \\ a_2 \\ . \\ . \\ . \\ a_N \end{bmatrix}_{NX1}, \quad \boldsymbol{\beta'} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ . \\ . \\ . \\ \beta_k \end{bmatrix}_{kX1},$$

where the dummy variable is the one that allows taking different group-specific estimates for each of the constants for each different section. The composite error ν_{it} is assumed that is uncorrelated with X_s, that is a strong or strict exogeneity assumption $E[u_{it}|\alpha_i, X_{it}, ..., X_{iT}] = 0$, where $t = 1, ..., T$, so that the error term is assumed to have zero mean conditional on past, current, and future values of the regressors. If α_i is not correlated with any of the independent variables, ordinary least squares linear regression methods can be used to yield unbiased and consistent estimates of the regression parameters. The fact that α_i does not have subscript t, tells us that it does not change over time and captures all unobserved, time-constant factors that affect Y_{it}. If α_i is unobserved and correlated with at least one of the independent variables, then it will cause omitted variable bias, and the assumption of strong exogeneity is violated. Thus, the pooled OLS is biased and inconsistent. This unobserved factor is called the unobserved effect or fixed effect, which helps us to remember that α_i is fixed over time. The resulting bias is called heterogeneity bias, from omitted time-constant variables.

Within transformation

One of the many ways to eliminate the unobserved effect or fixed effect α_i is called fixed effects transformation. This transformation, known as the within the transformation, involves subtracting the time mean for each entity away from the value of variables. So if it is defined $\bar{Y}_i = \frac{1}{T}\sum_{t=1}^{T} Y_{it}$ as the time mean of the observations on Y for cross-sectional unit i, the transformation will be as the following process:

First, consider the model for each i and for one explanatory variable as below:

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \tag{4.8}$$

where u_{it} is independent, identically distributed *(iid)* over i and t. The α_i are random variables that capture unobserved heterogeneity, already mentioned above. Now, for each i, average this equation over time is as below:

$$\bar{Y}_i = \alpha_i + \beta \bar{X}_i + \bar{u}_i \tag{4.9}$$

where $\bar{Y}_i = T^{-1} \sum_{t=1}^{T} Y_{it}$, and so on. Because α_i, is fixed over time, it appears in both above equations. Subtracting (4.8) from (4.9) each t the following results are obtained:

$$Y_{it} - \bar{Y}_i = \alpha_i - \bar{\alpha}_i + \beta(X_{it} - \bar{X}_i) + u_{it} - \bar{u}_i \tag{4.10}$$

or

$$\ddot{Y}_{it} = \beta_1 \ddot{X}_{it} + \ddot{u}_{it}, \quad t = 1, 2, ..., T, \tag{4.11}$$

where $\ddot{Y}_{it} = Y_{it} - \bar{Y}_i$ is the time-demeaned data on Y, and similarly for $\ddot{X}_{it}$ and $\ddot{u}_{it}$. Also, α_i is constant, hence $\bar{\alpha}_i = \alpha_i$ and the effect is eliminated. Thus, the fixed effects transformation, also called within transformation method, has disappeared the unobserved effect α_i suggesting that the (4.10) equation should be estimated by pooled OLS method. This pooled OLS based on time-demeaned variables is called fixed effect estimator and also known as the within estimator. The latter name comes from the fact that OLS on (4.11) uses the time variation in Y and X within each cross-sectional observation. Under a strict exogeneity assumption on the explanatory variables, the fixed effects estimator is unbiased, because the idiosyncratic error u_{it} should be uncorrelated with each explanatory variable across all periods.

It is also possible to extend the fixed effect model by including a set of time dummies. This is known as the two-way fixed effect model and has the further advantage of capturing any effects that vary over time but are common across the whole panel. Such a model combines both entity fixed effects and time fixed effects within the same model, and the LSDV equivalent model contains both cross-sectional and time dummies. However, the number of parameters to be estimated would now be $k + N + T$, and the within transformation in this two-way model would become more complex.

Before assessing the validity of the fixed effects method, it is necessary to apply tests to check whether fixed effects should be included in the model. Thus, the standard F-test can be used to check the fixed effect against the simple common constant OLS method. The null hypothesis is that all constants are the same (homogeneity) and that therefore, the common constant method is applicable:

$$H_0 : \alpha_1 = \alpha_2 = ... = \alpha_N \tag{4.12}$$

The F-statistic is:

$$F = \frac{(R^2_{FE} - R^2_{CC})/(N-1)}{(1 - R^2_{FE})/(NT - N - k)} \sim F(N-1, NT-N-k) \tag{4.13}$$

where R^2_{FE} is the coefficient of determination of the fixed effect model and R^2_{CC} is the coefficient of determination of the common constant model. If F-statistic is bigger than F-critical the null hypothesis is rejected.

4.2.4 Random effects method

The second case of panel estimator approaches that can be employed in the research is another panel data estimation technique, which is known as the random-effects model. The difference between the fixed effect and the random effect is that the latter handles the constants for each section not as a fixed, but as random parameters. Hence the variability of the constant for each section comes from:

$$\alpha_i = \alpha + \mu_i \tag{4.14}$$

where μ_i is a zero mean standard random variable. Now, consider the equation (4.2) above the general linear model with one explanatory variable for panel data is as below:

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \tag{4.15}$$

where similarly to the analysis of fixed effects method above, the error term is considered as a composite error term: $\nu_{it} = \alpha_i + u_{it}$, but unlikely to the fixed effect model, there are no dummy variables to capture the heterogeneity (variation) in the cross-sectional dimension. Instead, this occurs through the μ_i terms. In the random-effects model, the assumption requires the cross-sectional error term, which is the unobserved effect μ_i, to be uncorrelated with each explanatory variable. Considering the (4.14), the above equation becomes as below:

$$Y_{it} = (\alpha + \mu_i) + \beta X_{it} + u_{it} \tag{4.16}$$

which can be written as

$$Y_{it} = \alpha + \beta X_{it} + (\mu_i + u_{it}) \tag{4.17}$$

where the assumption is $Cov(X_{it}, \mu_i) = 0$, but the cross-correlations between error terms for a given cross-sectional unit at different point of times give the following results:

$$Cov(\nu_{it}, \nu_{is}) = Cov(\mu_i + u_{it}, \mu_i + u_{is}) = Var(\mu_i^2) = \sigma_\mu^2 > 0 \tag{4.18}$$

and the correlation is as below:

$$Corr(\nu_{it}, \nu_{is}) = \frac{Cov(\nu_{it}, \nu_{is})}{Var(\nu_{it}, \nu_{is})} = \frac{\sigma_\mu^2}{\sigma_\mu^2 + \sigma_u^2}, \quad t \neq s \tag{4.19}$$

where $\sigma_\mu^2 = Var(\mu_i)$ and $\sigma_u^2 = Var(u_{it})$. The positive serial correlation in the error term can be substantial, and, if the usual pooled OLS standard errors ignore this correlation, they will be incorrect in the usual test statistics. Generalized least squares (GLS) can be used to estimate models with autoregressive serial correlation and solve the serial correlation problem. This method can be used both for balanced and unbalanced panels. The transformation involved in the GLS procedure is to subtract a weighted mean of the Y_{it} and X_{it} over time (part of the mean rather than the whole mean).[2] This weighted mean of the Y_{it} and X_{it} is defined as 'quasi-demeaned' data as follows:

$$Y_{it} - \theta\bar{Y}_i = \alpha(1-\theta) + \beta_1(X_{it} - \theta\bar{X}_{i1}) + \cdots + \beta_k(X_{it} - \theta\bar{X}_i) + (u_{it} - \theta\bar{u}_i) \tag{4.20}$$

where

$$\theta = 1 - \left[\frac{\sigma_u^2}{(\sigma_u^2 + T\sigma_\mu^2)}\right]^{1/2} \tag{4.21}$$

which is between zero and one. Thus, the random effects transformation subtracts a fraction of that time average, where the fraction depends on σ_u^2, σ_μ^2, and the number of periods, T. The parameter θ is a function of the variance of the observation error term, σ_u^2, and the variance of the entity error term, σ_μ^2. This transformation is required to ensure that there are no cross-correlations in the error terms. Equation (4.20) allows us to relate the RE estimator to both pooled OLS and fixed effects. Pooled OLS is obtained when $\theta = 0$, and FE is obtained when $\theta = 1$. In practice, the estimate θ is never zero or one. But if θ is close to zero, the RE estimates will be close to the pooled OLS estimates. This is the case when the unobserved effect, μ_i, is relatively unimportant (because it has a small variance relative to σ_u^2). It is common for σ_μ^2 to be large relative to σ_u^2, in which

[2] The fixed effects estimator subtracts the time averages from the corresponding variable. The random-effects transformation subtracts a fraction of that time average.

case θ will be closer to unity. As T gets large, θ tends to one, and this makes the RE and FE estimates very similarly. The ideal random effects assumptions include all of the fixed effects assumptions. In applications of FE and RE, it is usually informative also to compute the pooled OLS estimates. Comparing the three sets of estimates help to determine the nature of the biases caused by leaving the unobserved effect, μ_i, entirely in the error term (as does Pooled OLS) or partially in the error term (as does the RE transformation). Indeed, it must be noticed that even if μ_i is uncorrelated with all explanatory variables in all periods, the pooled OLS standard errors and test statistics are generally invalid: they ignore the often substantial serial correlation in the composite errors, $\nu_{it} = \mu_i + u_{it}$.

Again, one needs to be very careful to check whether there are any implications when using random-effects compared with the fixed-effects model. Comparing the two methods, it is expected that the use of the random effects estimator is superior to the fixed effects estimator because the former is the GLS estimator and the latter is a limited case of the random-effects model. However, the random-effects model is built under the assumption that the fixed effects are uncorrelated with the explanatory variables, an assumption that in practice creates strict limitations in panel data treatment.

In general, the difference between the two possible ways of testing panel data models is that the fixed effects model assumes that each country differs in its intercept term, whereas the random-effects model assumes that each country differs in its error term. Also, when the panel is balanced, it might be expected that the fixed effects model works better. In other cases, where the sample contains limited observations of the existing cross-sectional units, the random-effects model might be more appropriate.

4.3 Hausman test

The Hausman test is formulated to choose between the fixed effects and random effects approaches. Hausman (1978) first proposed such a test, essentially whether should be using a random effect or a fixed effects estimation. Thus, consider the following model:

$$y_{it} = \beta_0 + \boldsymbol{\beta'} \boldsymbol{X_{it}} + \mu_i + \nu_{it} \tag{4.22}$$

where μ_i is the unobserved effect. In the random effects it is essentially assumed that: $Cov(X_{it}, \mu_i) = 0$, then, $\hat{\beta}_{RE}$, $\hat{\beta}_{FE}$ are consistent and $se(\hat{\beta}_{RE}) < se(\hat{\beta}_{FE})$. But if the assumption $Cov(X_{it}, \mu_i) = 0$ is not true and $Cov(X_{it}, \mu_i) \neq 0$, then fixed effects is solely consistent, and random effects is no longer consistent. On the basis of the statements above, Hausman (1978) suggested comparing $\hat{\beta}_{RE}$ and $\hat{\beta}_{FE}$, the test as below:

$$W = \frac{(\hat{\beta}_{FE} - \hat{\beta}_{RE})^2}{Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})} \overset{H_0}{\sim} \chi_1^2 \tag{4.23}$$

where the null hypothesis (H_0), that random effects are consistent and efficient, versus (H_1), that random effects are inconsistent, follows the chi-square distribution. If the value of the statistic is large, then the difference of the estimates is significant, so the null hypothesis is rejected. Hence, under the full set of random effects assumptions, the idea is that one uses the random effects estimates unless the Hausman test rejects. In practice, a failure to reject means that both RE and FE estimates are sufficiently close so that it does not matter which is used. A rejection using the Hausman test means that the fundamental RE assumption is false, and then the FE estimates are used.

4.4 Correlation analysis

An implicit assumption when using OLS estimation method is that the explanatory variables are not correlated with one another. Generally, it occurs when one predictor variable in a multiple regression model can be linearly predicted from the others. In this situation, the coefficient estimates of the multiple regression may change erratically in response to small changes in the model or the data. Multicollinearity does not reduce the predictive power as a whole, but it only affects calculations regarding individual predictors. Collinearity is a linear association between two explanatory variables. Two variables are perfectly collinear if there is an exact linear relationship between them. In particular, two variables X_1 and X_2 are perfectly collinear if there exist parameters λ_0 and λ_1 for all i observations with the following linear relationship:

$$X_{2i} = \lambda_0 + \lambda_1 X_{1i} \tag{4.24}$$

where $\lambda_s \neq 0$.
Multicollinearity refers to a situation in which two or more explanatory variables in a multiple regression model are highly linearly related. For k variables X_1, X_2, ...,X_k, an exact perfect linear relationship is said to exist if the following condition is satisfied:

$$\lambda_0 + \lambda_1 X_{1i} + \lambda_2 X_{2i} + \cdots + \lambda_k X_{ki} = 0 \tag{4.25}$$

where λ_s are constants. However, the term multicollinearity is used in a broader sense to include the case of perfect collinearity, as shown Eq. (4.25), as well as the case where the

X variables are intercorrelated but not perfectly as below:

$$\lambda_0 + \lambda_1 X_{1i} + \lambda_1 X_{2i} + \cdots + \lambda_k X_{ki} + \nu_i = 0 \tag{4.26}$$

where ν_i is a stochastic error term. In Eq. (4.26) above, there is no exact linear relationship among the variables, but the X_j variables are nearly perfectly multicollinear if the variance of ν_i is small for some set of values for the λ_s. To see the difference between perfect and near or less than perfect the equation (4.25) can be written as

$$X_{2i} = -\frac{\lambda_1}{\lambda_2} X_{1i} - \frac{\lambda_3}{\lambda_2} X_{2i} - \cdots - \frac{\lambda_k}{\lambda_2} X_{ki} \tag{4.27}$$

which shows that X_2 is exactly linearly related to other variables or how it can be derived from a linear combination of other X variables. In this situation, the coefficient of correlation between X_2 and the linear combination on the right side of equation (4.27) is bound to be unity. Similarly the equation (4.26) above can be written as

$$X_{2i} = -\frac{\lambda_1}{\lambda_2} X_{1i} - \frac{\lambda_3}{\lambda_2} X_{2i} - \cdots - \frac{\lambda_k}{\lambda_2} X_{ki} - \frac{1}{\lambda_2} \nu_i \tag{4.28}$$

which shows that X_2 is not an exact linear combination of other X variables because it is also determined by the stochastic error term ν_i. To see the problem of the estimation in presence of perfect multicollinearity, consider the following model

$$Y_i = \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \hat{u}_i \tag{4.29}$$

Let substitute $X_{3i} = \lambda X_{2i}$,

$$Y_i = \hat{\beta}_2 X_{2i} + \hat{\beta}_3 (\lambda X_{2i}) + \hat{u}_i \tag{4.30}$$

which gives

$$Y_i = (\hat{\beta}_2 + \lambda \hat{\beta}_3) X_{2i} + \hat{u}_i \tag{4.31}$$

and if $\hat{\alpha} = (\hat{\beta}_2 + \lambda \hat{\beta}_3)$, then applying the usual OLS method the estimation parameter $\hat{\alpha}$ is given by

$$\hat{\alpha} = (\hat{\beta}_2 + \lambda \hat{\beta}_3) = \frac{\sum X_{2i} Y_i}{\sum X_{2i}^2} \tag{4.32}$$

Therefore, although $\hat{\alpha}$ can be estimated uniquely, there is no way to estimate $\hat{\beta}_2$ and $\hat{\beta}_3$ uniquely. Mathematically,

$$\hat{\alpha} = \hat{\beta}_2 + \lambda\hat{\beta}_3 \tag{4.33}$$

gives only one equation in two unknowns (note λ is given) and there is an infinity of solutions to equation (4.33) above for given values of $\hat{\alpha}$ and λ.

Instead of perfect multicollinearity, it is possible the presence of high but imperfect multicollinearity as given below:

$$X_{3i} = \lambda X_{2i} + \nu_i \tag{4.34}$$

where $\lambda \neq 0$ and where ν_i is a stochastic error. In this case, estimation for regression coefficients β_2 and β_3 may be possible. A correlation matrix shows the correlation coefficients between sets of variables, and the probability values (p-values) to measure the significance of their relationship. Considering that the implicit assumption made when using OLS estimation method is that the relationship between the explanatory variables are orthogonal, adding or removing a variable from the regression model would not cause the values of coefficients on the other variables to change. In the context of very closed explanatory variables, the consequence is the difficulty in observing the individual contribution of each variable to the overall fit of the regression, which becomes very sensitive adding or removing explanatory variables leading to significant changes in the coefficient values or significance of the other variables. Also, the confidence intervals for the parameters become very wide, and significance tests might, therefore, give inappropriate conclusions. Finally, the high pair-wise correlation among regressors is a suggested rule of thumb, say over 0.8, is a serious problem. The problem with this criterion is that, although high zero-order correlations may suggest collinearity, it is not necessary that they be high to have collinearity in any specific case.

One of the methods of remedying multicollinearity is the transformation of variables such as the first difference form which reduces the severity of multicollinearity, although levels of regressors are highly correlated. Another method of remedying multicollinearity is to employ multivariate statistical techniques such as principal component and factor analysis.

4.5 Cross-sectional dependence test

A common assumption in panel data models is that disturbances are cross-sectionally independent, especially when the cross-section dimension N is large. There is, however, considerable evidence that cross-sectional dependence is often present in panel regression settings. A growing body of the panel-data literature concludes that panel-data models are likely to exhibit substantial cross-sectional dependence in the errors, which may arise because of the presence of common shocks and unobserved components that become a part of the error term, spatial dependence, and idiosyncratic pairwise dependence in the disturbances with no particular pattern of common components (Pesaran, 2004; Baltagi et al., 2002) . One reason for this result is the increasing economic and financial integration of countries and financial entities, which implies strong interdependencies between cross-sectional units.

The impact of cross-sectional dependence in estimation depends on the magnitude of correlations across sections and the nature of cross-sectional dependence itself. If it is assumed that cross-sectional dependence is caused by the presence of common factors, which are unobserved but uncorrelated with the included regressors, the standard fixed effects, and random effects estimators are consistent, although not efficient, and the estimated standard errors are biased. However, testing for cross-sectional dependence is important in fitting panel-data models. Consider the standard panel-data model:

$$Y_{it} = \alpha_i + \boldsymbol{\beta'} \boldsymbol{X_{it}} + \boldsymbol{u_{it}} \tag{4.35}$$

where Y_{it} is the independent variable, $i = 1, ..., N$, $t = 1, ..., T$, $\boldsymbol{\beta'}$ is a $K \times 1$ vector of parameters to be estimated, $\boldsymbol{X_{it}}$ is a $K \times 1$ vector of to be estimated, and α_i represents time-invariant individual nuisance parameters. Under the null hypothesis, $\boldsymbol{u_{it}}$ is assumed to be independent and identical distributed (i.i.d) over periods and cross-sectional units. Under the alternative, $\boldsymbol{u_{it}}$ may be correlated across cross sections, but the assumption of no serial correlation remains. Thus, the hypothesis of interest is

$$H_0 : \rho_{ij} = \rho_{ji} = cor(u_{it}, u_{jt}) = 0 \quad for \quad i \neq j \tag{4.36}$$

versus

$$H_1 : \rho_{ij} = \rho_{ji} = cor(u_{it}, u_{jt}) \neq 0 \quad for \quad i \neq j \tag{4.37}$$

where ρ_{ij} is the product-moment correlation coefficient of the disturbances and is given by

$$\rho_{ij} = \rho_{ji} = \frac{\sum_{t=1}^{T} u_{it}u_{jt}}{\left(\sum_{t=1}^{T} u_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T} u_{jt}^2\right)^{1/2}} \tag{4.38}$$

The number of possible pairings (u_{it}, u_{jt}) rises with N. Below are described three statistical procedures designed to test for cross-sectional dependence, namely Pesaran's (2004) cross-sectional dependence (CD) test, Friedman's (1937) statistic, and the statistic test proposed by Frees (1995).

4.5.1 Pesaran's CD test

Breusch and Pagan (1980) proposed an LM statistic, which is valid for fixed N as $T \to \infty$ and is given by

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \sim \chi^2 \frac{N(N-1)}{2} \tag{4.39}$$

where $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the residuals

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} \hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T} \hat{u}_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T} \hat{u}_{jt}^2\right)^{1/2}} \tag{4.40}$$

and $\hat{u}_{it}$ is the estimate of u_{it} in (4.17). LM is asymptotically distributed as χ^2 with $N(N-1)/2$ degrees of freedom under the null hypothesis of interest. However, LM test is likely to exhibit substantial size distortions when N is large and T is finite-a situation that is commonly encountered in empirical applications, primarily because the LM statistic is not correctly centered for finite T and the bias is likely to get worse with N large. Pesaran (2004) has proposed the following alternative,

$$CD = \sqrt{\frac{2T}{N/(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \to N(0,1) \tag{4.41}$$

and showed that under the null hypothesis of no cross-sectional dependence Pesaran's statistic follows a standard normal distribution ($CD \to N(0,1)$ for $N \to \infty$ and T sufficiently large). For unbalanced panels, Pesaran (2004) proposes a slightly modified version of the above as below:

$$CD = \sqrt{\frac{2}{N/(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T_{ij}}\hat{\rho}_{ij} \right) \tag{4.42}$$

where T_{ij} is the number of common time-series observations between units i and j.

4.5.2 Friedman's test

Friedman (1937) proposed a non parametric test based on Spearman's rank correlation coefficient. In particular, if it is defined $[r_{i,1}, ..., r_{i,T}]$ to be the ranks of $[u_{i,1}, ..., u_{i,T}]$, Spearman's rank correlation coefficient equals

$$r_{ij} = r_{ji} = \frac{\sum_{t=1}^{T}(r_{it} - (T + 1/2))(r_{ji} - (T + 1/2))}{\sum_{t=1}^{T}(r_{it} - (T + 1/2))^2} \tag{4.43}$$

Friedman's statistic is based on the average Spearman's correlation and is given by

$$R_{AVE} = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{r}_{ij} \tag{4.44}$$

where $\hat{r}_{ij}$ is the sample estimate of the rank correlation coefficient of the residuals. Large values of R_{ave} indicate the presence of non-zero cross-sectional correlations. He also showed that

$$FR = (T-1)[(N-1)R_{AVE} + 1] \tag{4.45}$$

is asymptotically χ^2 distributed with $T-1$ degrees of freedom, for fixed T as N gets large.

The CD and R_{ave} share a common feature; both involve the sum of the pairwise correlation coefficients of the residual matrix rather than the sum of the squared correlations used in the LM test. This feature implies that these tests are likely to miss cases of cross-sectional dependence where the sign of the correlation is alternative-that is, where there are largely positive and negative correlations in the residuals, which cancel each other out during averaging.

4.5.3 Frees' test

Frees (1995, 2004) proposed a statistic that is not subject to this drawback as mentioned above. In particular, the statistic is based on the sum of the squared rank correlation coefficients and equals

$$R_{AVE}^2 = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{r}_{ij}^2 \tag{4.46}$$

As shown by Frees, a function of this statistic follows a joint distribution of two independently drawn χ^2 variables. In particular, Frees shows that

$$FRE = N[R^2_{AVE} - (T-1)^{-1}] \rightarrow Q \tag{4.47}$$

where

$$Q = \alpha(T)[x^2_{1,T-1} - (t-1)] + b(T)[x^2_{2,T(T-3)/2} - T(T-3)/2]$$

and $x^2_{1,T-1}$, $x^2_{2,T(T-3)/2}$ are independently χ^2 variables with $T-1$ and $T(T-3)/2$ degrees of freedom, respectively, $\alpha(T) = 4(T+2)/[5(T-1)^2(T+1)]$ and $b(T) = 2(5T+6)/[5T(T-1)(T+1)]$. Thus the null hypothesis is rejected if $R^2_{AVE} > (T-1)^{-1} + Q_q/N$, where Q_q is the appropriate quantile of the Q distribution. In cases where T is not small, Frees suggests using the normal approximation to the Q distribution by computing the variance of Q as below:

$$\frac{FRE}{\sqrt{Var(Q)}} \rightarrow N(0,1) \tag{4.48}$$

where

$$Var(Q) = \frac{32(T+2)^2}{25(T-1)^3(T+1)^2} + \frac{4(5T+6)^2(T-3)}{5T(T-1)^2(T+1)^2} \tag{4.49}$$

Thus, the density of Q is different for different values of T. However, for T as large as 30, the approximation does well. Contrary to Pesaran's CD test, the test by Frees and Friedman have been originally devised for static models, and the finite sample properties of the tests have not been investigated yet in dynamic panels.

4.5.4 Driscoll and Kraay standard errors

Driscoll and Kraay presented a simple extension of common nonparametric covariance matrix estimation techniques that yield standard error estimates that are robust to very general forms of spatial and temporal dependence as the time dimension becomes large. In particular, they showed that a simple transformation of the orthogonality conditions that permit to construct a covariance matrix estimator which is robust to very general forms of spatial and temporal dependence as the time dimension becomes large. Moreover, in contrast to other techniques, the size of the cross-sectional dimension does not constraint the feasibility of the estimator they proposed.

4.6 Testing for Stationarity

4.6.1 Introduction

Many economic indicators present an upward trend, and it is important to confirm that the values of the data set do not depend upon their previous values. If they are dependent, this violates the fundamental assumptions of the regression model. This violation requires testing for stationarity. There are several reasons why the concept of non-stationarity is important and why it is essential variables that are non-stationary be treated differently from those that are stationary. Standard estimation techniques are mostly invalid when data is non-stationary. The use of non-stationary data can lead to spurious regressions. Granger and Newbold (1974) employed a test of diagnosing whether the model has spurious regression and found that if the estimation is made in non-stationary variables, is obtained a significant regression with high explanatory power *(R-square value).* Another indication that there is a spurious regression that is called more like a rule of thumb is that the high R-square value (R^2) is higher than the Durbin-Watson statistic.

The relevant concept of non-stationarity enabled Hendry (1980) to deduce what would occur and hence to construct the desired examples. In particular, trying to explain changes in the price level across time found a strong correlation between two variables with high explanatory power. These two variables were independent one another (prices and cumulative rainfall within the UK) and should have no or insufficient explanatory power. However, even though they were independent of one another, both variables were increasing across time, and the results were statistically significant. The cause of spurious results was the regressing of one non-stationary variable on another non-stationary variable. Thus, in general, there is a problem called "*spurious regression*" when regressing non-stationary variables and a spurious regression provides misleading statistical evidence of a linear relationship between two non-stationary variables. In statistics, a spurious relationship is a mathematical relationship in which two or more variables or events are not causally related to each other, yet it may be wrongly inferred that they are, due to either coincidence or the presence of a certain third, unseen factor.

The study needs to investigate the problem of spurious regression, which exists only in the presence of non-stationarity. The remainder of this section defines the meaning of stationary series and then describes the panel unit root and panel cointegration tests.

4.6.2 Stationary series

Stationary series can be defined as one with a constant mean, constant variance, and constant auto covariances for each given lag. To offer one illustration, shocks to the system will gradually die away. Thus, a shock during time t will have a smaller effect in time $t + 1$, a smaller effect still in time $t + 2$, and so on. This is in contrast with the case of non-stationary data, where the persistence of shocks is infinite so that for a non-stationary series, the effect of a shock during time t will not have a smaller effect in time t+1, and in time t+2, etc. When one variable is regressed on the other, the t-ratio on the slope coefficient would be expected not to be significantly different from zero, and the value of R^2 would be expected to be very low. The variables are not related to one another. However, if two variables are trending over time, regression of one on the other could have a high R^2 even if the two are unrelated. Consider the generalised time series model below:

$$y_t = \alpha + \rho y_{t-1} + u_t \tag{4.50}$$

where y_t is the dependent variable, the subscript t denotes the time period, α is the intercept, y_{t-1} is the independent variable that is determined by the dependent's variable value on the preceding period, ρ is the coefficient of independent variable and u_t is the (white noise)[3] error term. Dickey and Fuller (1979) developed a formal procedure to test the non-stationarity by subtracting y_{t-1} as follows:

$$y_t - y_{t-1} = \alpha + \rho y_{t-1} - y_{t-1} + u_t \tag{4.51}$$

that gives

$$\Delta y_t = \alpha + \overbrace{(\phi - 1)}^{\gamma} y_{t-1} + u_t \tag{4.52}$$

where the series has individual intercept and of course $\gamma = (\phi - 1)$. Now the null hypothesis is $H_0 : \gamma = 0$ and the alternative is $H_1 : \gamma < 0$. If $\gamma = 0$ then the model contains a unit-root. Dickey and Fuller (1979) also proposed two alternative regression equations that can be used for testing the presence of a unit-root. The first, allows a non-stochastic time trend in the model to obtain:

$$\Delta y_t = \alpha + \beta_{2t} + \gamma y_{t-1} + u_t \tag{4.53}$$

where the series has both intercept and trend. If H_0 rejected, the series is stationary. This is an important case, because the process presents a definite trend when $\gamma = 0$, which is often the case of macroeconomic variables. The second does not include intercept and

[3] A time series is said to be "white noise" if the underlying variable has zero mean, a constant variance and zero correlation between successive observations, i.e. no autocorrelation.

trend:

$$\Delta y_t = \gamma y_{t-1} + u_t \tag{4.54}$$

where the null hypothesis ($H_0 : \gamma = 0$) if rejected, the series is stationary. In general there are three possible cases: If H_0 :

- First case, $|\phi| < 1$ and therefore the series is stationary. Statistical stationarity means that the statistical properties such as mean, variance, autocorrelation, are all constant over time.
- Second case, $|\phi| > 1$ and therefore the series is non-stationary and explodes. In contrast to the stationary process, the non-stationary process has a variance and a mean that does not remain near, or returns to a long-run mean over time.
- Third case, $|\phi| = 1$ where the series contains a unit root and is non-stationary.

The stationarity testis employed for all conditions, and if a series contains a unit root in any two of them, it will be non-stationary series.

Although the relevant literature on time-series studies successfully answers stationarity issues, the adoption and adjustment of similar tests on panel data are yet in progress, mainly due to the complexity of considering relatively large T and N samples in the later studies. Asteriou and Price (2001) summarizes the significant differences between time-series and panel unit-root tests as follows: First, panel data allows to test the various approaches with different degrees of heterogeneity between individuals. Second, in the panel data analysis, so far, one cannot be sure as to the validity of rejecting a unit root. Third, the power of panel unit-root tests increases with an increase in N. Four, the additional cross-sectional components incorporated in panel data models provide better properties of panel unit-root tests, compared with the low-power standard ADF for time-series samples. Panel unit roots tests and panel cointegration tests are presented below and provide guidelines on how to use these tests in the study. Until recently, panel data studies have ignored the crucial stationarity and cointegration tests. However, with the growing involvement of macroeconomic applications in the panel data, where a large sample of countries constitutes the cross-sectional dimension providing data over long time series, the issues of stationarity and cointegration have also emerged in panel data.

4.6.3 Panel unit root tests

Before proceeding the panel regression model, it is necessary to verify that all variables are stationary. Both DF and ADF unit root tests are extended to panel data estimations, to consider cases that possibly exhibit the presence of unit root. Most of the panel unit root tests are based on an extension of the ADF test by incorporating it as a component in regression equations. However, when dealing with panel data, the estimation procedure is more complicated than that used in time series. The crucial factor in panel data estimation appears to be the degree of heterogeneity. In particular, it is important to realize that all the individuals in a panel may not have the same property; that is, they may not all be stationary or non-stationary or cointegrated/not cointegrated. So if a panel unit root test is carried out where some parts of the panel have a unit root and some do not the application for panel data becomes much more complicated than for single series.

A wide variety of procedures have been developed, with an emphasis on the attempt to combine information from the time series dimension with that obtained from the cross-sectional dimension, hoping that in taking into account the cross-sectional dimension the inference about the existence of unit roots will be more precise and straightforward. However, a variety of issues arise from this: one is that some of the tests proposed to require balanced panels missing any data for either i or t, whereas others allow for unbalanced panels. A second issue is related to the formulation of the null hypothesis; which is a generalization of the standard DF test where all series in the panel is assumed to be stationary. On the other hand, one can formulate the null hypothesis in precisely the opposite way, presuming that all the series in the panel are stationary processes, and rejecting it when there is sufficient evidence of non-stationarity.

Another important theoretical consideration, is the complication that arises from different asymptotic distribution for the test statistics, and this may depend on whether N identity is fixed, and T tends to infinity, or vice versa, or both T and N increase simultaneously in a fixed ratio. However, since the power of individual unit root test can be distorted when the span of data is short (Pierse and Snell, 1995) the use of panel unit root tests are more powerful compared to performing a separate unit root test for each time series (Levin et al., 2002).

Nevertheless, the study applies a variety of unit root tests for the panel data. These are denoted by Levin et al. (2002), Breitung (2001), Im et al. (2003), Phillips and Perron (1988) (Fisher-type tests) using either ADF or Phillips-Perron tests, and Hadri (2000). All tests are to be considered, to conclude if the variables are stationary or non-stationary. Levin et. al. (2002), Breitung (2000) and Hadri (2000) assume a common unit root process (that means ρ_i is identical across cross-sections) while Im, Pesaran, and Shin (2003) and Fisher ADF or Phillips-Perron tests assume individual unit root process (that means it is conducted a separate unit root test).

Tests with common unit root process

Levin-Lin-Chu (LLC), Breitung, and Hadri tests all assume that there is a common unit root process so that ρ_i is identical across cross-sections. The first two employ a null hypothesis of a unit root while the Hadri test uses a null of no unit root.

4.6.3.1 The Levin and Lin (LL) test

One of the first panel-unit root tests was that developed by Levin and Lin (2002). LLC statistic is based on the Dickey Fuller unit root tests and their model takes the following form:

$$\Delta Y_{it} = \alpha_i + \rho Y_{i,t-1} + \sum_{L=1}^{p_i} \phi_{iL} \Delta Y_{i,t-L} + \delta_i t + \theta_t + u_{it} \tag{4.55}$$

The model allows for two-way fixed effects, one coming from α_i and the second from θ_t. So both unit-specific fixed effects and unit-specific time effects are included. The unit-specific fixed effects are a very important component because they allow for heterogeneity, since the coefficient of the lagged Y_i is restricted to being homogenous across all units of the panel. Also, thae lag order p_i is permitted to vary across individuals. The null and the alternative hypotheses of this test for each individual time series are:

$$H_0 : \rho_i = 0 \tag{4.56}$$

$$H_1 : \rho_i \neq 0 \tag{4.57}$$

Since the lag order p_i is unmown, LLC suggest a three step procedure to implement their test: First, performing separate augmented Dickey-Fuller (ADF), two auxiliary regressions for each cross-section are run to get orthogonalized residuals:

Run ΔY_{it} on $\Delta Y_{i,t-L}$ and $Y_{i,t-1}$ on $\Delta Y_{i,t-L}$, the residuals u_{1it} and u_{2it} are obtained from both regressions as below:

$$u_{1it} = \Delta Y_{it} - \sum_{L=1}^{p_i} \hat{\beta_{iL}} \Delta Y_{i,t-L} - \alpha_i - \delta_i t - \theta_t \tag{4.58}$$

and

$$u_{2it} = Y_{it-1} - \sum_{L=1}^{p_i} \dot{\beta_{iL}} \Delta Y_{i,t-L} - \alpha_i - \delta_i t - \theta_t \tag{4.59}$$

where the model allows from two ways fixed effects, one coming from α_i and the second from θ_t. Second, the residuals from both regressions are standardised by dividing by the regression standard error:

$$\tilde{u}_{1it} = \hat{u}_{1it}/\hat{\sigma}_{\epsilon i} \tag{4.60}$$

$$\tilde{u}_{2it} = \hat{u}_{2it}/\hat{\sigma}_{\epsilon i} \tag{4.61}$$

where $\hat{\sigma}_{\epsilon i}$ are the estimated standard errors from estimating ADF specification. Thus, $\tilde{u}_{1it}$ and $\tilde{u}_{2it}$ both are equivalent to ΔY_{it} and Y_{it-1} but with the effects of the deterministic components removed. Finally, $\tilde{u}_{1it}$ is regressed on $\tilde{u}_{2it}$ and the slope δ estimated from the test regression is then used to construct a test statistic

$$\tilde{u}_{1it} = \rho\tilde{u}_{2it} + \eta_{it} \tag{4.62}$$

The test statistic in the output of LLC unit root is the conventional t-statistic for H_0 : $\rho = 0$ and computed as:

$$t_{\rho} = \hat{\rho}/se_{(\hat{\rho})} \tag{4.63}$$

and the adjusted t-statistic is:

$$t_{\rho}^{*} = \frac{t_{\rho} - N\tilde{T}\hat{S}_N\hat{\sigma}_{\tilde{\epsilon}}^{-2}\hat{\sigma}_{\tilde{\rho}}\mu_{m\tilde{T}}^{*}}{\sigma_{m\tilde{T}}^{*}} \tag{4.64}$$

Like most of the unit root tests in the literature, the LL test also assumes that the individual processes are cross-sectionally independent. Under this assumption, the test derives conditions for which the pooled OLS estimator of ρ will follow a standard normal distribution under the null hypothesis.

4.6.3.2 The Breitung test

The Breitung method differs from LLC in two district ways. First, only the autoregressive portion is removed when constructing the standardised residuals from the auxiliary regression. Second, the standardised residuals are transformed and detrended. Breitung and Das (2005) suggested a model that involves the following regressions for each i:

$$\Delta Y_{it} = \alpha_i + \sum_{L=1}^{p_i} \phi_{iL}\Delta Y_{i,t-L} + u_{it} \tag{4.65}$$

The first step is the same as for LLC, but only $\Delta Y_{i,t-L}$ is used in obtaining the residuals of the regression by $\Delta Y_{i,t-L}$ and $Y_{i,t-L}$ on $\Delta Y_{i,t-L}$ in computing tests. The obtained residuals are as below:

$$\hat{u}_{1it} = \left(\Delta\tilde{Y}_{it} - \sum_{L=1}^{p_i} \hat{\phi}_{iL}\Delta\tilde{Y}_{i,t-L}\right)/\hat{\sigma}_{\epsilon i}$$

and

$$\hat{u}_{2it} = \left(\tilde{Y}_{it} - \sum_{L=1}^{p_i} \dot{\beta}_{iL}\Delta\tilde{Y}_{i,t-L}\right)/\hat{\sigma}_{\epsilon i}$$

where $\hat{\phi}$, $\dot{\phi}$, and $\hat{\sigma}_{\epsilon i}$ are defined as for LLC. The proxies are transformed and detrended,

$$\hat{u}^*_{1it} = \sqrt{\frac{(T-t)}{(T-t-1}}\left(\Delta\tilde{Y}_{it} - \frac{\Delta\tilde{Y}_{it+1} + ... + \Delta\tilde{Y}_{iT}}{T-t}\right)$$

and

$$\hat{u}^*_{2it} = \tilde{Y}_{it} - \tilde{Y}_{i1} - \frac{t-1}{T-1}\left(\tilde{Y}_{iT} - \tilde{Y}_{i1}\right)$$

The persistence parameter α is estimated from the pooled proxy equation:

$$\hat{u}^*_{1it} = \alpha\hat{u}^*_{2it} + \nu_{it}$$

Breitung shows that under the null $\alpha = 0$, the resulting estimator α^* is asymptotically distributed as a standard normal.

4.6.3.3 Hadri

Hadri (2000), derived a residual-based LM test, where the null hypothesis is that the data are stationary and there is no unit root in any of the series in the panel, while the alternative that at least one panel contains a unit root. The test is design for cases with large and moderate N. In particular, Hadri (2000) considered the following model:

$$Y_{it} = r_{it} + \beta_i t + \epsilon_{it} \tag{4.66}$$

where $i = 1, ..., N; t = 1, ..., T$ and r_{it} is a random walk,

$$r_{it} = r_{i,t-1} + u_{it} \tag{4.67}$$

where ϵ_{it} and u_{it} are zero-mean i.i.d normal errors. Using back substitution, the model above becomes

$$Y_{it} = r_{i0} + \beta_i t + \sum_{s=1}^{t} u_{is} + \epsilon_{it} = r_{i0} + \beta_i t + \nu_{it} \tag{4.68}$$

where $\nu_{it} = \sum_{s=1}^{t} u_{is} + \epsilon_{it}$. The stationarity hypothesis is $H_0 : \sigma_u^2 = 0$ in which case $\nu_{it} = \epsilon_{it}$. The LM statistic is given by:

$$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N} \frac{1}{T^2} \sum_{t=1}^{T} S_{it}^2\right)/\hat{\sigma}_\epsilon^2 \tag{4.69}$$

where $S_{it} = \sum_{s=1}^{t} \hat{\epsilon}_{is}$ are the partial sums of OLS residuals $\hat{\epsilon}_{is}$ from (4.68) and $\hat{\sigma}_\epsilon^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T} \hat{\epsilon}_{it}^2$ is a consistent estimate of σ_ϵ^2.

An alternative form of the LM statistic allows for heteroscedasticity across i:

$$LM_2 = \frac{1}{N}\left[\sum_{i=1}^{N}\left(\frac{1}{T^2}\sum_{t=1}^{T} S_{it}^2/\hat{\sigma}_{\epsilon i}^2\right)\right] \tag{4.70}$$

The test statistic is given by $Z = \sqrt{N}(LM - \xi_1)/\zeta)$ where $\xi = 1/6$ and $/\zeta = 1/45$, if the model only includes constants, and $\xi = 1/15$ and $/\zeta = 11/6300$, otherwise.

Tests with Individual Root Processes

The LLC and Hadri tests are restrictive in the sense that require ρ to be homogenous across i. The Im, Pesaran, and Shin, and the Fischer-ADF and Phillips Perron tests all allow for individual unit root processes so that ρ_i may vary across-sections. The tests are all characterized by the combining of individual unit root tests to derive a panel-specific result.

4.6.3.4 The Im, Pesaran, and Shin (IPS) test

Im et al. (2003) extended the LLC test, allowing heterogeneity on the coefficient of $Y_{i,t-1}$ variable and proposing as a basic testing procedure one based on the average of the individual unit-root test statistics. The IPS test provides separate estimations for each i section and the model is given by:

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \sum_{L=1}^{p_i} \hat{\phi_{iL}} \Delta y_{i,t-L} + \delta_i t + u_{it} \tag{4.71}$$

while the null hypotheses are formulated as:

$$H_0 : \rho_i = 0 \tag{4.72}$$

$$H_1 : \rho_i < 0 \tag{4.73}$$

where H_0 is for all i, and H_1 allows for some but not for all of the individual series to have unit-roots. Thus the alternative

$$H_1 : \begin{cases} \rho < 0 \quad for \quad i = 1, 2, ..., N_1 \\ \rho = 0 \quad for \quad i = N_1 + 1, ...N \end{cases} \tag{4.74}$$

Formally the alternative hypothesis requires the fraction of the individual time series that are stationary to nonzero, where $lim_{N \to \infty}(N_1/N) = \delta$ and $0 < \delta \leq 1$. This condition is necessary for the consistency of the panel unit root test. Thus, the null hypothesis of this test is that all series are non-stationary processes under the alternative that a fraction of the series in the panel are assumed to be stationary. This is in sharp contrast with the LLC test, which presumes that all series are stationary under the alternative hypothesis. The test is based on the average of the $t-statistics$ for $\rho_i = 0$ for all i from the individual ADF regressions, t_{ρ_i}:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho_i} \tag{4.75}$$

Im et al. (1997) also showed that, under specific assumptions, t_{ρ_i} converges to a denoted as t_{iT} which is a standardised $\bar{t}$. This average is then transformed into a standard normal variate as follows:

$$W_{\overline{t_{NT}}} = \frac{\sqrt{N}\left(\overline{t_{NT}} - N^{-1}\sum_{i=1}^{N} E(\overline{t_{iT}}(p_i))\right)}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(\overline{t_{iT}}(p_i))}} \to N(0, 1)$$

or

$$W_{\overline{t_{NT}}} = \sqrt{N}\frac{\left(\overline{t_{NT}} - \mu\right)}{\sigma} \to N(0, 1)$$

This statistic is properly standardized, and it is asymptotically *N(0, 1)* distributed. Monte Carlo simulations reveal that the small sample performance of the Im-Pesaran-Shin test is better than Levin-Lin-Chu test. Im-Pesaran-Shin requires $N/T \to 0$ for $N \to \infty$. If either N is small or if N is large relative to T, then the test shows size distortions[4]. Thus, when N is modest relative to T, are sufficiently powerful. Additionally, the tests have little power if deterministic terms are included in the analysis.

4.6.3.5 The Maddala and Wu (MW) test (Fisher-ADF-PP test)

Maddala and Wu (1999) attempted to improve to some degree the drawbacks of all previous tests by proposing a model that could also be estimated with unbalanced panels.

[4]Size is the probability of rejecting the null when it is true. Thus, a size distortion implies that the null is rejected too often

Maddala and Wu are in line with the assumption that a heterogeneous alternative is preferable, but they disagree with the use of the average ADF-statistics by arguing that it is not the most effective way of evaluating stationarity. Their approach is to derive tests that combine the p-values from individual unit root tests. Assuming that there are N unit root tests, MW test takes the following form:

$$P = -2 \sum_{i=1}^{N} log(\pi) \rightarrow x_{2N}^2 \tag{4.76}$$

where π_i is defined as the p-value and P is the probability limit values from regular ADF tests for each cross-section i. The test is asymptotically chi-square distributed with *2N* degrees of freedom ($T_i \rightarrow \infty$ for finite N. A significant benefit is that the test can handle unbalanced panels. To consider the dependence between cross-sections, Maddala and Wu propose obtaining the π_i values using bootstrap procedures by arguing that correlations between groups can induce significant size distortions for the tests. Furthermore, the lag lengths of the individual augmented Dickey-Fuller tests are allowed to differ. A drawback of the test is that the p-values have to be obtained by Monte Carlo simulations. The null and alternative hypotheses are the same as for the as IPS. For both Fisher tests, it must be specified the exogenous variables for the test equations. All in all, there is no dominant performance of one particular test. Thus, in this study, given that the dataset is relatively small ($N = 26, T = 27$), the study employs the summary of panel unit root tests.

4.7 Panel cointegration tests

The main purpose of this section is to describe the panel cointegration tests. The motivation is linked primarily with the need to investigate the problem of spurious regression, which exists only in the presence of non-stationarity. A simple regression is spurious when two variables X_{it} and Y_{it} are integrated of the same order, and the residuals u_{it} of regressing Y_{it} on X_{it} contain a stochastic trend-denoted I(1). On the other hand, it is the case of both X_{it} and Y_{it} being integrated of the same order, but the u_{it} sequence is stationary-denoted I(0). Thus, in order to test for cointegration, it is essential to ensure that the regression variables are α priori integrated of the same order. However, when a linear combination of several I(1) series is stationary, they are said to be integrated, and this cointegration implies that the I(1) series are in long-run equilibrium and they move together, although the group of them can wander arbitrarily. The study is based on two methods for cointegration tests in panels. The first is the Engle-Granger two-step method, which is residual-based, and if a set of variables are cointegrated, there always exists an error-correcting formulation of the dynamic model. The second method is based on an asymptotic analysis of residuals, where the test statistic is constructed as a ratio of variances and do not have the usual Dickey-Fuller distributions under the null hypothesis of no-cointegration (Phillips and Ouliaris, 1990).

Test details

Before proceeding to present the methods and formulas, an overview is provided. Consider the panel-data model

$$Y_{it} = \boldsymbol{X'_{it}\beta_i} + \boldsymbol{Z'_{it}}\gamma_i + \boldsymbol{e_{it}} \tag{4.77}$$

where Y_{it} is a non-stationary dependent variable for which the first difference is stationary, $i = 1, ..., N$ sections and $t = 1, ...T$; time period. $\boldsymbol{X_{it}}$ is a $k \times N$ matrix of $I(1)$ variables. $\boldsymbol{\beta_i}$ denotes the cointegrating vector that varies across panels. $\boldsymbol{Z'_{it}}$ is the deterministic term that controls for panel-specific effects and linear time trends. $\boldsymbol{\gamma_i}$ is the vector of coefficients on the deterministic terms $\boldsymbol{Z'_{it}}$. $\boldsymbol{e_{it}}$ is an error term. The vector $\boldsymbol{Z'_{it}}$ allows for panel-specific means and panel-specific time trends, or nothing, depending on options specified to cointegration tests. In the first option $\boldsymbol{Z'_{it} = 1}$ and the term $\boldsymbol{Z'_{it}}\gamma_i$ represents panel-specific means (fixed effects), while in the second option is $\boldsymbol{z'_{it} = 1, t}$, and the term $\boldsymbol{Z'_{it}}\gamma_i$ represents panel-specific means and panel-specific linear time trends. Also, there is the option to omit the $\boldsymbol{Z'_{it}}\gamma_i$ term.

Overview of tests

Kao (1999), Pedroni (2004), Westerlund (2005) extend the Engle-Granger method and implement different types of tests, namely Dickey-Fuller *(DF-t)*, augmented Dickey-Fuller *(ADF)*, Phillips Perron *(PP)* and variance ratio *(VR)* tests for whether e_{it} is non-stationary. Specifically, Kao (1999) uses the *DF-t* and *ADF* tests, Pedroni (2004) the *PP*, *VR* and *ADF* tests, while Westerlund (2005) uses only the *VR* test. All variants of the test statistics are constructed using ordinary least squares of the (4.77) model. After obtaining the predicted residuals (e_{it}) they fit the following regressions models:
For **Kao's** tests the *(DF-t)* regression model is

$$\hat{e}_{it} = \rho\hat{e}_{i,t-1} + \nu_{it} \tag{4.78}$$

and the *ADF*

$$\hat{e}^*_{it} = \rho^*\hat{e}^*_{i,t-1} + \sum_{j=1}^{p}\phi_j\Delta e^*_{i,t-j} + \nu^*_{it} \tag{4.79}$$

where ρ, ρ^* are assumed the same AR parameters for each regression model across all panels, and $\nu_{it}, \nu_{it}^* v$ are stationary error terms.

For **Peroni's** tests the *(PP-t)* regression model is

$$\hat{e}_{it} = \rho_i \hat{e}_{i,t-1} + \nu_{it} \tag{4.80}$$

and the *ADF*

$$\hat{e}_{it}^* = \rho_i^* \hat{e}_{i,t-1}^* + \sum_{j=1}^{p} \phi_j \Delta e_{i,t-j}^* + \nu_{it}^* \tag{4.81}$$

where in this case ρ_i, ρ_i^* are panel-specific AR parameters and $\nu_{it}, \nu_{it}^* v$ are stationary error terms.

For **Westerlund's** tests the regression models are

either the same AR parameter

$$\hat{e}_{it} = \rho \hat{e}_{i,t-1} + \nu_{it} \tag{4.82}$$

or panel-specific AR parameter

$$\hat{e}_{it}^* = \rho_i^* \hat{e}_{i,t-1}^* + \nu_{it}^* \tag{4.83}$$

The tests share a common null hypothesis that Y_{it} and X_{it} are not cointegrated. Rejection of the null hypothesis implies that e_{it} is stationary and that the series Y_{it} and X_{it} are cointegrated. The alternative hypothesis of Kao and Pedroni tests is that the variables are cointegrated in all panels. The alternative hypothesis of the Westerlund test has two options. The first is that some panels are cointegrated, while the second is that all panels are cointegrated. Below are described the three cointegration tests that will be employed in the present study.

4.7.1 The Kao tests

Kao (1999) presented DF and ADF-type of tests for cointegration in panel data and assumed the same cointegrating vector $\boldsymbol{\beta_i} = \boldsymbol{\beta}$ in (4.77) so that all panels share a common slope coefficient. Then, consider the bivariate case without panel specific means and time trend:

$$Y_{it} = \gamma_i + \boldsymbol{X_{it}'}\boldsymbol{\beta} + \boldsymbol{e_{it}} \tag{4.84}$$

for

$$Y_{it} = Y_{i,t-1} + u_{it} \tag{4.85}$$

$$X_{it} = X_{i,t-1} + \epsilon_{it} \tag{4.86}$$

where $i = 1, ...N$, stands for the sections, $t = 1, ...T$ for the time period, and γ_i denotes panel-specific fixed effects requiring to be heterogeneous. $\boldsymbol{\beta}$ is homogeneous across cross-sections, Y_{it} and X_{it} are I(1) and non cointegrated, while $\boldsymbol{e_{it}}$ is the error term. Kao then runs either the pooled auxiliary *DF* regression (4.78) or the augmented version *ADF* of the pooled specification (4.79), and the OLS estimate of ρ is given by:

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}\hat{e}_{i,t-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}^2} \tag{4.87}$$

and its corresponding t-statistic is given by:

$$t_\rho = \frac{\left(\hat{\rho}-1\right)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}^2}}{\frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}\left(\hat{e}_{it}-\hat{\rho}\hat{e}_{i,t-1}\right)^2} \tag{4.88}$$

Under the null of no cointegration, Kao proposes five test statistics. The *DF-t*, the modified *DF-t*, the unadjusted *DF-t*, the unadjusted modified *DF-t* and the *ADF* tests. The test statistics based on *DF* regression are

$$DF_t = \frac{t_\rho + \sqrt{6N}\hat{\sigma}_\nu/2\hat{\omega}_\nu}{\sqrt{\hat{\omega}_\nu^2/2\hat{\sigma}_\nu^2 + 3\hat{\sigma}_\nu^2/10\hat{\omega}_\nu^2}} \tag{4.89}$$

$$\text{Modified} \quad DF_t = \frac{\sqrt{N}T\left(\hat{\rho}-1\right) + 3\sqrt{N}\hat{\sigma}_\nu^2/\hat{\omega}_\nu^2}{\sqrt{3 + 36\hat{\sigma}_\nu^4/5\hat{\omega}_\nu^4}} \tag{4.90}$$

$$\text{Unadjusted} \quad DF_t = \sqrt{1.25}t_p + \sqrt{1.875N} \tag{4.91}$$

$$\text{Unadjusted-modified} \quad DF_t = \frac{\sqrt{N}T\left(\hat{\rho}-1\right) + 3\sqrt{N}}{\sqrt{10.2}} \tag{4.92}$$

The test statistic based on *ADF* regression is calculated by:

$$ADF \quad t = \frac{t_{ADF} + \sqrt{6N}\hat{\sigma}_\nu/2\hat{\omega}_\nu}{\sqrt{\hat{\omega}_\nu^2/2\hat{\sigma}_\nu^2 + 3\hat{\sigma}_\nu^2/10\hat{\omega}_\nu^2)}} \tag{4.93}$$

where

$$t_{ADF} = \frac{\hat{\rho}}{\hat{SE}(\hat{\rho})} \tag{4.94}$$

The $\hat{\rho}$ is the estimated value of ρ. $\hat{\sigma}_\nu^2$ and $\hat{\omega}_\nu^2$ are scalar terms that are consistent estimates of $\hat{\sigma}_\nu^2 = \hat{\sigma}_u^2 - \boldsymbol{\Sigma}_{u\epsilon}^{'}\boldsymbol{\Sigma}_{\epsilon}\boldsymbol{\Sigma}_{u\epsilon}$ and $\hat{\omega}_\nu^2 = \hat{\omega}_u^2 - \boldsymbol{\Omega}_{u\epsilon}^{'}\boldsymbol{\Omega}_{\epsilon}\boldsymbol{\Omega}_{u\epsilon}$.[5] t_ρ is the t statistic for testing the null hypothesis $H_0 : \rho = 1$. Also, the first two DF_t tests are based on the cointegration with endogenous relationship between the regressors and errors, while the unadjusted assume strict exogeneity and absence of serial correlation. Following the standard normal distribution, the asymptotic distribution of all five test statistics converges to *N(0,1)*.

4.7.2 The Pedroni tests

Pedroni (2004) proposes test statistics based on a model in which the AR parameter either is panel-specific, where all panels have individual slope coefficients, or is the same over the panels. He also calls the panel-specific-AR test statistics "between dimension" and the same-AR test statistics "within dimension".

Now, consider again the following regression:

$$Y_{it} = \gamma_i + \boldsymbol{X_{it}^{'}}\boldsymbol{\beta_i} + \boldsymbol{e_{it}} \tag{4.95}$$

where $i - 1, ...N$ denotes the panel and $t = 1, ...T$ the time. γ_i is the panel-specific fixed effects requiring to be heterogeneous, and $\boldsymbol{\beta_i}$ is the panel-specific cointegrating vector. Also, Y_{it} and X_{it} are I(1) and non cointegrated, while $\boldsymbol{e_{it}}$ is the error term. The general approach by Pedroni is to obtain residuals from the equation above and then to test whether residuals are I(1) by running the auxiliary regressions, either DF (4.80) or the augmented version *(ADF)* 4.81. He describes various methods of constructing statistics for testing for null hypothesis of no cointegration ($\rho_i = 1$). There are also two alternative hypotheses, such that of the homogenous $(\rho_i = \rho) < 1$ for all i and the heterogeneous $\rho_i < 1$ for all i. Seven different cointegration statistics are proposed and can be classified into two categories. The first category includes three tests and is the panel specific AR test, while the second is based on the same AR across all panels. The panel-specific-AR test statistics are given below:

$$\text{Modified} \quad PP \quad t = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^2\right)^{-1}\sum_{t=1}^{T}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right) \tag{4.96}$$

[5]See details below for the long-run variance matrix.

$$PP \quad t = N^{-1/2} \sum_{i=1}^{N} \left(\hat{\sigma}_i^2 \sum_{t=1}^{T} \hat{e}_{i,t-1}^2 \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right) \tag{4.97}$$

$$ADF \quad t = N^{-1/2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^{*2} \hat{e}_{i,t-1}^2 \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} \right) \tag{4.98}$$

where e_{it} are the residuals from the panel-data regression model in *(4.77)*, and λ_i is calculated as below:

$$\hat{\lambda}_i = \frac{1}{2} \left(\hat{\sigma}_i^2 - \hat{s}_i^2 \right) \tag{4.99}$$

$\hat{s}_i^2$ and $\hat{\sigma}_i^2$ are the individual contemporaneous and long-run variances of the residuals from the DF regression. $\hat{s}_i^{*2}$ is the individual contemporaneous variance of the residuals from the ADF regression, where the panel-specific ρ_i is instead of ρ.

The same-AR test statistics are

$$\text{Modified} \quad VR \quad = \frac{T^2 N^{3/2}}{\left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{i,t-1}^2 \right)} \tag{4.100}$$

$$\text{Modified} \quad PP \quad t = \frac{T\sqrt{N} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{\epsilon}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right)}{\left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{i,t-1}^2 \right)} \tag{4.101}$$

$$PP \quad t = \frac{\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{\epsilon}_{i,t-1} \Delta \hat{\epsilon}_{i,t} - \hat{\lambda}_i \right)}{\sqrt{\tilde{\sigma}_{N,T}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{i,t-1}^2}} \tag{4.102}$$

$$ADF \quad t = \frac{\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{i,t-1} \Delta \hat{\epsilon}_{i,t}}{\sqrt{\tilde{s}_{N,T}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{i,t-1}^2}} \tag{4.103}$$

where the residuals are as defined above and

$$\tilde{\sigma}_{N,T}^2 = \frac{1}{N} \hat{L}_{11i}^{-2} \hat{\sigma}_i^2 \tag{4.104}$$

$$\hat{L}_{11i}^{-2} = \hat{\omega}_{u,i}^2 - \hat{\Omega}_{\boldsymbol{u\epsilon,i}} \hat{\Omega}_{\boldsymbol{\epsilon,i}} \hat{\Omega}_{\boldsymbol{u\epsilon,i}}' \tag{4.105}$$

$$\tilde{s}^{*2}_{N,T} = \frac{1}{N}\sum_{i=1}^{N} \tilde{s}^{*2}_i \tag{4.106}$$

The asymptotic distribution of all test statistics, after appropriate standardization, converges to $N(0,1)$. The adjustment is given by

$$\frac{\chi - \mu\sqrt{N}}{\sqrt{\nu}} \tag{4.107}$$

where χ is any of the test statistics given above, and the parameters μ and ν are the mean and variance of the test statistic obtained through simulation.

4.7.3 Westerlund tests

Westerlund (2005) assumes panel-specific cointegrating vectors as in *(4.77)*, where all panels have individual slope coefficients. The VR test statistics are obtained by testing for a unit root in the predicted residuals using the DF regression in *(4.80)*. He derives test statistics based on a model in which the AR parameter either is panel-specific or is the same over the panels. The panel-specific-AR test statistic is used to test the null hypothesis of no cointegration against the alternative hypothesis that some panels are cointegrated. The same-AR test statistic is used to test the null hypothesis of no cointegration against the alternative hypothesis that all the panels are cointegrated.

The panel-specific-AR test statistic is given by

$$VR = \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{E}^2_{it}\hat{R}^{-1}_i \tag{4.108}$$

The same-AR test statistic is given by

$$VR = \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{E}^2_{it}\left(\sum_{i=1}^{N}\hat{R}_i\right)^{-1} \tag{4.109}$$

where $\hat{E}_{it} = \sum_{j=1}^{t}\hat{e}_{ij}$, $\hat{R}_i = \sum_{T=1}^{t}\hat{e}^2_{ij}$ are the residuals from the panel-data regression model in *(4.77)*. The asymptotic distribution of all test statistics, after appropriate standardization, converges to $N(0,1)$.

Long run covariance matrix

Considering the model (4.77) the data generating process for y_{it} and $\boldsymbol{x_{it}}$ is given by

$$y_{it} = y_{i,t-1} + u_{it} \tag{4.110}$$

$$\boldsymbol{x_{it}} = \boldsymbol{x_{i,t-1}} + \boldsymbol{\epsilon_{it}} \tag{4.111}$$

The covariance of

$$\boldsymbol{\omega_{it}} = \begin{bmatrix} u_{it} \\ \boldsymbol{\epsilon_{it}} \end{bmatrix},$$

denotes a $(k+1) \times 1$ vector process with zero mean and long-run covariance matrix Ω_i. The long-run matrix can be decomposed as $\boldsymbol{\Omega_i = \Sigma_i + \Gamma_i' + \Gamma_i}$, where Σ_i and Γ_i denote the contemporaneous and autocovariance matrices for a given panel i. The elements of long-run contemporaneous matrices Ω_i and Σ_i are given by

$$\boldsymbol{\Omega_i} = \begin{pmatrix} \hat{\omega}^2_{u,i} & \boldsymbol{\Omega}_u \boldsymbol{\epsilon_i} \\ \boldsymbol{\Omega'}_u \boldsymbol{\epsilon_i} & \boldsymbol{\Omega\epsilon_i} \end{pmatrix} \tag{4.112}$$

$$\boldsymbol{\Sigma_i} = \begin{pmatrix} \hat{\sigma}^2_{u,i} & \boldsymbol{\Sigma}_u \boldsymbol{\epsilon_i} \\ \boldsymbol{\Sigma'}_u \boldsymbol{\epsilon_i} & \boldsymbol{\Sigma\epsilon_i} \end{pmatrix} \tag{4.113}$$

Consistent estimators $\boldsymbol{\hat{\Omega}_i}$ and $\boldsymbol{\hat{\Sigma}_i}$ are obtained using Newey and West (1987), which is given by

$$\boldsymbol{\hat{\Omega}_i} = \frac{T}{1} \sum_{t=1}^{T} \boldsymbol{\hat{\omega}_{it} \hat{\omega}'_{it}} + \frac{1}{T} \sum_{j=1}^{m} K(j,m) \sum_{t=j+1}^{T} (\boldsymbol{\hat{\omega}_{it} \hat{\omega}'_{it}} + \boldsymbol{\hat{\omega}_{i,t-j} \hat{\omega}'_{i,t-j}})$$

where m is the maximum number of lags and $K(j,m)$ is the kernel weight function.

4.8 Dynamic heterogeneous panels

4.8.1 Introduction

The dynamic models are very important, especially in economics, because many economic relationships are dynamic in nature and are used to express and model the behaviour of the system over time (Asteriou and Price, 2001). Consider the following simple dynamic model:

$$Y_{it} = \alpha_i + \lambda Y_{i,t-1} + \beta_i' X_{it} + \epsilon_{it} \tag{4.114}$$

where *i=1,...N, and t=1,...T*, λ_i is a scalar, and β_i and X are each $k \times 1$. Also, as a dynamic model, includes a lagged dependent variable ($Y_{i,t-1}$) among the explanatory variables. In this model, the only heterogeneity comes from the intercepts α_i, which are allowed to vary across different sections. The time dimension of panel data is used to capture the dynamics of adjustment. The dynamic panel data regression described in *(4.115)* is characterised by two sources of persistence over time: autocorrelation due to the presence of a dependent variable among the regressors, and individual effects characterizing the heterogeneity among the individuals (Baltagi, 1997). Thus, the problem with dynamic panels is that the traditional OLS estimators are biased and therefore different methods of estimation need to be introduced (Asteriou and Price, 2001).

The bias and inconsistency in fixed and random effect

Since Y_{it} is a function of α_i, it immediately follows that $Y_{i,t-1}$ is also a function of α_i. Therefore $Y_{i,t-1}$ which is a right hand regressor in *(4.74)*, is correlated with the error term.[6] This renders the OLS estimator biased and inconsistent even if the ϵ_{it} are not serially correlated. For the Fixed effects estimator, the within transformation eliminates the α_i, but $Y_{i,t-1} - \bar{Y}_{i,-1}$, where $\bar{Y}_i = \sum_{t=2}^{T} Y_{i,t-1}/\big(T-1\big)$, will still be correlated with $\big(\epsilon_{it} - \bar{\epsilon}_i\big)$ even the ϵ_{it} are not serially correlated. This is because $Y_{i,t-1}$ is correlated with $\bar{\epsilon}_i$. As for the random effect estimator, the problem is similar to the that of the estimation of the fixed effects model.

For panel data studies when the regression coefficients vary across individuals, they are heterogeneous but assumed homogeneous in estimation. Asteriou and Price (2001) argued that all panel data models make the basic assumption that at least some parameters are the same across the panel; this is referred to as the pooling assumption. When pooling assumption does not hold, a panel is referred to as a heterogeneous panel, and severe biases can occur in dynamic estimation. Pesaran and Smith (1995) considered the problem of estimating the dynamic panel data model when the coefficients are individually heterogeneous. Their model is given by

$$Y_{it} = \lambda_i Y_{i,t-1} + \beta_i' \boldsymbol{X}_{it} + u_{it} \tag{4.115}$$

where *i=1,...,N,* and *t=1,...T*. The objective is to obtain consistent estimates of the mean values of λ_i and β_i. The difficulty is in obtaining consistent estimates for λ and β. Assuming that the coefficients vary across groups Pesaran and Smith (1995) presented the following random coefficient model:

$$\lambda_i = \lambda + \eta_{1i} \quad and \quad \beta_i = \beta + \eta_{2i} \tag{4.116}$$

where η_{1i} and η_{2i} are assumed to have zero means and constant covariances. This is the standard formulation of the random coefficients model (RCM), and introduces parameter

[6]The composite error term is $u_{it} = \alpha_i + \epsilon_{it}$

heterogeneity through the short-run coefficients, β_i and λ_i (Fabozzi and Francis, 1978). Substituting these two equations of *(4.117)* to *(4.116)* it is obtained:

$$Y_{it} = \alpha_i + \lambda Y_{i,t-1} + \eta_{1i} Y_{i,t-1} + \boldsymbol{\beta' X_{it}} + \boldsymbol{\eta'_{2i} X_{it}} + \epsilon_{it} \tag{4.117}$$

and

$$\nu_{it} = \epsilon_{it} + \eta_{1i} Y_{i,t-1} + \boldsymbol{\eta'_{2i} X_{it}} \tag{4.118}$$

It is now easily seen that $Y_{i,t-1}$ and $\boldsymbol{X_{it}}$ are correlated with ν_{it}, thus rendering the OLS estimator inconsistent.

Solutions to the bias problem

Two different solutions to heterogeneity bias come from Pesaran *et al.* (1995, 1999), who suggested two different estimators resolve the bias caused by heterogeneous slopes in dynamic panels. They showed that when both T and N are large, the regression procedure will yield consistent estimates of the mean values of λ and β. These two solutions are the mean group (MG) estimator and the pooled mean group (PMG) estimator. In MG method, when T is large, the individual parameters λ_i and β_i can be consistently estimated by using T observations of each individual i, giving $\hat{\lambda}_i$ and $\hat{\beta}_i$. Then averaging these individual estimators will lead to consistent estimators of the mean values of λ and β. In PMG method, if the data allows, they proposed estimation by pooling only the long-run parameters, while the short-run coefficients are allowed to vary. Below, is introduced the cross-section estimator aggregating over time, to get consistent estimators:

$$\bar{Y}_i = \boldsymbol{\beta'_i \bar{X}}_i + \lambda_i \bar{Y}_{i,-1} + \bar{\epsilon}_i \tag{4.119}$$

where,
$\bar{Y}_i = T^{-1}\sum_{t=1}^{T} Y_{it}$, $\bar{Y}_{i,t-1} = T^{-1}\sum_{t=1}^{T} Y_{i,t-1}$, $\bar{X}_i = T^{-1}\sum_{t=1}^{T} X_{it}$, $\epsilon_i = T^{-1}\sum_{t=1}^{T} \epsilon_{i,t}$.
Hence, the equation above becomes as below:

$$\bar{Y}_i = \boldsymbol{\beta' \bar{X}_i} + \lambda \bar{Y}_{i,-1} + \bar{\nu}_i \tag{4.120}$$

where

$$\bar{\nu}_i = \eta_{1i} \bar{Y}_{i,-1} + \boldsymbol{\eta'_{2i} \bar{X}_i} + \bar{\epsilon}_i \tag{4.121}$$

The regression defined by (4.120) will produce inconsistent estimates of β and λ as $N, T \to \infty$. This is due to the fact that $\bar{\nu}_i$ is correlated with $\bar{Y}_{i,-1}$ even for large T. A more promising route is to rewrite (4.120) using back substitution which yields

$$\bar{Y}_i = \beta_i' \bar{\boldsymbol{X}}_i + \lambda_i \big(\bar{Y}_i - \Delta_T Y_i\big) + \bar{\epsilon}_i \tag{4.122}$$

where the growth term $\Delta_T Y_i = (Y_{iT} - Y_{i0}/T)$ captures the end effects. Then $\bar{Y}_i$ becomes

$$\bar{Y}_i = \frac{\beta_i'}{1-\lambda_i} \bar{\boldsymbol{X}}_i - \frac{\lambda_i}{1-\lambda_i} \Delta_T Y_i + \frac{1}{1-\lambda_i} \bar{\epsilon}_i = \theta_i' \bar{\boldsymbol{X}}_i - \psi_i \Delta_T Y_i + \frac{1}{1-\lambda_i} \bar{\epsilon}_i \tag{4.123}$$

which can be rewritten

$$\bar{Y}_i = \theta_i' \bar{\boldsymbol{X}}_{\boldsymbol{i}} - \psi_i \Delta_T Y_i + \frac{1}{1-\lambda_i} \bar{\epsilon}_i \tag{4.124}$$

Thus the coefficients in this cross-section regression are in fact the appropriate long-run averages. With the coefficients varying across groups according to the random coefficient model, $\psi_i = \psi + \xi_{1i}$ and $\theta_i = \theta + \xi_{2i}$, the cross-section regression is

$$\bar{Y}_i = \theta' \bar{\boldsymbol{X}}_i - \psi \Delta_T Y_i + \bar{u}_i \tag{4.125}$$

where

$$\bar{u}_i = \frac{1}{1-\lambda_i} \bar{\epsilon}_i + \xi_{2i}' \bar{\boldsymbol{X}}_i - \xi_{1i} \Delta_T Y_i \tag{4.126}$$

and the cross-section estimates of the average long-run coefficients are given by

$$\hat{\theta} = \left(\sum_{i=1}^{N} \bar{\boldsymbol{X}}_{\boldsymbol{i}} \bar{\boldsymbol{X}}_{\boldsymbol{i}}' \right)^{-1} \left(\sum_{i=1}^{N} \bar{\boldsymbol{X}}_{\boldsymbol{i}} \bar{Y}_i \right) \tag{4.127}$$

However, the growth terms now such as $\Delta_T Y_i$ are uncorrelated with the level terms. This suggests that cross-section estimates of the average long-run effect, θ will be robust and consistent. In order to identify the long-run and short-run effects, as well as to investigate the heterogenous dynamic issues across cross-sections, the appropriate technique to be used to the analysis of dynamic panels is based on the autoregressive distributed lag ARDL *(p,q)* model in the error correction form. The ARDL model, especially Mean Group (MG) and Pooled Mean Group (PMG), provide consistent coefficients despite the possible presence of endogeneity because it includes lags of dependent variables (Pesaran et al., 1999). The two different estimators (MG and PMG), are presented below.

4.8.2 The mean group (MG) estimator

The mean group (MG) estimates method was introduced by Pesaran and Smith (1995), where a separate regression for each cross-section and calculating the coefficients as unweighted means of the estimated coefficients for the individual cross-sections. This does not impose any restrictions and allows for all coefficients to vary and be heterogeneous in the long-run and short-run. The method estimates short-run parameters by taking an average of individual parameters of each cross-section. The long-run coefficients can be obtained through different ways; from the mean of the long-run cross-section coefficients; from the average of cross-section short-run coefficients; from the mean coefficients in the cross-section cointegrating regressions. In order to illustrate how this method works and based on Pesaran and Smith (1995) study, it is estimated the equation for each cross-section with the autoregressive distributed lag (ARDL) form as below:

$$Y_{it} = \alpha_i + \lambda_{1i} Y_{i,t-1} + \lambda_{2i} Y_{i,t-2} + \beta_{0i} X_{it} + \beta_{1i} X_{i,t-1} + \beta_{2i} X_{i,t-2} + \epsilon_{it} \tag{4.128}$$

where λ_{1i}, λ_{2i}, β_{1i} and β_{2i} are the coefficients of the first and second lags of Y_{it} and X_{it} accordingly. For cross-section *i=1,2,...,N,* then the long-run parameter with respect to X is as:

$$\phi_i = \beta_{0i} + \beta_{1i} + \beta_{2i}/(1 - \lambda_{1i} - \lambda_{2i}) \tag{4.129}$$

and if

$$\beta_i = \beta_{0i} + \beta_{1i} + \beta_{2i} \tag{4.130}$$

then

$$\theta_i = 1 - \lambda_{1i} - \lambda_{2i} \tag{4.131}$$

then the long-run parameter becomes,

$$\phi_i = \beta_i / \theta_i \tag{4.132}$$

Now, according to the first way, the mean of the long-run cross-section coefficients for the whole panel will be given by:

$$\hat{\phi} = \sum_{i=1}^{N} \hat{\phi}_i / N. \tag{4.133}$$

and

$$\hat{\alpha} = \sum_{i=1}^{N} \hat{\alpha}_i / N. \tag{4.134}$$

According to the second way, the long run estimates is calculated from the means of the short-run coefficients use for λ_s

$$\bar{\lambda}_1 = \sum_{i=1}^{N} \hat{\lambda}_{1i}/N \quad \bar{\lambda}_2 = \sum_{i=1}^{N} \hat{\lambda}_{1i}/N \tag{4.135}$$

and for β_s

$$\bar{\beta}_0 = \sum_{i=1}^{N} \hat{\beta}_{0i}/N, \quad \bar{\beta}_1 = \sum_{i=1}^{N} \hat{\beta}_{1i}/N \quad \bar{\beta}_2 = \sum_{i=1}^{N} \hat{\beta}_{2i}/N \tag{4.136}$$

to give estimates for the long-run as follows:

$$\bar{\phi} = \frac{(\bar{\beta}_0 + \bar{\beta}_1 + \bar{\beta}_2)}{(1 - \lambda_{1i} - \lambda_{2i})} \tag{4.137}$$

The cointegrating regressions have the form

$$Y_{it} = \alpha_i + \phi_i X_{it} + u_{it} \tag{4.138}$$

and the average long-run effects are computes as $\bar{\phi} = \sum_{i=1}^{N} \hat{\phi}_i/N$. The MG is consistent and has sufficiently large asymptotic distributions for N and T. The necessary condition for the consistency and validity of this approach is to have a sufficiently sizeable time-series dimension of data *(to include about 20 to 30 cross-sections)*. When T is small, the MG estimator is biased and can cause misleading results. Additionally, for small N, the average estimators (MG) are quite sensitive to the outliers (Favara, 2003).

4.8.3 The pooled mean group (PMG) estimator

The PMG method of estimation only the short-run coefficients are allowed to differ across cross-sections, while long-run slope coefficients are restricted to be homogeneous across cross-sections. Also, the model includes the intercepts, the speed of adjustment to the long-run equilibrium values. Based on Pesaran et al. (1999), the dynamic heterogeneous panel regression can be incorporated into the error correction model using the autoregressive distributed lag ARDL (p,q) technique. Consider the following simple dynamic ARDL model for only one lagged term of X and Y:

$$Y_{it} = \lambda_i Y_{i,t-1} + \beta_{1i} X_{it} + \beta_{2i} X_{i,t-1} + \mu_i + \epsilon_{it} \tag{4.139}$$

where all coefficients are allowed to vary across cross-sectional units. If the ARDL model above is re-parameterized as below:

$$\overbrace{Y_{it} - Y_{i,t-1}}^{\Delta Y_{it}} = \overbrace{\lambda_i Y_{i,t-1} - Y_{i,t-1}}^{-\left(1-\lambda_i\right)Y_{i,t-1}} + \overbrace{\beta_{1i}X_{it} - \beta_{1i}X_{i,t-1}}^{\beta_{1i}\Delta X_{i,t-1}} + \overbrace{\beta_{1i}X_{i,t-1} + \beta_{2i}X_{i,t-1}}^{\left(\beta_{1i}+\beta_{2i}\right)X_{i,t-1}} + \mu_i + \epsilon_{it} \tag{4.140}$$

then

$$\Delta Y_{it} = \beta_{1i}\Delta X_{it} - \left(1-\lambda_i\right)\left(Y_{i,t-1} - \frac{\beta_{1i}+\beta_{2i}}{1-\lambda_i}X_{i,t-1}\right) + \mu_i + \epsilon_{it} \tag{4.141}$$

and substituting $1-\lambda_i = \phi_i$, $\beta_{1i}+\beta_{2i} = \beta_i$ the equation becomes:

$$\Delta Y_{it} = \beta_{1i}\Delta X_{it} - \phi_i \overbrace{\left(Y_{i,t-1} - \beta_i^{'}X_{i,t-1}\right)}^{ECM} + \mu_i + \epsilon_i \tag{4.142}$$

where *ECM= Error correction model*, and if the heterogenous model is generalised incorporating a range of lags of first differences in *Xs* and *Ys* as well as the error correction model the equation is as follows:

$$\Delta Y_{it} = \sum_{j=1}^{p-1}\gamma_i\Delta Y_{i,t-j} + \sum_{j=0}^{q-1}\delta_i\Delta X_{i,t-j} - \phi_i\left(Y_{i,t-1} - \theta_i^{'}X_{i,t-1}\right) + \mu_i + \epsilon_i \tag{4.143}$$

where $\boldsymbol{Y}$ is the dependent variable, $\boldsymbol{X}$ is a set of independent variables, $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ represent the short-run coefficients related growth to its past values of lagged dependent and independent variables respectively, $\boldsymbol{\theta}_{1i} = -\beta_i/\phi_i$ are the long-run coefficients, $\boldsymbol{\phi}_i$ is the coefficient of speed of adjustment to the long-run equilibrium. The subscripts i and t represent units and time respectively. The pooled mean group restriction is that the elements of β are common across cross-sections:

$$\Delta y_{it} = \sum_{j=1}^{p-1}\gamma_i\Delta y_{i,t-j} + \sum_{j=0}^{q-1}\delta_i\Delta x_{i,t-j} - \phi_i\left(y_{i,t-1} - \beta^{'}x_{i,t-1}\right) + \mu_i + \epsilon_i \tag{4.144}$$

Therefore, the long-run relationship is expected to be identical in the cross-sections. The homogeneity of long-run slope coefficients can be easily carried out using maximum likelihood (ML) estimation of the long-run coefficients, $\boldsymbol{\theta}$, and the group-specific error-correction coefficients, ϕ_i. The ML estimators will be referred to as the "pooled mean group" estimators in order to highlight the pooling effect of the homogeneity restrictions on the estimates of the long-run coefficients. Also, Pesaran et al. (1999) proved that under some assumptions, the parameter estimates of this model are consistent and asymptotically normal for both stationary and non-stationary I(1) regressors. Both methods, MG and PMG, require the appropriate lag lengths using the Schwartz Bayesian criterion. Also, Pesaran proposed a Hausman test based on the result that an estimate of the long-run parameters can be derived from the average mean group of the cross-section regressions. This is consistent even under heterogeneity. The test statistic is constructed as below:

$$H = \hat{q}^{'} \left[var(\hat{q}) \right]^{-1} \hat{q} \sim \chi^2_k \tag{4.145}$$

where $\hat{q}$ is a $(k \times 1)$ vector of the difference between the mean group and PMG estimates and $var(\hat{q})$ is the corresponding covariance matrix. The null hypothesis is that the two estimators are consistent but only one is efficient, $var(\hat{q})$ is easily calculated as the difference between the covariance matrices for the two parameter vectors. If the poolability assumption is invalid, then the PMG estimates are no longer consistent and the test fails.

4.9 Multivariate analysis-Factor models

4.9.1 Introduction

The field of multivariate analysis consists of those statistical methods that consider two or more related random variables as a single entity and attempts to produce an overall result taking into account the relationship among the variables. These statistical methods, namely factor models, can measure things which cannot be measured directly (so-called unobservable or latent variables). For example, the present study might be interested in measuring financial development as one, two, or more indices, which cannot be measured directly, and has many facets. However, different aspects of financial development can be measured such that of financial development of bank sector, financial development of the stock market sector, and so on. Having done this, it would be helpful whether these aspects reflect a single variable.

Also, factor models try to measure different variables driven by the same underlying factor. In particular, the models are employed primarily as dimensionality reduction techniques in situations where a large number of closely related variables have the most important influence at the same time. The models decompose the structure of a set of series into factors that are common to all series and a proportion that is specific to each series. There are broadly two types of such factor models to analyze. The first is the principal component analysis, and the second is the factor analysis. The key distinction between the two is that the factors are observable for the former but are latent for the latter. The primary use of these statistical methods is to reduce a data set to more meaningful size while retaining as much of the original information. Also, both techniques are used to identify clusters of variables, which are called factors in factor analysis and components in the principal component analysis.

Pricipal component analysis (PCA) transforms the data into a set of linear components; it does not estimate unmeasured variables; it just transforms measured ones. Also, it tries to explain the maximum amount of total variance (not just common variance) in a correlation matrix by transforming the original variables into liner components.

Factor analysis, in contrast, attempts to achieve parsimony by explaining the maximum amount of common variance in a correlation matrix using the smallest number of explanatory constructs. These explanatory constructs are known as factors or latent variables in factor analysis, and they represent clusters variables that correlate highly with each other. Also, the factors are estimated from the data and reflect constructs that cannot be measured directly.

4.9.2 Principal component analysis *(PCA)*

The most common mathematical factor model is PCA. The method of principal components is a statistical technique used for data reduction and was developed by Pearson (1901) and Hotelling (1933). It helps to reduce the number of variables through a linear transformation of a group of correlated variables, and the obtained transformed variables are uncorrelated (orthogonal), containing most of their variance. However, PCA is a technique that is useful when the independent variables are highly correlated-for example, in the context of near multicollinearity. Generally, PCA is employed with two perspectives in mind. One is the lowered dimension, and the other is the orthogonality of new dimensions (PC_s). Consider the matrices of k observable random variables $\boldsymbol{X_1, ..., X_k}$, with N observations each of them

$$\boldsymbol{X_1} = \begin{bmatrix} x_1^1 \\ x_1^2 \\ . \\ . \\ . \\ x_1^N \end{bmatrix}_{N\times 1}, \boldsymbol{X_2} = \begin{bmatrix} x_2^1 \\ x_2^2 \\ . \\ . \\ . \\ x_2^N \end{bmatrix}_{N\times 1}, \quad . \quad . \quad . \quad \boldsymbol{X_k} = \begin{bmatrix} x_k^1 \\ x_k^2 \\ . \\ . \\ . \\ x_k^N \end{bmatrix}_{N\times 1},$$

When the regression model includes k explanatory variables, PCA will transform them into k uncorrelated new variables. The new transformed uncorrelated variables are the principal components and are denoted by $\boldsymbol{Z_1, ..., Z_k}$. These principal components $\boldsymbol{Z_i}$ are independent linear combinations of the original data and standardized (mean 0, variance

1). The representing model in PCA can be written in two ways. The first is the vector of equations, where this particular model ignores the vector of observations and estimates the equations on the row. Specifically, the vector of equations is as below:

$$\begin{aligned}
\boldsymbol{Z_1} &= \alpha_{11}\boldsymbol{X_1} + \alpha_{12}\boldsymbol{X_2} + ... + \alpha_{1j}\boldsymbol{X_j} + ... + \alpha_{1k}\boldsymbol{X_k} \\
\boldsymbol{Z_2} &= \alpha_{21}\boldsymbol{X_1} + \alpha_{22}\boldsymbol{X_2} + ... + \alpha_{2j}\boldsymbol{X_j} + ... + \alpha_{2k}\boldsymbol{X_k} \\
\cdots & \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\
\boldsymbol{Z_i} &= \alpha_{i1}\boldsymbol{X_1} + \alpha_{i2}\boldsymbol{X_2} + ... + \alpha_{ij}\boldsymbol{X_j} + ... + \alpha_{ik}\boldsymbol{X_k} \\
\cdots & \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\
\boldsymbol{Z_k} &= \alpha_{k1}\boldsymbol{X_1} + \alpha_{k2}\boldsymbol{X_2} + ... + \alpha_{kj}\boldsymbol{X_j} + ... + \alpha_{kk}\boldsymbol{X_k}
\end{aligned} \tag{4.146}$$

where $i = 1, 2, ..., k$ is the number of principal components, $j = 1, ..., k$ is the number of variables, α_{ij} are coefficients to be calculated, representing the coefficient on the j_{th} explanatory variable in the i_{th} principal component. The coefficients are also known as loading factors or component loadings in PCA, and are the correlation coefficients between the variables (rows) and factors (columns). Also, there will be n observations on each principal component if there are n observations on each explanatory variable. The values of the principal components represent the component scores in PCA, and these scores are the scores of each case (row) on each factor (column).

$$\boldsymbol{Z_1} = \begin{bmatrix} z_1^1 \\ z_1^2 \\ . \\ . \\ . \\ z_1^N \end{bmatrix}_{N\times 1}, \quad \boldsymbol{Z_2} = \begin{bmatrix} z_2^1 \\ z_2^2 \\ . \\ . \\ . \\ z_2^N \end{bmatrix}_{N\times 1}, \quad . \quad . \quad . \quad \boldsymbol{Z_i} = \begin{bmatrix} z_i^1 \\ z_i^2 \\ . \\ . \\ . \\ z_i^N \end{bmatrix}_{N\times 1},$$

If those observations are stacked, the Z_i vectors of equations are

$$\begin{bmatrix} Z_1 \\ Z_2 \\ . \\ . \\ Z_k \end{bmatrix}_{k\times 1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & . & \alpha_{1k} \\ \alpha_{21} & \alpha_{22} & . & . \\ . & . & . & . \\ . & . & . & . \\ \alpha_{k1} & . & . & \alpha_{kk} \end{bmatrix}_{k\times k} \begin{bmatrix} X_1 \\ X_2 \\ . \\ . \\ X_k \end{bmatrix}_{k\times 1}$$

which can be written in matrix notation

$$\boldsymbol{Z} = \boldsymbol{A^T X}$$

and the matrix representation is

$$\begin{bmatrix} z_{11} & z_{12} & . & . & . & z_{1k} \\ z_{21} & z_{22} & . & . & . & z_{2k} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ z_{i1} & . & . & . & . & z_{ik} \\ . & . & . & . & . & . \\ z_{N1} & . & . & . & . & z_{Nk} \end{bmatrix}_{N\times k} = \begin{bmatrix} x_{11} & x_{12} & . & . & . & x_{1k} \\ x_{21} & x_{22} & . & . & . & x_{2k} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ x_{i1} & . & . & . & . & x_{ik} \\ . & . & . & . & . & . \\ x_{N1} & . & . & . & . & x_{Nk} \end{bmatrix}_{N\times k} \begin{bmatrix} \alpha_{11} & \alpha_{12} & . & \alpha_{1k} \\ \alpha_{21} & \alpha_{22} & . & \alpha_{2k} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ \alpha_{k1} & \alpha_{k2} & . & \alpha_{kk} \end{bmatrix}_{k\times k}$$

It is also required that the sum the squares of the coefficients for each component is one.[7]

$$\begin{aligned} \alpha_{11}^2 + \alpha_{12}^2 + ... + \alpha_{1k}^2 &= 1 \\ \alpha_{21}^2 + \alpha_{22}^2 + ... + \alpha_{2k}^2 &= 1 \\ \cdots \quad \cdots \quad &\cdots \\ \cdots \quad \cdots \quad &\cdots \\ \alpha_{k1}^2 + \alpha_{k2}^2 + ... + \alpha_{kk}^2 &= 1 \end{aligned} \tag{4.147}$$

This requirement can be written using the following notation

$$\sum_{j=1}^{k} \alpha_{ij}^2 = 1 \quad \forall \quad i = 1, ..., k$$

The principal components are derived in such a way that they are in descending order of importance. Although there are k principal components, which is the same as the number of explanatory variables; if there is collinearity between these original variables, some of the principal components will likely account for so little of the variation that they can be discarded. However, if all of the original explanatory variables were already essentially uncorrelated, all of the components would be required, but in such a case there is little motivation for using PCA. The principal components can also be understood as the eigen decomposition of the squared matrix of (XX'), where X is the matrix of observations on the original variables. Thus the number of eigenvalues and corresponding eigenvectors will be equal to the number of variables, k. If the ordered eigenvalues[8] as denoted λ_i where $i = 1, ..., k$, the ratio

$$\phi_i = \frac{\lambda_i}{\sum_{i=1}^{k} \lambda_i} \tag{4.148}$$

[7] See further details in Appendix 4A.

[8] Eigenvalues are also called characteristic roots. See Appendix 4A.

gives the proportion of the total variation in the original data explained by the principal component i. Suppose that only the first j principal components, where $(0 < j < k)$, are deemed sufficiently useful in explaining the variation of (XX'), and that they are to be retained, with the remaining k-j components being discarded. Taking into account that the matrix of eigenvalues is diagonal and ordered from the largest to the smallest, the first factor scores extract as much of the variance of the original data as possible.

Hence, the first principal component has maximal overall variance. The second principal component has maximal variance among all unit length linear combinations that are uncorrelated to the first principal component, etc. The last principal component has the smallest variance among all unit length linear combinations of the variables. In particular, the leading eigenvectors from the eigendecomposition of the correlation or co-variance matrix of the variables describe a series of uncorrelated linear combinations of the variables that contain most of the variance.

All principal components combined contain the same information as the original variables, but the important information is partitioned over the components in a particular way. The components are orthogonal, and earlier components contain more information than later components. The regression finally estimated, after the principal components have been formed, would be one of the y on the j principal components

$$y_{ij} = \hat{\gamma}_0 + \hat{\gamma}_1 z_{i1} + \hat{\gamma}_2 z_{i2} + ... + \hat{\gamma}_j z_{ij} + u_{ij} \tag{4.149}$$

where y_{ij} are the elements of matrix $\boldsymbol{Y}$, i stands for the observations and j is the number of factors. $\hat{\gamma}_j$ are the coefficient estimates for the principal component, and u_{ij} the residuals. In this way, the principal components keep most of the important information contained in the original explanatory variables, but are orthogonal. This may be particular useful for independent variables that are very closely related. If the OLS estimator for the original regression of y on x is denoted $\hat{\beta}$, then

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{u}$$

then it can be re-arranged as

$$\boldsymbol{y} = \boldsymbol{XAA^T\beta} + \boldsymbol{u}$$

where $\boldsymbol{AA^T}$, are the eigenvectors in orthonormal form, that is orthogonal (uncorrelated) and normalised (with unit length, $\boldsymbol{AA^T} = I$). Considering that $\boldsymbol{Z} = \boldsymbol{XA}$ are the transformed principal components, and $\boldsymbol{A^T\beta} = \boldsymbol{\gamma}$ is the new coefficient vector it is obvious to find that

$$\boldsymbol{y} = \boldsymbol{Z}'\boldsymbol{\gamma}$$

where $\boldsymbol{\gamma}$ are the coefficient estimates for the principal components, and $\boldsymbol{Z}'$ is the matrix of the first j principal components. The principal components estimates are simply linear combinations of the original OLS estimates.

4.9.3 Postestimation statistics

After the estimation of principal components and the associated eigenvalues, there are more issues to resolve.

- The first is about the components needed to retain.
- The second is how well is the correlation or covariance matrix approximated by the retained components.
- The third is the interpretation of principal components and if it is possible to improve the interpretability by rotating the retained principal components.

Squared multiple correlations (SMC)

Squared multiple correlations is a standard method for studying correlation matrix to assess whether the variables have strong linear relations with each other. In a sense, these methods could be seen as pre-estimation rather than as a post estimation method. The SMC method is the inspection of the squared multiple correlations (the regression R^2) of each variable on all other variables. SMC measures help identify variables that cannot be explained well from the other variables. For such variables, it should be reevaluated whether they should be included in the analysis.

Also, Kaiser (1974) developed a method to measure the sampling adequacy and compares the correlations and the partial correlations between variables.

0.00	*to*	0.49	*unacceptable*
0.50	*to*	0.59	*miserable*
0.60	*to*	0.69	*mediocre*
0.70	*to*	0.79	*middling*
0.80	*to*	0.89	*meritorious*
0.90	*to*	1.00	*marvelous*

and the formula is

$$KMO = \frac{\sum pr_{ij}^2}{\sum p(\alpha_{ij}^2 + r_{ij}^2)}$$

where $p = (j; i \neq j)$. If the partial correlations are relatively high compared to the correlations, the Kaiser-Meyer-Olkin (KMO) measure is small, and a low-dimensional representation of the data is not possible. Using the characterization of KMO values,

Plots of eigenvalues

After estimating the principal components, it has to be determined how many components to keep. The process of how many PCA_s to keep is called extraction. A useful tool for visualizing the eigenvalues relative to one another, so that to decide the number of components to retain, is the scree plot, which was proposed by Cattell (1966). The author suggested plotting each eigenvalue (Y-axis), against factor with which it is associated (X-axis), and the large eigenvalues should be retained. The retaining components are all with eigenvalues greater than **1** (Kaiser, 1960). Also, another graph developed by Gabriel (1971) is the biplot, which is employed as an enhanced scatterplot that uses both points and vectors to represent structure. In Principal Component Analysis, the axes of a biplot are a pair of principal components.

Rotating the components

Rotating components eliminates some of the properties of principal components. In particular, the first rotated component no longer has maximal variance, the second rotated component no longer has maximal variance among those linear combinations uncorrelated to the first component, etc. If preserving the maximal variance property is very important for the interpretation, and is better not rotating them. In orthogonal rotation, the rotated components are still uncorrelated. The only thing that has changed is that the explanation is distributed differently among the rotated components. If the rotated components have a clearer interpretation, it might be better to use them in subsequent work. The Varimax rotation method maximizes the sum over the columns of the within-column variances. The oblique rotation method does not change the variance that is unexplained by the components, and the rotated components are no longer uncorrelated. This makes measuring the importance of the rotated components more ambiguous.

Component scores

After extracting the number of components and, possibly, the rotation of the components, the component scores are estimated for all respondents. The PC_s are obtained as weighted sum of standardized variables. Finally, for a better understanding, the method of principal components will be illustrated by a hypothetical two-variable example, allowing to introduce the mechanics of *PCA* in Appendix 4A. In particular, it is described how the number of variables is reduced and how principal components and principal components scores are orthogonal as well as several useful properties, some of which are geometric.

4.9.4 Mathematical approach of principal components

Consider the following dataset X

$$X = \begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \\ . & \\ . & \\ . & \\ x_{N1} & x_{n2} \end{bmatrix}_{NX2}$$

where x_1 and x_2 are the two variables of dataset with n observations. One of the first things to be considered, is to provide a quick indication of the relationship between the two variables, and this is a simple two-dimensional data plot between x_1 and x_2, which is displayed below.

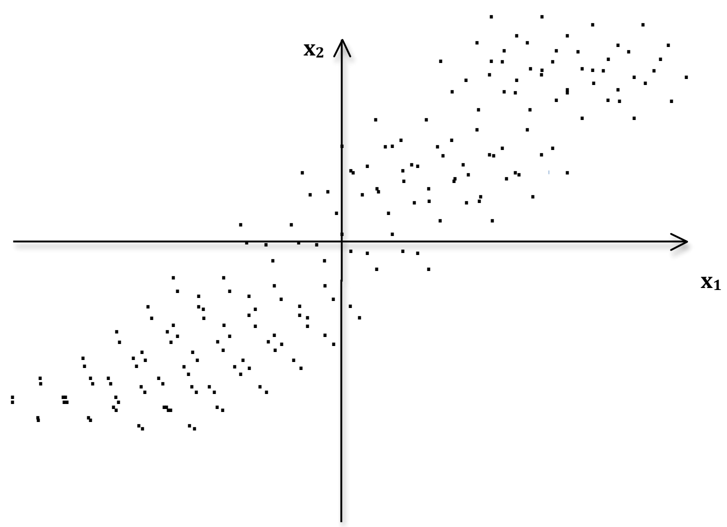


Figure 4.1: The data plot

The figure 4.1 is a graphical representation that shows the relationship between x_1 and x_2. Such a graphical representation is called a scatterplot. Each individual in the data appears as a point of the graph. The values of the one variable (x_1) appear on the horizontal axis, and the values of the other variable, (x_2) appear on the vertical axis. The variables have a positive association, and the graph illustrates a linear relationship as the points of the scatterplot closely resemble a straight line. Also, the crucial information from the graph is the strength of the relationship between x_1 and x_2, which is strong. This means that the variables are highly correlated.

To perform a linear transformation, an orthogonal rotation of the axes is operated, where the PC_s are extracted and the new axes are maintained at 90 degrees. This geometrical procedure is described in figure 4.2 below.

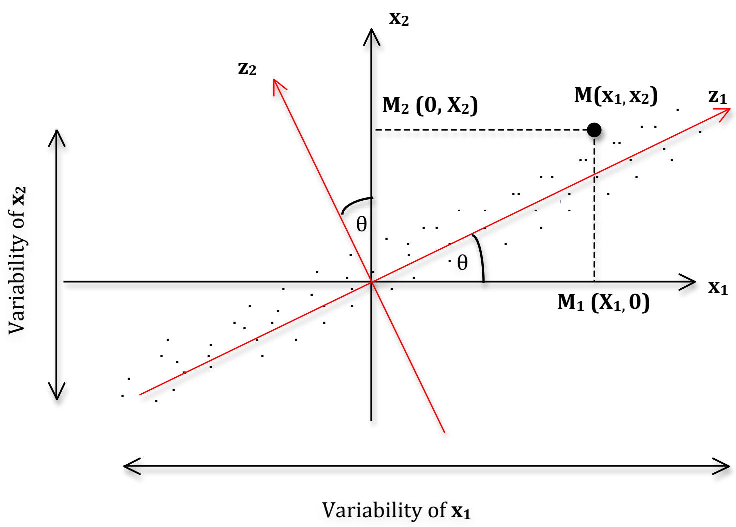


Figure 4.2: The geometry of principal components

Figure 4.2 is a visual of what happens during rotation when there are only two dimensions (x-and y-axis). The points $M_1(X_1, 0)$ and $M_2(0, X_2)$ are the projections of the point $M(x_1, x_2)$ on the axes x_1 and x_2 respectively. The orthogonal rotation of axes x_1 and x_2 by angle θ is nothing more than a principal axis rotation of the original coordinates axes x_1 and x_2. The new axes are the principal components z_1 for x_1 and z_2 for x_2. The new axes coincide with the directions of maximum variation of the original observations, and according to the graph, the variability of x_1 is greater than the variability of x_2. The scatterplot below shows clearly the variability of z_1 and z_2 after the orthogonal rotation.

Figure 4.3 displays the orthogonal rotation of the whole graph, and the two lines are the new axes z_1 and z_2. This rotation makes the left/right and up/down variation easier to see. The data varies a lot left and right and a little up and down. These rotated axes that describe the variation in the data are the principal components (PC_s). z_1 (the first principal component) is the axis that spans the most variation of transformed data, while z_2 (the second principal component)is the axis that has much less variation and can be ignored because the statistical information needed is the variance. Thus, z_1 alone is sufficient to give the information from the original data set and the dimension is reduced. However, it is convenient to use this geometrical representation, and the figure below shows the mathematical procedure that transforms the original data set into a reduced dimension of data set as well as preserve the orthogonality.

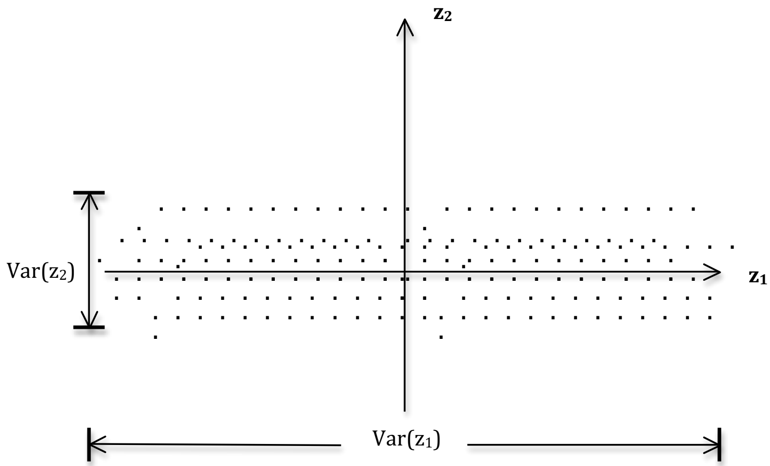


Figure 4.3: The orthogonal rotation axis

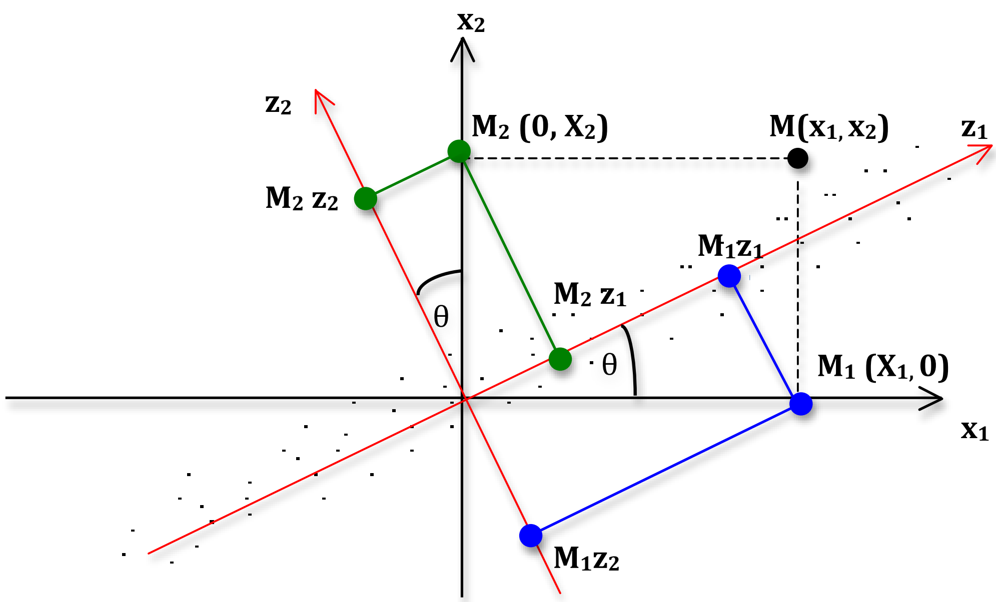


Figure 4.4: Projection of original data

Figure 4.4 illustrates the projection of a representative original data point M_1 onto z_1 and M_2 onto z_2 axes *(Projection of point M onto x_1 and x_2 axes is described in figure 3.1* *above).* The points $\boldsymbol{M_1 z_1, M_2 z_1}$ are the projections of $\boldsymbol{M_1}$ and $\boldsymbol{M_2}$ onto the axis defined by the direction of z_1. This axis has the property that the variance of the projected points x_{1n}, is greater than the variance of points $\boldsymbol{M_1 z_2}$, $\boldsymbol{M_2 z_2}$, when projected on the axis defined by the direction of z_2. The maximum variation of the projected points define the principal axes. It is the line or direction with a maximum variation of the projected values of the original data points. The projected values of maximum variation are the principal component scores. The first principal axis is often called the line of best fit since the sum of squares of the vertical deviations of the original data points from the line is a minimum. Successive principal axes are determined with the property that they are orthogonal to the previous principal axes.

The two principal components z_1 and z_2 are the direction cosines of the new axes related to the old, and the following equations give their linear transformation

$$
\begin{aligned}
z_1 &= x_1 \cos\theta + x_2 \sin\theta \\
z_2 &= -x_1 \sin\theta + x_2 \cos\theta
\end{aligned}
$$

and the matrix notation is

$$
\begin{bmatrix} z_1 \\ z_2 \end{bmatrix}_{2x1} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}_{2x2} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}_{2x1}
$$

This can be re-written as

$$
\boldsymbol{Z = A^T X}
$$

and the vectors obtained from the matrix are

$$
\alpha_1 = \begin{bmatrix} \cos\theta \\ \sin\theta \end{bmatrix}_{2x2} = \begin{bmatrix} \alpha_{11} \\ \alpha_{12} \end{bmatrix}_{2x2}, \quad \textit{and} \quad \alpha_2 = \begin{bmatrix} -\sin\theta \\ \cos\theta \end{bmatrix}_{2x1} = \begin{bmatrix} \alpha_{21} \\ \alpha_{22} \end{bmatrix}_{2x2},
$$

where

$$
\boldsymbol{Z} = \begin{bmatrix} z_1 \\ z_2 \end{bmatrix}_{2x1} \quad \boldsymbol{A^T} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}_{2x2} \quad \boldsymbol{A} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}_{2x2},
$$

However, the vectors α_1 and α_2 are orthogonal, that is,

$$\alpha_1^T \alpha_1 = 1$$

$$\alpha_2^T \alpha_2 = 1$$

$$\alpha_1^T \alpha_2 = 0$$

where this is verified below

$$\alpha_1 = \begin{bmatrix} \cos\theta \\ \sin\theta \end{bmatrix}_{2x2},$$

$$\alpha_1^T \alpha_1 = \begin{bmatrix} \cos\theta \\ \sin\theta \end{bmatrix}_{1x2} \begin{bmatrix} \cos\theta & \sin\theta \end{bmatrix}_{2x1} = \cos^2\theta + \sin^2\theta = 1$$

Similarly, $\alpha_2^T \alpha_2 = 1$, and

$$A^T A = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}_{2x2} \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}_{2x2} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}_{2x2} = AA^T = A^{-1}A = I$$

The identity matrix denotes orthogonal transformation.

Thus, if the original variables are $x_1, ..., x_p$ the following matrix is given

$$\begin{bmatrix} z_1 \\ z_2 \\ . \\ z_j \\ . \\ z_p \end{bmatrix}_{px1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & . & . & \alpha_{1p} \\ \alpha_{21} & \alpha_{22} & . & . & \alpha_{2p} \\ . & . & . & . & . \\ \alpha_{j1} & \alpha_{j2} & . & . & \alpha_{jp} \\ . & . & . & . & . \\ \alpha_{p1} & \alpha_{p2} & . & . & \alpha_{pp} \end{bmatrix}_{pxp} \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ x_p \end{bmatrix}_{px1}$$

and the conceptual model with p variables is

$$\begin{aligned} z_1 &= \alpha_1^T x = \alpha_{11}x_1 + \alpha_{12}x_2 + ... + \alpha_{1p}x_p \\ z_2 &= \alpha_2^T x = \alpha_{21}x_1 + \alpha_{22}x_2 + ... + \alpha_{2p}x_p \\ &\vdots \\ z_j &= \alpha_j^T x = \alpha_{j1}x_1 + \alpha_{j2}x_2 + ... + \alpha_{jp}x_p \\ &\vdots \\ z_p &= \alpha_p^T x = \alpha_{p1}x_1 + \alpha_{p2}x_2 + ... + \alpha_{pp}x_p \end{aligned}$$

where the first principal component z_1, has the maximum of variation. Each j_{th} PC $(\alpha_j^T x)$ is a linear combination of X that maximizes $Var(\alpha_j^T x)$, and subjected to a $\alpha_j^T \alpha_j = 1$ and $Cov(\alpha_j^T x, \alpha_j^T) = 0$.

Given that the variability of PC_s is,

$$Var(\alpha_j^T x) = \alpha_j^T Var(x) \alpha_j$$

then, under the orthogonality condition the covariances are equal to zero, and the variance of the sample is

$$Var(x) = Cov(x) = \boldsymbol{S} = \begin{bmatrix} s_1^2 & s_{12} & . & . & s_{1p} \\ s_{12} & s_2^2 & . & . & s_{2p} \\ . & . & . & . & . \\ . & . & . & . & . \\ s_{1p} & . & . & . & s_p^2 \end{bmatrix}_{pxp},$$

where $\boldsymbol{S}$ is the sample of covariance matrix for p-variable problem, s_i^2 is the variance of the i_{th} variable x_i, and s_{ij} is the covariance between the i_{th} and the j_{th} variables $(i, j = 1, ..., p)$. If the covariances are not equal to zero, it indicates that a linear relationship exists between these two variables, the strength of their relationship is being represented by the correlation coefficient, $r_{ij} = s_{ij}/(s_i s_j)$. The maximization of variability is obtained by the Lagrange multiplier method

$$L = \alpha_j^T S \alpha_j - \lambda(\alpha_j^T \alpha_j - 1)$$

subject to

$$\alpha_j^T \alpha_j = 1$$

$$\frac{\vartheta L}{\vartheta \alpha_j} = 0$$

and gives the following characteristic or determinantal equation of the matrix $\boldsymbol{S}$:

$$(\boldsymbol{S} - \lambda \boldsymbol{I})\alpha_j = \mid \boldsymbol{S} - \lambda \boldsymbol{I} \mid = 0$$

where $\boldsymbol{S}$ is the covariance matrix, λ is a scalar and $\boldsymbol{I}$ is the identity matrix. The equation produces p_{th} path degree of polynomial in λ, since the formula for the determinant is a sum containing p terms, each of which is a product of p elements, one element from each column of $\boldsymbol{S}$. From the solution of the equation, the characteristics roots with the values $\lambda_1, \lambda_2, ..., \lambda_p$, are obtained

$$\mid \boldsymbol{S} \mid = \mid \boldsymbol{\Lambda} \mid = \lambda_1, \lambda_2, ..., \lambda_p$$

or

$$\boldsymbol{det(S)} = \lambda_1, \lambda_2, ..., \lambda_p$$

that is, the determinant of the original covariance matrix is equal to the product of the characteristics roots, which are the component loadings (correlation coefficients between the variables (rows) and factors (columns)) in PCA nd help to interpret the principal components.

Chapter Five

Estimation results

5.1 Introduction

This chapter reports the estimation results, which are displayed in Tables. All findings from the Tables are described, noting any interesting features, whether expected or unexpected. Also, inferences related to the original aims and objectives of the research are analyzed and discussed. Before proceeding to the estimation results, a preliminary analysis of data is reported (section 2), summarizing the entire sample of data and applying panel data tests, namely panel unit root tests, testing for stationarity; Hausman tests to decide between fixed or random effects as well as cross-sectional dependence tests to examine for contemporaneous correlation across countries. Hausman tests and cross-sectional dependence tests are executed across all estimated models.

After the preliminary analysis of data, the estimation results are reported in three studies as follows: In the first study (section 3), it is examined the impact of the financial development on economic growth during the recent financial crisis, using standard panel models. In the second study (section 4), it is investigated whether the bank or stock market sector prevails in any positive or negative effect on economic growth before and after the crisis. Additionally, it is examined the response of financial development measures to the quality of the fiscal policy, which plays an essential role in economic growth.

As the first two studies employ static panel models, the third study (section 5), examines the existence of the long-run equilibrium of the finance-growth relationship employing the panel cointegration tests. Next, the short and long-run effects of financial development on economic growth is investigated through heterogeneous panel models of Pesaran and Smith (1995) and Pesaran et al. (1999). Furthermore, through all studies, a discussion and explanation of results are provided as well as potential policy-implications, which are the critical points of the thesis.

5.2 Preliminary analysis of data

5.2.1 Introduction

This section deals with the preliminary data analysis. The main objective is to summarize the dataset as well as to edit and prepare them for further analysis. The following section presents the summary statistics, while section 3 reports the correlation analysis. Section 4 displays the panel unit root tests, while sections 5 and 6 report the results for Hausman and cross-sectional dependence tests, respectively.

5.2.2 Summary statistics

Summary statistics describe the essential features of the data. They are broken down into measures of central tendency and measures of variability or spread. Measures of central tendency included in the study are mean and median, while measures of variability or spread included are maximum, minimum, standard deviation, kurtosis, skewness, and coefficient of variation (cv). Apart from the full sample of EU countries, the summary statistics describes the three regional panels (See chapter three and section 3.2.1 for further details).

Table 5.1 presents the summary statistics for all variables used for the estimation of results. There are disparities in many variables across regions. In particular, the North-West panel presents the highest growth average, which is around 2.11%, followed by the Central-Eastern and Baltic panel (1.81%) and the South countries panel (1.60%). Also, it appears that the average growth rate in the full sample is approximately the same as that of the transition economies (Panel B).

Following with the financial development measures of bank sector, the average of liquid liabilities as a percentage of GDP over the period 1990-2016 varies from a low of 46% in the Central-Eastern and Baltic panel to around 84% in North-West panel and 100.6% in the South panel, which is approximately more than two times as much in the panel of transition economies. Similarly to the liquid liabilities, private credit averages around 41% in transition economies, while in the North-West and the South panels is 94.5% and 105% respectively, which are also approximately two and a half times as much in the panel of transition economies. Commercial-bank assets do not present disparities, which varies from a low of 94% in South countries to around 99% in North-West panel.

Regarding the financial development measures of the stock market, it is noted that market capitalization in North-West presents the highest average across all panels, which is around 66%, while in South and Central-Eastern panels is approximately 45% and 21%

respectively. Likewise, turnover ratio is approximately 69% in North-West panel, 65% in South panel, and 30% in the panel of transition economies. Also, total value traded varies from a low of 4.5% in the Central and Eastern panel to around 33% in South panel and 47% in the North-West countries.

Table 5.1: Summary statistics

Statistics	GGDP	LLY	PRIVY	BTOT	MCAP	TOR	TVT	INFL	FDI	OPEN
Full-sample of countries										
Mean	1.889	71.42	74.99	96.07	45.02	53.74	28.18	13.10	9.483	92.12
Median	2.392	63.15	68.30	99.19	33.61	42.39	11.28	2.523	2.593	84.43
Maximum	11.88	258.0	261.4	107.1	238.8	341.2	242.9	1494.6	734.0	221.1
Minimum	-34.90	7.867	7.089	40.76	0.025	0.027	0.000	-4.479	-43.46	33.00
St.D.	4.340	37.42	45.15	8.513	38.31	46.20	37.77	78.97	42.26	37.80
Skewness	-2.108	1.621	1.002	-4.137	1.385	1.445	1.933	14.11	11.14	0.648
Kurtosis	13.84	7.405	4.226	23.00	5.219	6.798	7.016	233.6	159.0	2.682
CV	1.693	0.522	0.599	0.091	0.852	0.859	1.336	5.926	4.457	0.410
Obs	696	688	681	681	623	614	606	678	637	702
Panel A: North and West countries of EU										
Mean	2.118	83.45	94.45	98.95	66.43	69.32	47.03	1.993	17.53	90.93
Median	2.056	78.99	91.01	99.57	59.90	64.92	33.86	1.940	2.529	82.16
Max	10.86	170.3	201.2	107.1	238.8	247.7	182.8	10.46	734.0	221.1
Min	-8.269	37.82	29.53	81.04	8.116	4.485	1.480	-4.479	-5.670	39.57
St.D.	2.612	30.05	36.19	2.393	37.82	41.01	41.42	1.471	65.36	38.90
Skewness	-0.011	0.655	0.667	-4.002	0.923	0.666	1.018	1.352	7.299	0.964
Kurtosis	5.801	2.692	3.506	24.93	4.200	3.396	3.279	10.45	67.77	3.342
CV	1.233	0.360	0.383	0.024	0.569	0.591	0.880	0.738	3.728	0.427
Obs	270	270	270	270	264	258	255	268	248	270
Panel B: Central-Eastern countries and Baltic of EU										
Mean	1.811	46.02	41.12	94.31	20.62	30.01	4.476	28.67	4.502	104.3
Median	3.282	46.24	40.37	99.17	14.58	16.70	1.865	4.401	3.514	98.51
Maximum	11.88	85.90	102.5	100.0	210.3	198.2	30.14	1494.6	50.74	185.7
Minimum	-34.9	7.867	7.089	40.76	0.025	0.027	0.0003	-1.500	-16.07	33.00
St.D.	5.885	16.96	20.87	11.83	24.55	32.56	5.933	122.4	5.781	34.60
Skewness	-1.947	0.000	0.338	-3.132	3.977	1.834	2.042	8.987	4.167	0.290
Kurtosis	9.378	2.142	2.319	12.78	24.49	7.248	7.181	95.47	31.61	2.309
CV	3.249	0.368	0.507	0.125	1.190	1.084	1.325	4.269	1.284	0.331
Obs	291	283	276	276	232	231	226	275	259	297
Panel C: South countries of EU										
Mean	1.601	100.6	105.3	93.92	45.09	65.46	32.60	3.434	4.047	67.58
Median	1.772	86.84	94.70	95.38	37.90	48.03	16.72	2.846	1.536	57.52
Maximum	9.400	258.0	261.4	101.2	198.6	341.2	242.9	20.40	198.3	140.8
Minimum	-9.132	50.86	26.64	67.96	8.663	1.831	0.211	-2.096	-43.46	33.98
St.D.	2.972	47.41	52.61	6.410	33.17	58.36	40.10	3.489	18.83	29.17
Skewness	-0.726	1.784	0.832	-2.045	1.860	1.840	2.402	2.327	8.575	1.213
Kurtosis	4.288	5.709	3.428	7.353	8.031	7.891	10.64	10.80	89.17	3.208
CV	1.856	0.471	0.499	0.068	0.735	0.822	1.230	1.016	4.652	0.431
Obs	135	135	135	135	127	125	125	135	130	135

Note: CV denotes coefficient of variation and is estimated by dividing the standard deviation by the mean. The higher the coefficient of variation, the greater the level of dispersion around the mean.

In general, it is worth to notice that North-West panel of countries illustrate more significant development in the market sector than the other panels, while the South region have more significant development in the bank sector. Besides, North-West countries have the lowest inflation rate, which is approximately 2%, while in South countries the rate is 3.5% and in transition economies 28%. Indeed, these countries experienced very high rates of inflation at the beginning of their reform programs. As for the net foreign direct investments, North-West countries have the highest level (17%), while in the transition economies and South countries is approximately 4% to 4.5%. Another remarkable conclusion is that the coefficient of variation of GDP growth rate is the most volatile for the Central and Eastern panel of countries followed by countries in the South region, while the North-West group of countries presents the lowest volatility. Finally, the kurtosis and skewness statistics suggest that most of the data series are non-normal distributed.

5.2.3 Correlation analysis

An implicit assumption when using OLS estimation method is that the explanatory variables are not correlated with one another. A correlation matrix shows the correlation coefficients between sets of variables, and the probability values (p-values) to measure the significance of their relationship. The line of 1.00s going from the top left to the bottom right is the main diagonal, which shows that each variable always perfectly correlates with itself.

Table 5.2: Correlation-Probability matrix

Statistics	LLY	PRIVY	BTOT	MCAP	TOR	TVT	INFL	FDI	OPEN
LLY	1.000								
PRIVY	**0.792**	1.000							
	(0.000)								
BTOT	0.163	0.307	1.000						
	(0.000)	(0.000)							
MCAP	0.452	0.551	0.323	1.000					
	(0.000)	(0.000)	(0.000)						
TOR	0.223	0.318	-0.025	0.418	1.000				
	(0.000)	(0.000)	(0.532)	(0.000)					
TVT	0.449	0.543	0.196	**0.801**	**0.811**	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
INFL	-0.420	-0.425	-0.295	-0.401	-0.222	-0.423	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
FDI	0.0367	0.0038	0.211	0.184	-0.066	0.068	0.025	1.000	
	(0.356)	(0.924)	(0.000)	(0.000)	(0.108)	(0.097)	(0.518)		
OPEN	0.049	-0.045	0.255	-0.065	-0.316	-0.222	-0.105	0.426	1.000
	(0.191)	(0.236)	(0.000)	(0.102)	(0.000)	(0.000)	(0.006)	(0.000)	

Note: Boldface values indicate the high pair-wise correlation. For the macroeconomic variables, high pair-wise correlation is not detected.

The matrix is symmetrical, with the same correlation above the main diagonal (not displayed) being a mirror image of those below the main diagonal. P-values are reported in parentheses. A low p-value such that of 0.01 to 0.05, indicates that there is a 1 or 5 in a 100 chances of no relationship, which is the same as a 99% or a 95% chance that there is a relationship. The coefficients that are closer to +1 show a positive linear correlation, which indicates that one variable tends to increase when the other variable increases. In contrast, if the coefficients are closer to minus 1, show a negative linear correlation, which indicates that one variable tends to decrease when the other variable increases.

Table 5.2 presents the results and suggest that there is high pair-wise correlation between *TVT* and *TOR*, which is approximately 81%, followed by *LLY* and *PRIVY* (80%) as well as, *MCAP* and *TVT* (79%), all significant at the 1% level of significance. According to the results for the macroeconomic variables high pair-wise correlation is not detected.

5.2.4 Panel unit root tests

Before proceeding to estimate the results of the panel regression models, it will be necessary to verify that all variables are stationary. For this reason, a variety of panel unit root tests or stationarity tests in the panel dataset is implemented. Table 5.3 presents the results obtained from the panel unit root tests. The Levin et al. (2002), Breitung and Das (2005), Im et al. (2003) and Fisher type tests (Augmented Dickey Fuller-ADF and Phillips-Perron-PP tests) have a null hypothesis that all panels contain unit-root, thus are non-stationary. The Hadri (2000) test has a null hypothesis that all panels are stationary.

In the first column, the variables are displayed, while in column two, three specification models (intercept, intercept and trend, none) are examined, and when the level of significance is either 5% or 1%, the null hypothesis is rejected. The decision is of great importance, and the most robust option is to do all three tests. Also, looking into the graphs of the dataset (Chapter 3), which show whether the variables of interest over time are going in a clear direction, is an additional way to check their trend. Finally, the last column summarises the order of integration of each variable.

Turning now to the results, it is apparent that *GGDP* is stationary at level (I(0)), while very few variables of financial development are stationary and most series are best characterized by unit root processes in levels but become stationary in first differences. In particular, *(LLY, PRIVY, BTOT, MCAP and TVT)* are integrated of first order (I(1)), while *(TOR)* is stationary at level (I(0)). Regarding the macroeconomic variables, *INFL* and *FDI* are founded stationary (I(0)) at level, while *OPEN* is founded to be integrated of the first order (I(1)).

Thus, to proceed to the estimation of results, the non-stationary variables will be differenced in order to be converted and become stationary, so that only stationary series are used in the estimated models. The results of the panel unit root tests in first difference confirm that the non-stationary variables are transformed to stationary. More precisely, ΔLLY, ΔPRIVY, ΔBTOT, ΔMCAP and ΔOPEN have been converted in first difference and transformed to stationary. The Greek letter Δ denotes the first difference of the variables that have been found to be non-stationary at level.

Table 5.3: Estimation results of panel unit root tests at levels and first difference

Variables	Model specification	LLC	Breitung	IPS	ADF	PP	Hadri	I(·)	I(·)
GGDP	Intercept	-7.84***		-9.03***	180.6 ***	226.2***	2.67***	I(0)	
GGDP	Intercept-trend	-6.84***	-4.37***	-7.36***	146.1***	203.5***	5.85***	I(0)	I(0)
GGDP	none	-9.85***			177.7***	220.5***		I(0)	
LLY	Intercept	-1.37		2.54	24.74	29.83	16.29***	I(1)	
LLY	Intercept-trend	-4.83***	-0.31	-4.47***	113.4***	74.7**	8.56***	I(0)	I(1)
LLY	none	3.92			10.22	8.718		I(1)	
ΔLLY	Intercept	-11.81***		-12.51***	251.46***	2572.55***	0.561	I(0)	
ΔLLY	Intercept-trend	-8.83***	-2.88***	-9.552***	189.78***	453.78***	5.36***	I(0)	I(0)
ΔLLY	none	-15.73***			305.93***	342.93***		I(0)	
PRIVY	Intercept	-3.15		-0.73	56.75	36.72	15.19***	I(1)	
PRIVY	Intercept-trend	-0.92	1.89	-2.81***	86.13***	31.51	6.82***	I(1)	I(1)
PRIVY	none	-0.98			26.26	25.65		I(1)	
ΔPRIVY	Intercept	-11.01***		-10.54***	207.43***	209.66***	1.89**	I(0)	
ΔPRIVY	Intercept-trend	-7.31***	-4.50***	-6.58***	156.8***	152.69***	8.39***	I(0)	I(0)
ΔPRIVY	none	-16.26***			328.88***	330.30***		I(0)	
BTOT	Intercept	-3.01		-2.4***	99.65***	461.5***	14.45***	I(0)	
BTOT	Intercept-trend	17.71	-1.60	-0.14	83.99***	495.9***	8.17***	I(1)	I(1)
BTOT	none	3.06			20.70	12.20		I(1)	
MCAP	Intercept	-4.53***		-3.87***	90.03***	47.68	3.07***	I(0)	
MCAP	Intercept-trend	-1.79**	-3.51***	-1.51	61.64	26.99	8.66***	I(1)	I(1)
MCAP	none	-0.27			29.80	28.90		I(1)	
ΔMCAP	Intercept	-12.60***		-10.49***	207.23***	198.18***	-0.658	I(0)	
ΔMCAP	Intercept-trend	-11.07***	-12.83***	-8.82***	167.50***	151.92***	2.41***	I(0)	I(0)
ΔMCAP	none	-17.24***			349.14***	318.62***		I(0)	
TOR	Intercept	-14.22***		-11.38***	210.9***	159.2***	10.01***	I(0)	
TOR	Intercept-trend	-11.03***	-4.59***	-9.72***	179.2***	141.1***	7.15***	I(0)	I(0)
TOR	none	-5.94***			136.6***	121.2***		I(0)	
TVT	Intercept	-11.03***		-6.52***	125.8***	49.78	8.46***	I(0)	
TVT	Intercept-trend	-1.01	-4.93***	-3.83***	90.75***	30.89	7.63***	I(1)	I(1)
TVT	none	-2.33***			52.59	61.76		I(1)	
ΔTVT	Intercept	-13.89***		-11.64***	230.69***	142.32***	-1.56	I(0)	
ΔTVT	Intercept-trend	-16.67***	-9.82***	-11.85***	195.87***	83.57***	-0.526	I(0)	I(0)
ΔTVT	none	-18.57***			371.65***	268.78***		I(0)	
INFL	Intercept	-390.3***		-171.23***	1057***	1233***		I(0)	
INFL	Intercept-trend	-440***	-2.14**	-171.01***	1253***	1485***		I(0)	I(0)
INFL	none	-164.2***			559.1***	551.5***		I(0)	
FDI	Intercept	-7.73***		-8.37***	174.09***	183.7***	9.76***	I(0)	
FDI	Intercept-trend	-4.84***	-2.4***	-4.35***	-103.6***	176.9***	2.72***	I(0)	I(0)
FDI	none	-5.91***			98.74***	158.3***		I(0)	
OPEN	Intercept	-0.83		2.68	23.61	23.27		I(1)	
OPEN	Intercept-trend	-3.38***	-4.44***	-3.85***	86.02***	88.24***		I(0)	I(1)
OPEN	none	6.23			4.31	2.73		I(1)	
ΔOPEN	Intercept	-21.68***		-20.14***	408.51***	478.24***	0.939	I(0)	
ΔOPEN	Intercept-trend	-18.74***	-13.19***	-17.61***	326.85***	479.99***	6.89***	I(0)	I(0)
ΔOPEN	none	-24.16***			550.81***	561.77***		I(0)	

Note:(***),(**) reflect the 1%, 5% of significance level respectively. Automatic selection of maximum lags based on Akaike Info Criterion (AIC). (***),(**) reflect the 1%, 5% of significance level respectively. Automatic selection of maximum lags based on Akaike Info Criterion (AIC).

5.2.5 Fixed or Random effects-Hausman tests

The first decision before proceeding to the panel estimation models is whether the explanatory variables have fixed or random effects. A central assumption is that the random effects estimation is uncorrelated with the explanatory variables and the Hausman (1978) test is employed to compare the fixed and random effects across all estimated models. The null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects. Table 5.4 reports the results and it is found that the null hypothesis is rejected across all models. In particular, the χ_k^2 statistics and the p-values indicate that all diagnostic tests reject the null hypothesis. Rejecting the null hypothesis implies that the random effects (RE) estimator is not consistent. Hence, the fixed effects model is appropriate.

Table 5.4: Hausman test

Test Summary	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX	Model X
χ_k^2	21.29	17.77	33.78	58.62	68.46	41.65	20.41	44.18	63.59	72.32
P-value	0.001	0.038	0.000	0.000	0.000	0.002	0.008	0.000	0.000	0.000

5.2.6 Cross-sectional dependence tests

It is commonly assumed that disturbances in panel data models are cross sectionally independent. There is, however, considerable evidence that cross-sectional dependence is often present in panel regression settings. Due to globalisation and an increasing amount of integration among European Union countries, a shock that occurs in the financial sector in one member country is likely to affect other countries.

The recent European bond crisis influenced all member countries and was felt around the world. The results, as shown in Table 5.5, indicate that the null hypothesis of no cross-sectional dependence is rejected at 1% level of significance for all specification models. The findings imply that a shock that occurs in the financial sector in one member country is transmitted to other countries.

Table 5.5: Cross-sectional dependence test

Test Summary	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX	Model X
Pesaran	35.517	32.548	19.66	19.664	13.724	7.655	19.638	17.957	17.040	16.542
P-value	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Frees	2.407	5.229	2.034	2.034	2.546	2.226	2.120	1.939	2.180	2.313
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Friedman	120.8	163.02	79.829	79.83	77.927	44.482	87.486	81.842	93.036	92.573
P-value	0.000	0.000	0.000	0.000	0.000	0.009	0.002	0.000	0.000	0.000

After getting the estimation results of Hausman and cross-sectional dependence tests, panel fixed effects models are employed using Driscoll and Kraay (1998) standard errors estimates that are robust to disturbances being heteroscedastic, autocorrelated and cross-sectional dependent. Hence, the spatial correlation consistent standard errors (SCC) estimator is used, and the program xtscc is the selection for Stata commands that produce robust standard error estimates for linear panel models.

5.3 Study 1: Financial development and economic growth during the recent crisis

5.3.1 Introduction

According to the empirical literature (Chapter 2), many cross-sectional studies concluded that financial development positively affects economic growth (King and Levine, 1993c; Levine and Zervos, 1996; Gregorio and Guidotti, 1995; Levine, 1997; Azman-Saini et al., 2010), while more recent studies that used time-series or panel data models arrived at a less uniform conclusion (Arestis et al., 2001; Demetriades and Hussein, 1996; Levine, 1999; Caporale et al., 2015; Samargandi et al., 2015; Bumann et al., 2013). However, although the literature is extensively vast so far, to the best of my knowledge, no study has attempted to compare the financial development conventional measures that led to economic growth across the European Union (EU) countries, before, during and after the recent financial crisis in 2008. The contribution of this study is described in the introduction chapter (See Chapter 1, contribution of the research). The following section includes a description of data and section 3 presents the model specification. Section 4 provides the empirical results and discussion, while section 5 concludes.

5.3.2 Data

The empirical analysis uses annual data for 26 European Union countries (N=26) over the period 1990 to 2016 (T=27). The list of countries is provided in chapter 3.5. Also, descriptive statistics and correlation analysis are reported in the preliminary analysis of data above (Tables 5.1 and 5.2). The financial development measures used in this thesis are described in detail in Chapter 3.3 (Description of data). However, a brief description of the variables used in the current study is provided in Table 5.6 below.

Table 5.6: List of variables

variables	Description of variables
GGDP	Annual percentage growth rate of Gross Domestic Product (GDP)
LLY	Liquid liabilities as percentage to GDP(%).
PRIVY	Credit to private sector as percentage to GDP(%).
BTOT	Total bank assets (%).
MCAP	Stock market capitalization as percentage to GDP (%).
TVT	Stock market total value traded as a percentage of GDP(%).
TOR	Stock market turnover ratio (%).
INFL	Inflation rate (%).
FDI	Net inflows of foreign direct investments to GDP(%).
OPEN	Trade openness to GDP(%).
Cr0809	The dummy variable for years 2008 and 2009.
Cr0816	The dummy variable for the years 2008 to 2016.

5.3.3 Model specification

To analyse the finance-growth relationship before and after the crisis various panel regressions are employed. The basic econometric model, is as below:

$$GGDP_{it} = \alpha_0 + \boldsymbol{\beta}'\boldsymbol{FD_{it}} + \boldsymbol{\gamma}'\boldsymbol{X_{it}} + u_{it} \tag{5.1}$$

where the dependent variable is GDP growth, i and t subscripts are defined as *i=1,2,...,26* EU countries and *t=1990,...,2016*. Then, α_0 denotes the intercept; $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are the vectors of coefficients; $\boldsymbol{FD_{it}}$ is a matrix of financial development measures *(LLY, PRIVY, BTOT, MCAP, TVT, TOR);* $\boldsymbol{X_{it}}$ is a matrix of control variables *(INFL, FDI, OPEN)* and u_{it} captures an error term. Given that the primary purpose is to investigate the impact of financial development on economic growth through a comparative approach before/after crisis, in the above model two dummy variables are used; one for the sub-prime crisis period (years 2008 and 2009); and one for the ongoing crisis period (years 2008 to 2016).

5.3.4 Estimation results

5.3.4.1 All countries results

The results from the full panel of countries are reported in Table 5.7. Models (I) and (II) present the results for the whole sample period. Models (III) to (VI) estimate the results for the ongoing crisis and models (VII) to (X) for the subprime crisis. Model (I) includes the financial development measures, while model (II) includes the financial development measures and the macroeconomic control variables. Model (III) includes the financial development measures and their interaction with the crisis dummy Cr0816, thus capturing slope effects, while model (IV) includes the intercept dummy variable as well. Model (V) includes the financial development measures and the control variables along with their interaction with the crisis dummy Cr0816, while model (VI) also includes the intercept dummy Cr0816 variable as well. Models (VII) to (X) are defined similarly to models (III) to (VI) using the Cr0809 dummy variable instead.

In the first column (model I), where the whole sample period is examined, *BTOT* and *MCAP* have a positive and statistically significant impact on economic growth, while *LLY* is significantly negative.

In column two, model (II) includes the macroeconomic variables, and the results confirm the negative and significant effect of *BTOT* and *MCAP* on growth, while *LLY* is insignificant. Additionally, the macroeconomic variables have no impact on economic growth. The next four models (III to VI) include the *Cr0816* dummy variable and estimate the pre-ongoing and ongoing crisis periods.

In the third column, the results of the model (III) that includes interaction terms (slope dummies) on the financial development variables, show that during the pre-crisis period, *BTOT, MCAP* and *TOR* have a positive and statistically significant impact on economic growth, while the effect of *LLY* is significantly negative. Through the statistical significance and estimated coefficients of the slope dummies, the findings suggest that for the ongoing crisis period, *PRIVY* and *TOR* have a negative and statistically significant effect on economic growth, while the effect of *TVT* is significantly positive. In contrast, the regression parameters of *LLY* and *BTOT* are statistically insignificant.

In column four, model (IV) is specified similarly to (III) but also includes the intercept dummy *Cr0816* that captures the effect of the ongoing crisis period along with the slope dummies. The results show that during the pre-crisis period, *BTOT* has a positive and significant effect on economic growth, while the effect of *LLY* is significantly negative. Also, *PRIVY* is positive and significant before the crisis, which is fully reversed after the crisis.

In column five, model (V) includes the macroeconomic variables, and the results show that without accounting for the ongoing crisis period *BTOT, MCAP* and *TOR* have a positive and significant effect on growth, while during the ongoing crisis period, *TVT* has a positive and significant effect, but *MCAP* and *TOR* are significantly negative.

In column six is reported the fullest specification, which is that of the model (VI). As evidenced by the results, during the pre-crisis period, *BTOT* is positive and significant, while *LLY* is significantly negative. As for the ongoing crisis period, *TOR* is positive and significant, whereas PRIVY is significantly negative. Regarding the macroeconomic variables, during the pre-crisis period *INFL* is found to be negative and significant only in the fullest specification model (VI), while in the ongoing crisis period this is the case only in the model (V). Interestingly, during the crisis period, there is substantial evidence of positive effects from trade, given that *OPEN* is found to be positive and significant in models (V) and (VI).

In last four columns, in models (VII) to (X) and when the dummy variable is not used as an interaction term, the results show that *PRIVY, BTOT, MCAP* and *TOR* are statistically significant and positive. However, during the subprime crisis period (2008-2009), across all models, *LLY, MCAP* are negative and significant, while *BTOT* is significantly positive with significant economic value (approximately 7% to 9%). As for the macroeconomic variables, the results show that at regular periods there is no impact on economic growth, while at stress time *FDI* is statistically positive and again trade openness *(OPEN)* is a positive and significant driving force of economic growth.

The overall results from the full sample suggest that during the whole sample period, and without accounting for the crisis period, financial development positively affected the economy, as PRIVY, BTOT, MCAP and TOR contributed to economic growth. In contrast, during the same period, the impact of LLY on growth is significantly negative and insignificant at regular periods (models VII to X).

Table 5.7: Full panel

period	whole sample		ongoing crisis Cr=Cr0816				subprime crisis Cr=Cr0809			
	model	model	model	model	model	model	model	model	model	model
Variables	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
Intercept	1.931***	2.017***	1.778***	3.049***	2.068***	3.485***	1.928***	2.177***	2.236***	2.327***
	[3.94]	[3.54]	[3.40]	[6.21]	[3.30]	[7.49]	[3.76]	[4.32]	[4.11]	[4.23]
ΔLLY	-0.087*	-0.126	-0.038*	-0.042***	-0.037	-0.060**	-0.026	-0.027	0.003	0.003
	[-1.81]	[-1.44]	[-2.01]	[-2.91]	[-1.13]	[-2.39]	[-0.94]	[-1.01]	[0.08]	[0.08]
ΔPRIVY	0.029	0.044	0.053	0.038*	0.063	0.041*	0.041**	0.040**	0.045**	0.044**
	[1.48]	[1.69]	[1.50]	[1.92]	[1.47]	[1.82]	[2.07]	[2.24]	[2.34]	[2.40]
ΔBTOT	0.351***	0.296***	0.260***	0.208***	0.203***	0.153***	0.277***	0.255***	0.236***	0.235***
	[3.76]	[2.42]	[5.04]	[3.99]	[4.30]	[2.89]	[4.84]	[4.98]	[4.03]	[3.98]
ΔMCAP	0.030**	0.023**	0.027**	0.012	0.024**	0.008	0.019**	0.017*	0.021*	0.020*
	[2.465]	[2.42]	[2.48]	[1.36]	[2.31]	[0.88]	[2.10]	[1.84]	[2.02]	[1.92]
ΔTVT	0.025	0.023	-0.004	0.013	-0.004	0.013	0.002	0.006	0.004	0.005
	[1.35]	[1.49]	[-0.42]	[1.32]	[-0.44]	[1.52]	[0.29]	[0.59]	[0.47]	[0.58]
TOR	0.006	0.005	0.017***	0.003	0.016***	0.003	0.011**	0.008**	0.010**	0.009**
	[1.40]	[1.52]	[3.28]	[0.57]	[3.40]	[0.51]	[2.58]	[2.05]	[2.61]	[2.36]
INFL		-0.022			-0.032	-0.06***			-0.031	-0.033
		[-1.00]			[-1.51]	[-5.69]			[-1.53]	[-1.64]
FDI		-0.0006			0.0004	0.0006			-0.002	-0.002
		[-0.20]			[0.38]	[0.73]			[-0.90]	[-0.79]
ΔOPEN		0.055			0.017	0.024			-0.0122	-0.013
		[1.15]			[0.83]	[1.57]			[-0.64]	[-0.67]
Crisis				-3.87***		-5.691***		-6.563***		-5.078***
				[-5.88]		[-5.74]		[-4.40]		[-3.26]
Cr*ΔLLY			-0.131	-0.084	-0.100	-0.008	-0.548***	-0.305***	-0.497***	-0.321***
			[-0.84]	[-0.67]	[-0.69]	[-0.10]	[-8.28]	[-4.98]	[-12.10]	[-5.70]
Cr*ΔPRIVY			-0.120**	-0.126***	-0.080	-0.110**	-0.092	0.082*	-0.020	0.018
			[-2.32]	[-2.87]	[-1.31]	[-2.75]	[-1.27]	[1.74]	[-0.34]	[0.47]
Cr*ΔBTOT			0.041	-0.150	0.082	-0.093	9.20***	7.685***	8.574***	7.257***
			[0.13]	[-0.72]	[0.27]	[-0.53]	[4.06]	[5.90]	[5.29]	[6.89]
Cr*ΔMCAP			-0.025	-0.019	-0.042**	-0.022	-0.039***	-0.092***	-0.049***	-0.076***
			[-1.19]	[-0.91]	[-2.72]	[-1.37]	[-3.55]	[-4.27]	[-3.65]	[-4.02]
Cr*ΔTVT			0.047**	0.019	0.043***	-0.001	0.056***	0.053***	0.010	0.009
			[2.68]	[0.98]	[3.52]	[0.39]	[3.29]	[5.49]	[0.73]	[0.91]
Cr*TOR			-0.023***	0.015*	-0.019***	0.023**	0.002	0.03***	0.004	0.020***
			[-3.59]	[1.78]	[-3.05]	[2.64]	[0.97]	[4.50]	[1.50]	[3.17]
Cr*INFL					-0.404**	0.166			-0.346***	0.044
					[-2.70]	[1.33]			[-4.34]	[0.35]
Cr*FDI					-0.003	0.001			0.016***	0.017***
					[-1.57]	[0.39]			[4.70]	[5.32]
Cr*ΔOPEN					0.131*	0.167***			0.305***	0.207***
					[2.01]	[4.84]			[10.58]	[6.05]
R^2	0.111	0.143	0.225	0.346	0.299	0.463	0.281	0.35	0.380	0.395
Obs	575	552	575	575	552	552	575	575	552	552

Note: Dependent variable is the *GGDP*. (***), (**), (*) reflect the 1%, 5%, 10% level of significance respectively. Δ denotes the first difference operator that were transformed to become stationary. *Cr* denotes the dummy variables for the 08-09 and the 08-16 time periods.

During the subprime crisis period (2008-2009), there is substantial evidence that *LLY* and *MCAP*, which are the main proxies for the size of the bank and stock market sectors respectively, negatively affected economic activity, while eight years after the crisis (2008-2016, ongoing crisis period) this is the case for PRIVY, which is another proxy of the size of the bank sector. On the other hand, the most remarkable result is the positive and significant effect of *(BTOT)* in the years 2008 and 2009, with a meaningful economic size.

Furthermore, during the crisis periods, the results show that *TOR*, is positive and significant when the intercept dummy is included in the models (IV, VI, VIII, X) and significantly negative or insignificant otherwise. However, the higher liquidity *(TOR)* observed in the stock market during the ongoing crisis period is not accompanied by higher activity *(TVT)*, and this is counter-intuitive. It is also surprising that during the subprime crisis period, the higher activity *(TVT)* and liquidity *(TOR)* are accompanied by the negative results, of stock market capitalization *(MCAP)*, which is also unexpected. Since there is a co-movement between MCAP and TVT (as found in the correlation matrix), one could expect that TVT rises faster than MCAP. However, a possible explanation might be that more selling activity occurred during the crisis period, thus leading to higher supply, and prices fell. Since prices fall, MCAP drops, thus leading the denominator of TOR to decline and-as a result-TOR to rise. Even though volume may have declined, MCAP has declined even faster. This is an indication of how dynamics of stock markets work. The forces that influence prices and behaviour of investors are signals from fluctuations of supply and demand.

Nevertheless, during the crisis periods, the results are mixed, and there is no clear evidence if financial development promoted economic growth or hindered economic activity. Hence, it follows further investigation for the regional panels, which may contribute to this and lead to more accurate inferences.

5.3.4.2 Regional results

Table 5.8 presents the results for the North-West panel of countries. The results show that during the full sample period and when the crisis period is not included in the models, *MCAP* has a significant positive impact on economic growth across all models, while for *TOR*, there is substantial evidence that is significantly positive at normal periods (models VII to X). In contrast, at regular periods, the findings suggest that *LLY* hindered economic activity.

In the years 2008 and 2009, the negative effect of *LLY* and *MCAP*, as well as the positive effect of *BTOT* and *TVT*, become insignificant eight years after the crisis (2008-2016, ongoing crisis). However, the results for the subprime crisis period are still mixed, while for the ongoing crisis period it seems that financial development hindered economic activity as *TOR* is significantly negative, but the evidence is only weak as it is not reported significant impact in models IV and VI.

Finally, regarding the macroeconomic variables, the negative and significant effect of *INFL* on growth, during the pre-ongoing crisis period, becomes positive and significant eight years after the crisis. *FDI*, is insignificant at regular periods and becomes significantly positive only in the subprime crisis period. *OPEN* is the only positive and significant driving force of growth during the ongoing crisis period.

Table 5.9 presents the estimation results for Central-Eastern and Baltic EU countries. The findings suggest that during the whole sample period and when the models include the crisis period, *PRIVY, BTOT*, and TVT have a significant positive effect, indicating that financial development promoted economic growth.

On the other hand, during the crisis periods LLY and $PRIVY$ harm growth, while TVT and TOR have a positive effect. Also, in the years 2008 and 2009, the positive and significant impact of $BTOT$ on economic growth is presented across all models with a value of around 13% to 14%. Furthermore, it is worth to notice that the higher liquidity (proxied by TOR), is accompanied with higher activity, (proxied by TVT), but not with an increased size of stock market capitalization *(MCAP)*, since stock prices fell and TOR rises.

Regarding the macroeconomic variables, in the pre-ongoing crisis period, there is a negative effect of *INFL* on growth, which becomes positive and significant in the ongoing crisis period. *FDI* is presented positive and significant in the ongoing crisis period, while *OPEN* is positive and significant during both crisis periods. However, the results for the crisis periods do not provide clear evidence if financial development promoted or hindered economic activity.

Table 5.10 presents the estimation results for South EU countries. The findings suggest that during the full sample period and without accounting for the crisis period, financial development promoted economic growth as $BTOT$ is significantly positive. The positive and significant effect of TOR seems to be negligible as the coefficient has not significant economic size and the level of significance in only 10%.

During the sub-prime crisis period, the findings suggest that LLY has an adverse impact on growth, while for $PRIVY$, there is evidence that enhanced economic activity. Moreover, the positive effect of $BTOT$ is observed only in the full specification model (X). During the ongoing crisis period, there is substantial evidence that LLY and $BTOT$ are positive and significant, while the effect of $PRIVY$ is insignificant. Also, the results for the stock market indicators show that any higher stock market activity *(TVT)* is accompanied by negative liquidity *(TOR)*, which is again counter-intuitive. However, the results show that financial development enhanced the economic activity in the ongoing crisis period, while for the subprime crisis period, this is not the case.

From the macroeconomic variables, the impact of *FDI* on growth seems to be weak at regular times, while in the years 2008 and 2009 is positive and significant. During the ongoing crisis period, appears to be significantly negative, but is not confirmed in the fullest specification model (VI). Finally, *OPEN* is found positive and significant in the fullest specification models both crisis periods being considered.

The overall results from the regional panels suggest that at regular periods a positive and significant effect is found for *MCAP* in North-West region; for *PRIVY, BTOT* and *TVT* in Central-Eastern and Baltic panel; and *BTOT* in the South group of countries. In contrast, *LLY* negatively affected economic growth only in the North-West panel.

During the sub-prime crisis period, the positive effect on growth is found for *BTOT* and *TVT* across all panels, while for the South region *PRIVY* is significantly positive as well. In contrast, LLY has negative effect on growth across all regions, while *MCAP* and *PRIVY* are found to be significantly negative in North-West and transition panels as well. During the ongoing crisis period, only in the North-West panel there is clear evidence that financial development hindered economic activity as *TOR* is significantly negative. In transition economies the results are mixed as LLY and PRIVY are positive, whereas *TVT* and *TOR* are negative. In South region, *LLY, BTOT* and *TVT* are positive and significant, while *TOR* is significantly negative.

However, one of the main conclusions is that finance led growth at regular periods, while during the crisis periods, there is no clear evidence that financial development promoted or hindered economic activity as the results are mixed. Also, the results reveal that the impact of financial development on economic growth is heterogeneous and varies across countries over time. Nevertheless, two main questions remain unanswered at present. The first is related to the impact of financial development on growth during the crisis periods; and the second is that there is no clear picture of which sector prevails in the positive or negative effect on economic growth. It is required further work and issues such that of the intercept dummy and the imperfect (near) multicollinearity will be addressed to get more conclusive results.

Table 5.8: North-West panel

period	whole sample		ongoing crisis Cr=Cr0816				subprime crisis Cr=Cr0809			
	model	model	model	model	model	model	model	model	model	model
Variables	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
Intercept	1.499**	1.386*	0.868	1.443*	0.808	2.695***	0.916	0.999	1.292*	1.443*
	[2.30]	[2.22]	[1.43]	[1.84]	[1.09]	[4.41]	[1.32]	[1.42]	[1.90]	[2.13]
ΔLLY	-0.64**	-0.113**	-0.038***	-0.037***	-0.039	-0.057**	-0.030**	-0.029**	-0.020	-0.019
	[-2.53]	[-2.37]	[-5.64]	[-4.52]	[-1.78]	[-2.79]	[-2.75]	[-2.71]	[-0.86]	[-0.83]
ΔPRIVY	0.018	0.028	0.016	0.013	0.019	0.014	0.022	0.021	0.023	0.022
	[1.58]	[1.36]	[1.24]	[1.31]	[1.20]	[1.35]	[1.68]	[1.63]	[1.83]	[1.76]
ΔBTOT	0.080	0.060	0.098	0.112	0.050	0.017	0.030	0.036	-0.012	-0.005
	[0.62]	[0.43]	[0.97]	[1.11]	[0.67]	[0.20]	[0.25]	[0.30]	[-0.10]	[-0.05]
ΔMCAP	0.036**	0.033**	0.042***	0.036***	0.045***	0.033***	0.029**	0.028**	0.030**	0.0299**
	[2.43]	[2.33]	[3.78]	[3.78]	[3.48]	[3.36]	[2.53]	[02.47]	[2.91]	[2.84]
ΔTVT	0.020	0.016	-0.015	-0.006	-0.016	-0.006	-0.01	-0.009	-0.012	-0.011
	[1.01]	[1.07]	[-0.95]	[-0.40]	[-0.91]	[-0.35]	[-0.94]	[-0.84]	[-1.04]	[-0.97]
TOR	0.006	0.006	0.024**	0.018	0.025**	0.012	0.020**	0.019*	0.020**	0.019**
	[0.65]	[0.69]	[3.04]	[1.17]	[2.86]	[1.22]	[2.33]	[2.23]	[2.48]	[2.41]
INFL		0.068			0.004	-0.369**			-0.175	-0.208
		[0.28]			[0.01]	[-2.53]			[-1.10]	[-1.38]
FDI		-0.001			-0.001	-0.001			-0.003	-0.002
		[-0.79]			[-1.22]	[-0.67]			[-1.43]	[-1.40]
ΔOPEN		0.059			0.010	0.017			-0.002	-0.003
		[1.74]			[0.57]	[1.09]			[-0.13]	[-0.17]
Crisis				-2.803***		-5.066***		-5.048***		-5.024***
				[-3.85]		[-5.04]		[-7.35]		[-5.94]
Cr*ΔLLY			-0.155	-0.134	-0.161	-0.097	-0.434***	-0.263***	-0.482***	-0.303***
			[-1.24]	[-1.18]	[-1.43]	[-1.03]	[-8.47]	[-5.23]	[-7.54]	[-5.42]
Cr*ΔPRIVY			-0.008	-0.033	0.029	-0.003	0.038	0.013	0.082	0.055
			[-0.15]	[-0.65]	[0.48]	[-0.08]	[0.61]	[0.56]	[0.60]	[0.72]
Cr*ΔBTOT			-0.216	-0.397	-0.144	-0.288	6.754***	1.331	4.875***	-0.556
			[-0.81]	[-1.80]	[-0.57]	[-1.51]	[7.06]	[0.56]	[5.49]	[-0.21]
Cr*ΔMCAP			-0.020	-0.003	-0.026	0.008	-0.070***	-0.126***	0.017	-0.060***
			[-0.56]	[-0.10]	[-0.91]	[0.42]	[-5.02]	[-8.02]	[0.96]	[-3.56]
Cr*ΔTVT			0.040	0.022	0.030	0.003	0.090***	0.084***	0.046*	0.068***
			[1.53]	[0.83]	[1.38]	[0.15]	[8.49]	[9.02]	[2.20]	[6.26]
Cr*TOR			-0.020***	0.007	-0.021**	0.0155	-0.008	0.009	-0.010	0.004
			[-3.99]	[0.87]	[-2.78]	[1.83]	[-1.56]	[1.36]	[-1.57]	[0.78]
Cr*INFL					-0.028	0.714**			0.668**	0.650***
					[-0.08]	[2.71]			[2.55]	[3.86]
Cr*FDI					-0.003	-0.002			0.021***	0.019***
					[1.34]	[-0.87]			[6.92]	[8.13]
Cr*ΔOPEN					0.133***	0.125***			0.080**	0.002
					[3.62]	[4.09]			[2.27]	[0.06]
R^2	0.184	0.236	0.355	0.406	0.410	0.517	0.439	0.46	0.491	0.508
Obs	246	226	246	246	226	226	246	246	226	226

Note: See notes Table 5.7.

Table 5.9: Central-Eastern and Baltic panel

period	whole sample		ongoing crisis Cr=Cr0816				subprime crisis Cr=Cr0809			
	model	model	model	model	model	model	model	model	model	model
Variables	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
Intercept	3.370***	2.514**	3.374***	4.512***	3.211***	4.862***	3.688***	3.676***	3.714***	3.644***
	[7.33]	[3.10]	[5.75]	[8.02]	[3.69]	[6.46]	[7.37]	[7.04]	[4.95]	[4.95]
ΔLLY	-0.411	-0.404	0.050	-0.038	-0.007	-0.086	-0.057	-0.056	-0.101*	-0.097*
	[-1.39]	[-1.68]	[0.65]	[-0.73]	[-0.11]	[-1.73]	[-1.07]	[-1.07]	[-1.93]	[-1.93]
ΔPRIVY	0.135**	0.141**	0.229**	0.183***	0.202**	0.164**	0.182***	0.182***	0.168***	0.168***
	[2.46]	[2.90]	[3.12]	[3.21]	[2.69]	[3.09]	[3.78]	[3.79]	[3.71]	[3.67]
ΔBTOT	0.417***	0.389***	0.234***	0.252***	0.196**	0.198**	0.285***	0.285***	0.273***	0.270***
	[3.96]	[3.91]	[4.50]	[3.61]	[3.11]	[2.31]	[5.90]	[5.89]	[5.70]	[5.92]
ΔMCAP	0.025	0.018	-0.005	-0.019	-0.007	-0.021*	-0.010	-0.009	-0.007	-0.005
	[1.59]	[1.20]	[-0.25]	[-1.68]	[-0.40]	[-1.87]	[-0.63]	[-0.62]	[-0.51]	[-0.41]
ΔTVT	0.373**	0.189**	0.112	0.188**	-0.018	0.102*	0.197***	0.196***	0.167**	0.164**
	[2.91]	[2.34]	[1.44]	[2.46]	[-0.22]	[2.16]	[3.66]	[3.67]	[3.11]	[3.03]
TOR	-0.0005	0.013*	0.0007	-0.012	0.010	-0.002	-0.002	-0.002	0.003	0.005
	[-0.10]	[2.08]	[0.12]	[-1.62]	[1.53]	[-0.32]	[-0.37]	[-0.34]	[0.51]	[0.80]
INFL		-0.036**			-0.038*	-0.055***			-0.031	-0.031
		[-2.29]			[-2.05]	[-4.54]			[-1.75]	[-1.76]
FDI		0.089**			0.068	0.008			0.053	0.050
		[2.24]			[1.17]	[0.28]			[1.30]	[1.15]
ΔOPEN		0.103*			0.060	0.037			-0.022	-0.020
		[1.89]			[1.73]	[1.08]			[-0.50]	[-0.46]
Crisis				-3.206***		-5.427***		0.477		7.75*
				[-4.17]		[-6.51]		[0.46]		[1.90]
Cr*ΔLLY			-1.026**	-0.763*	-0.973**	-0.564	-1.830***	-1.878***	-1.645***	-2.23***
			[-2.48]	[-1.87]	[-2.33]	[-1.81]	[-13.39]	[-10.59]	[-10.61]	[-9.80]
Cr*ΔPRIVY			-0.301**	-0.321**	-0.208*	-0.278**	-0.149**	-0.165***	-0.082	-0.137**
			[-3.07]	[-2.98]	[-2.33]	[-3.10]	[-2.85]	[-3.45]	[-1.29]	[-2.45]
Cr*ΔBTOT			0.959	0.672	1.117	0.857	13.03***	12.95***	12.94***	13.94***
			[1.22]	[0.75]	[1.30]	[1.19]	[16.12]	[13.85]	[9.72]	[5.42]
Cr*ΔMCAP			-0.017	-0.023	-0.028	-0.032	-0.004	-0.001	-0.012	0.025
			[-0.65]	[-1.13]	[-0.90]	[-1.60]	[-0.26]	[-0.09]	[-0.71]	[1.07]
Cr*ΔTVT			0.644***	0.473**	0.662***	0.351*	0.620**	0.646**	0.564*	0.923*
			[4.11]	[2.95]	[3.26]	[1.92]	[2.56]	[3.11]	[2.16]	[1.91]
Cr*TOR			0.009	0.061***	0.013	0.057***	0.081***	0.079***	0.078***	0.065**
			[0.58]	[4.60]	[1.10]	[6.07]	[3.94]	[3.27]	[3.17]	[2.93]
Cr*INFL					-0.187	0.162*			-0.144	-0.666
					[-1.33]	[1.91]			[-1.22]	[-1.75]
Cr*FDI					-0.021	0.081**			-0.035	-0.042
					[-0.25]	[2.39]			[-0.88]	[-0.99]
Cr*ΔOPEN					0.0002	0.092*			0.080	0.147**
					[0.00]	[2.21]			[1.45]	[2.44]
R^2	0.197	0.272	0.448	0.502	0.505	0.592	0.571	0.571	0.594	0.605
Obs	209	207	209	209	207	207	209	209	207	207

Note: See notes Table 5.7.

Table 5.10: South panel

period	whole sample		ongoing crisis Cr=Cr0816				subprime crisis Cr=Cr0809			
	model	model	model	model	model	model	model	model	model	model
Variables	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
Intercept	1.079	-0.236	1.114	2.186**	0.323	2.944***	1.119	1.139	0.253	0.282
	[1.69]	[-0.21]	[1.82]	[4.64]	[0.30]	[5.57]	[1.63]	[1.65]	[0.23]	[0.25]
ΔLLY	-0.027	-0.001	-0.071	-0.080	-0.089	-0.096	0.009	0.010	0.042	0.042
	[-0.55]	[-0.02]	[-1.01]	[-1.29]	[-1.14]	[-1.56]	[0.24]	[0.27]	[0.72]	[0.73]
ΔPRIVY	-0.016	-0.029	0.030	0.045	0.008	0.005	-0.038	-0.038	-0.031	-0.031
	[-0.42]	[-0.89]	[0.57]	[0.97]	[0.16]	[0.13]	[-1.02]	[-1.03]	[-1.06]	[-1.04]
ΔBTOT	0.478**	0.505**	0.363**	0.315***	0.400**	0.287**	0.431**	0.424**	0.463**	0.458**
	[2.86]	[2.88]	[3.87]	[4.70]	[4.11]	[4.08]	[3.02]	[2.99]	[2.86]	[2.82]
ΔMCAP	0.023	0.033	0.012	-0.001	0.008	-0.010	0.018	0.018	0.030	0.030
	[1.24]	[1.37]	[1.15]	[-0.23]	[0.76]	[-1.41]	[0.97]	[0.96]	[1.26]	[1.25]
ΔTVT	0.026	0.020	-0.0001	0.008	-0.002	0.002	0.0155	0.015	0.015	0.015
	[1.14]	[1.00]	[-0.03]	[1.80]	[-0.43]	[0.56]	[0.93]	[0.93]	[1.02]	[1.02]
TOR	0.003	0.008*	0.015*	0.005	0.011**	0.006**	0.006	0.006	0.009*	0.009*
	[0.68]	[2.37]	[2.88]	[1.65]	[2.89]	[3.31]	[1.47]	[1.43]	[2.67]	[2.60]
INFL		0.294			0.152	-0.105			0.204	0.200
		[1.75]			[1.12]	[-1.41]			[1.34]	[1.29]
FDI		-0.017*			0.255*	-0.066			-0.018**	-0.018**
		[2.32]			[2.58]	[-0.88]			[-3.02]	[-3.02]
ΔOPEN		0.016			0.097	0.106**			-0.056	-0.057
		[0.19]			[1.67]	[3.79]			[-0.54]	[-0.55]
Crisis				-4.338***		-6.848***		-3.560**		-5.079**
				[-5.60]		[-8.89]		[-3.72]		[-3.00]
Cr*ΔLLY			0.201	0.207*	0.243*	0.329***	-0.131**	-0.93	-0.183	-0.704***
			[1.87]	[2.73]	[2.68]	[4.56]	[-3.08]	[-2.00]	[-0.90]	[7.99]
Cr*ΔPRIVY			-0.134	-0.143	-0.103	-0.123	0.190***	0.230***	0.077*	0.038
			[-1.92]	[-1.89]	[-1.40]	[-1.76]	[4.99]	[6.81]	[2.22]	[1.36]
Cr*ΔBTOT			4.664**	3.611**	3.823**	2.662*	0.355	-0.518	0.004	4.746***
			[3.50]	[3.97]	[3.17]	[2.18]	[0.57]	[-1.31]	[0.00]	[6.54]
Cr*ΔMCAP			0.141*	0.100*	0.085	0.008	0.031	-0.080	-0.071	-0.915***
			[2.62]	[2.35]	[1.33]	[0.18]	[0.45]	[-1.31]	[-0.22]	[-6.59]
Cr*ΔTVT			0.128**	0.055	0.108*	-0.026	0.153***	0.129**	0.039	0.048
			[4.27]	[1.76]	[2.24]	[-1.12]	[5.76]	[4.63]	[1.23]	[1.44]
Cr*TOR			-0.024**	0.009	-0.014*	0.018**	-0.005	0.006	-0.010	0.055**
			[-3.39]	[1.26]	[-2.18]	[3.78]	[-1.64]	[1.55]	[-0.72]	[3.41]
Cr*INFL					-0.403	-0.274			-0.196	-4.90
					[-0.89]	[-1.38]			[-0.11]	[-5.70]
Cr*FDI					-0.268**	0.066			0.197	1.616***
					[-2.87]	[0.89]			[0.47]	[5.57]
Cr*ΔOPEN					-0.021	0.297**			0.303	1.212***
					[-0.10]	[3.45]			[0.80]	[7.60]
R^2	0.127	0.213	0.477	0.636	0.551	0.704	0.222	0.226	0.299	0.301
Obs	121	120	121	121	120	120	121	121	120	120

Note: See notes Table 5.7.

5.3.5 Alternative estimation results

The previous results have been unable to demonstrate any clear evidence of the effect of financial development on economic growth during the crisis periods. In this section is introduced an alternative estimation of results by removing intercept dummy and collinear variables. Considering the multicollinearity, the implicit assumption made when using OLS estimation method is that the relationship between the explanatory variables are independent (orthogonal). Thus, adding or removing a variable from the regression model would not cause the estimated coefficients of the other variables to change. Klein (1953) suggested as a rule of thumb, that multicollinearity may be a problem only if the value of R^2 obtained from the auxiliary regressions, that is a regression of each explanatory variables on the remaining explanatory variables, exceed the overall value of R^2 that is the one obtained from the regression of dependent on all the independent variables. Therefore, applying Klein's rule of thumb, $PRIVY$ and TVT are dropped and the results are reported in the tables below.

5.3.5.1 All countries results

Table 5.11 reports the results for the full panel of countries. Model (I) includes the financial development measures, while model (II) includes the the financial development measures and the control variables. Model (III) includes the financial development measures and their interaction with crisis dummy *(Cr0816)*, while model (IV) includes interactions with the control variables as well. Model (V) and (VI) are defined similarly to the ongoing crisis with crisis dummy *(Cr0809)*.

The first two models, present the results from the whole sample period. It is found that the ratio of commercial bank assets and market capitalisation have a positive and statistically significant impact on economic growth, while the other financial development variables are insignificant.

In models III and IV, it is found that in the pre-ongoing crisis period the ratio of commercial bank assets, market capitalisation and turnover ratio have a positive and statistically significant impact on economic growth, while liquid liabilities is insignificant. During the ongoing crisis period the only statistically significant variable is the turnover ratio which has a negative effect on economic growth.

In the last two models, when the sub-prime crisis period is not included in the models (V and VI), the results are similar to those in the pre-ongoing crisis period. During the sub-prime crisis period (models V and VI) the ratio of commercial bank assets has a positive and significant impact on economic growth with a remarkable great value (approximately 9%), while liquid liabilities is negatively related to economic growth and statistically significant.

Interestingly, *INF* and *FDI* are negative and significant during the ongoing crisis, while *INF* is negative and significant for the subprime crisis as well. *OPEN* is the only positive and significant driving force of growth during both crisis periods.

Table 5.11: Full panel

period	whole sample		ongoing crisis Cr=Cr0816		subprime crisis Cr=Cr0809	
Variables	model (I)	model (II)	model (III)	model (IV)	model (V)	model (VI)
Intercept	1.94 ***	2.07***	1.914***	2.20***	2.00***	2.280***
	[7.94]	[3.41]	[3.72]	[3.52]	[3.76]	[9.93]
ΔLLY	-0.08	-0.100	-0.030	-0.018	-0.014	0.018
	[-1.47]	[-1.18]	[-1.51]	[-0.62]	[-0.43]	[0.73]
ΔBTOT	0 .273**	0 .237**	0.198***	0.145**	0.192***	0.158**
	[2.73]	[2.65]	[3.24]	[2.68]	[2.97]	[2.44]
ΔMCAP	0.041**	0.037***	0.025**	0.026***	0.020*	0.024***
	[2. 54]	[3.41]	[2.62]	[2.80]	[1.97]	[2.70]
TOR	0.007	0.007	0.016***	0.015 ***	0.010**	0.010***
	[1.49]	[1.48]	[3.10]	[3.21]	[2.07]	[2.77]
INFL		-0.020		-0.031		-0.027**
		[-0.91]		[-1.54]		[-2.29]
FDI		-0.001		0.00007		-0.001
		[-0.60]		[0.06]		[-055]
ΔOPEN		0.032		0.0013		-0.021*
		[0.79]		[0.08]		[-1.78]
Cr*ΔLLY			-0.149	-0.112	-0.570***	-0.474***
			[-0.97]	[-0.80]	[-7.42]	[-6.57]
Cr*ΔBTOT			-0.171	0.004	9.11***	8.60***
			[-0.77]	[0.002]	[5.15]	[5.15]
Cr*ΔMCAP			0.010	-0.017	-0.009	-0.031
			[0.50]	[-1.15]	[-0.68]	[-1.42]
Cr*TOR			-0.023***	-0.019***	-0.0003	0.002
			[-4.63]	[-4.57]	[-0.11]	[0.39]
Cr*INFL				-0.400**		-0.307 ***
				[-2.52]		[-3.19]
Cr*FDI				-0.004*		0.017
				[-1.80]		[1.26]
Cr*ΔOPEN				0.134**		0.293***
				[2.11]		[7.27]
R^2	0.082	0.096	0.177	0.244	0.234	0.326
obs	596	567	596	567	596	567

Note: See notes Table 5.7.

5.3.5.2 Regional results

Table 5.12 presents the results from the regional panels. Model (I) includes the financial development measures and the control variables for the North-West countries, while model (II) includes the variables as in model (I) and their interactions with crisis dummy *(Cr0816)*. Model (III) is similar to the model (II), but the crisis dummy is for the subprime crisis period *(Cr0809)* for the North-West countries as well. Similarly to the first three models, models (IV), (V), and (VI) are defined for Central-Eastern and Baltic countries, while models (VII), (VIII), and (IX) are defined for South countries as well.

During the whole sample period and before the crisis periods, in the North-West panel, the financial stock market development indicators promoted growth, while in

Central-Eastern and South panels the ratio of commercial bank assets prevailed. Also, in South countries the stock market liquidity contributed to economic growth. During the ongoing crisis period, the adverse effect of liquid liabilities is from the group of transition economies, while in the sub-prime crisis period is from all panels. Also, in the sub-prime crisis period, the ratio of commercial banks assets have a positive and significant effect on economic growth in the North-West and Central Eastern panels.

Table 5.12: Regional panels

Panel	A: North-West EU countries			B: Central-Eastern EU countries Transition economies			C: South EU countries		
period	whole sample	ongoing Cr=Cr0816	sub-prime Cr=Cr0809	whole sample	ongoing Cr=Cr0816	sub-prime Cr=Cr0809	whole sample	ongoing Cr=Cr0816	sub-prime Cr=Cr0809
Variables	model (I)	model (II)	model (III)	model (IV)	model (V)	model (VI)	model (VII)	model (VIII)	model (IX)
Intercept	0.805	0.586	1.157	2.627**	3.589***	3.605***	-0.770	-0.275	-0.233
	[1.10]	[0.77]	[1.80]	[3.06]	[4.34]	[4.35]	[-0.59]	[-0.24]	[-0.18]
ΔLLY	-0.084	-0.024	0.049	-0.315	0.076	-0.012	0.029	0.028	0.140
	[-1.03]	[-0.66]	[0.87]	[-1.36]	[0.88]	[-0.23]	[1.038]	[0.29]	[1.62]
ΔBTOT	0.066	0.041	0.075	0.316**	0.164*	0.218**	0.625***	0.467***	0.559**
	[0.55]	[0.49]	[0.75]	[2.75]	[1.95]	[3.02]	[2.96]	[3.57]	[2.75]
ΔMCAP	0.048**	0.040***	0.026*	0.036	0.0008	0.008	0.044	0.016	0.036
	[2.43]	[3.35]	[2.00]	[1.28]	[0.02]	[0.27]	[1.46]	[1.17]	[1.30]
TOR	0.011	0.022**	0.017**	0.007	-0.002	-0.0013	0.010**	0.012**	0.010**
	[1.53]	[3.06]	[2.44]	[0.93]	[-0.42]	[-0.16]	[2.76]	[2.42]	[2.43]
INFL	0.111	0.076	-0.141	-0.030*	-0.032**	-0.024	0.307**	0.216	0.230
	[0.43]	[0.25]	[-0.92]	[-2.22]	[-2.37]	[-1.60]	[2.19]	[1.41]	[1.57]
FDI	-0.002	-0.002	-0.003	0.126***	0.116**	0.115***	-0.015**	0.261**	-0.016**
	[-0.87]	[-1.52]	[-1.64]	[3.54]	[2.38]	[3.34]	[-2.10]	[2.73]	[-2.50]
ΔOPEN	0.127***	0.095*	0.089	0.082	0.038	-0.036	0.133	0.162**	0.062
	[3.64]	[2.11]	[1.70]	[1.76]	[1.23]	[-0.76]	[1.70]	[2.68]	[0.57]
Cr*ΔLLY		-0.138	-0.503***		-0.967**	-1.561***		0.183*	-0.317*
		[-1.36]	[-12.26]		[-2.26]	[-7.67]		[1.96]	[-1.80]
Cr*ΔBTOT		-0.076	4.897**		-0.052	12.70***		1.611*	0.358
		[-0.26]	[2.39]		[-0.18]	[11.25]		[1.74]	[0.53]
Cr*ΔMCAP		-0.011	0.033		-0.003	-0.005		0.034	-0.085
		[-0.55]	[1.57]		[0.08]	[-0.17]		[0.48]	[-0.31]
Cr*TOR		-0.016**	-0.007		-0.009	0.039**		-0.010**	-0.015
		[-2.41]	[-1.46]		[-1.09]	[2.46]		[-2.25]	[-1.35]
Cr*INFL		-0.121	0.809***		-0.20	-0.112		-0.984***	-0.020
		[-0.34]	[4.28]		[-1.24]	[-0.93]		[-2.90]	[-0.02]
Cr*FDI		-0.003	0.018***		-0.115	-0.104***		-0.266***	0.319
		[-1.66]	[4.59]		[-1.27]	[-3.22]		[-2.92]	[1.06]
Cr*ΔOPEN		0.045	0.028		0.030	0.107		0.129	0.199
		[0.85]	[0.50]		[0.52]	[1.63]		[0.73]	[0.73]
R^2	0.287	0.417	0.511	0.173	0.375	0.462	0.254	0.521	0.337
obs	228	228	228	214	214	214	119	119	119

Note: See notes Table 5.7.

The results confirm that markets have a greater contribution to the economic performances than the banks in North-West countries indicating that economic activities take place through organised markets. In Central-Eastern and South countries the banks' assets contributed to economic growth suggesting that the capital adequacy of banks ensured the stability of the financial system. Also, the major indicator of size relative to economy liquid liabilities, hindered economic growth during the sub-prime crisis period showing that any expansion of broad money as a share of GDP, has detrimental effects on economic growth.

The overall findings suggest that when the crisis period is not included, financial development promoted economic growth, while during the crisis periods has an adverse effect on economic activity. During the years 2008 and 2009, the findings suggest that the ratio of commercial bank assets kept the economy from falling out, implying that the capital adequacy of banks promoted the stability the financial system. Also, the results obtained in the subprime crisis period suggest that liquid liabilities hindered economic growth. Finally, the degree of international trade openness in the economy of a country was the primary factor that led growth during both crisis periods.

5.3.6 Conclusions

This study aims to examine the relationship between financial development and economic growth on the face of the recent financial crisis, using a panel dataset of 26 European Union countries over the period 1990-2016. Also, six indicators are used as proxies for the financial development and two phases of crisis periods are examined, namely the subprime crisis period (2008-2009), and the ongoing crisis period (2008-2016). The empirical approach uses multiplicative dummies to compare two distinct sub-periods before (pre-ongoing)/after (ongoing) the crisis for the ongoing crisis models, and two distinct sub-periods stress time (2008-2009)/regular for all the rest sample period. The initial findings concluded that finance led growth at regular periods, while during the crisis periods the results are mixed. Next, issues such that of the intercept dummy and the imperfect (near) multicollinearity were addressed to get more conclusive results. However, the overall results of the study lead to several conclusions:

First, at regular periods, financial development has a positive effect on economic growth, while during the crisis periods has an adverse effect on economic activity. From the regional results, the main conclusion is that the impact of financial development indicators on economic growth is heterogeneous and varies across countries over time, thus confirming the assumption of the panel heterogeneity, which may be due to differences in levels of financial development.

Second, one of the most remarkable findings is that during the subprime crisis period (2008 and 2009), total banks assets *(BTOT)* have a significantly positive effect on growth, with a meaningful economic size. The relative importance of this finding is that the Deposit Guarantee Scheme, which is a EU legislation that protects banks deposits in case of bank failure, prevented the mass withdrawal of deposits. Hence, the capital adequacy kept the stability of the financial system as well as the economy in permissible growth level that did not lead to collapse.

Third, from the regional results it is worth noting that in North-West countries, the stock market capitalization has a greater contribution to the economic performance than banks, while in Central-Eastern and South countries the banks' assets contributed to economic growth. However, this may be a challenge for further financial integration efforts.

Fourth, the results reveal that the higher activity of the stock market is not a driving force of the economic growth, since it is not accompanied by higher liquidity, implying that at stress times, investors feel hesitant about the direction of the stock market, and thus future trading tends to increase, causing derivatives on specified securities to trade more actively. A future trading is a standardized contract to buy and sell a fixed quantity of specified assets at a pre-argue price, which is used by investors to hedge and to perfectly offset their risk. Hedging is a recurring feature of every financial crisis, and helps to reduce the risk of adverse price movement in an asset (Eales, 1997; Lioui and Poncet, 2005; Valdez and Molyneux, 2015). Additionally, the higher stock market activity is not accompanied by a higher stock market capitalization, implying that share prices fell. Thus, the stock market size drops resulting in weakening of the economy.

Nevertheless, from the results there is no clear picture of which sector prevails in the positive or negative effect on economic growth before and after the crisis. Principal component analysis (PCA) will be employed in the next study to create two new aggregate indices, one for banks and one for markets sectors, to get more specific results.

In relation to the previous literature, the findings refute the prior research of the positive finance-growth relationship as found by Christopoulos and Tsionas (2004), Apergis and Fillipidis (2007), Pradhan et al. (2016), Anwar and Cooray (2012), Muhammad et al. (2016) among others. These studies have not attempted to compare the effect of financial development to identify what went wrong or what went well before, during and after the recent financial crisis in a group of countries that implement the same regulations for the financial sector. Adversely, the findings have corroborated the research of Menyah et al. (2014), Swamy and Dharani (2018), Durusu-Ciftci et al. (2017), Narayan and Narayan (2013), Ductor and Grechyna (2014), Cojocaru et al. (2015) who found a negative relationship between financial development and economic growth and their data sets extend the year of crisis (2008). The current research has extended thinking and empirical evidence in this field, exploring the role of financial development in economic growth and investigating the relationship between the two in both short and long horizons, within and outside the recent global financial crisis. However, what merits the current sub-study, is that the work is a timely contribution to the knowledge providing important policy implications for the reforms to put forward to enforce the financial system's stability since the EU governments are currently developing new regulatory reforms to build a safer financial system.

5.4 Study 2: Financial Development, Economic Growth and the Role of Fiscal Policy

5.4.1 Introduction

According to the empirical literature (Chapter 2), several studies examined the finance-growth relationship and focused more on the employed methods, investigating either developed or developing countries. Also, most of the literature uses bank based financial proxies due to the unavailability of long-span time series data of the stock market for many of the countries. However, the impact of financial bank and stock market development on economic growth is not widely investigated and the existing studies provide ambiguous results. Levine (2002) documented that bank-based financial systems promote faster economic growth than market-based that are at an early stage of development. Likewise, Allen et al. (2012) found that bank-based financial systems are more helpful in economies in which the major industries are associated with manufacturing and technology. In contrast, Narayan and Narayan (2013) found different results, suggesting that the financial market sector has a significantly positive effect on economic growth, while the impact of the banking sector is significantly negative.

This study investigates the behavior of two sectors of the economy, namely the banking sector and the market sector, attempting to examine the effect they had on economic growth, before and after the crisis, which has not been addressed in the existing literature. Furthermore, it is investigated the response of the financial development measures to the quality of fiscal policy, which plays an essential role for the economic growth. The contribution of this study is described in the introduction chapter (See Chapter 1, contribution of the research). The remainder is organized as follows. Section 2 describes the data and section 3 presents the specification model. Section 4 reports the empirical results, while section 5 concludes.

5.4.2 Data

The current study is also based on a panel dataset covering 26 EU countries over the period 1990-2016. The financial development measures are two aggregate indices, one for the bank sector and one for the stock market sector, thus capturing the size of the financial system. The indices are created through the principal component analysis, which is described in the next section. Also, additional macroeconomic variables are used for the quality of the fiscal policy. The list of variables, descriptive statistics of new macroeconomic variables, and correlation analysis are presented in Tables 5.13 to 5.15 below.

Table 5.13: List of variables

variables	Description of variables
GGDP	Annual percentage growth rate of Gross Domestic Product (GDP)
LLY	Liquid liabilities to GDP(%), also known as broad money or M3.
PRIVY	Credit to private sector as percentage to GDP(%).
MCAP	Stock market capitalization to GDP (%).
TVT	Stock market total value of all traded shares as a percentage of GDP(%).
INFL	Inflation rate as a proxy for macroeconomic stability.
FDI	Net inflows of foreign direct investments to GDP(%).
OPEN	Trade openness to GDP(%), which is the sum of exports plus imports.
DEBT	Central government debt to GDP(%).
EXP	Government expenditures to GDP(%).
TAX	Tax revenue to GDP(%).

Note: The variables DEBT, EXP and TAX are stationary since the obtained residuals from an autoregressive time series model of order one are used as proxies for the fiscal policy in the estimation models (further details in model specification).

Descriptive statistics and correlation analysis

Table 5.14 present the summary statistics of the additional macroeconomic variables which are used as proxies for the fiscal policy. It is worth noticing that the mean of the public debt is 58%, while the average of taxrevenues (41.4%) exceeds the average of public spending (36.6%).

Table 5.14: Descriptive statistics of additional macroeconomic variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Full-sample of countries					
DEBT	656	58.74	32.59	3.66	181.32
EXP	653	36.25	11.06	1.87	63.06
TAX	665	41.46	7.72	14.94	61.92
Panel A: North and West countries of EU					
DEBT	270	62.63	23.36	13.84	126.35
EXP	265	38.74	6.02	24.77	62.24
TAX	54	77.61	30.08	44.09	126.35
Panel B: Central-Eastern countries and Baltic of EU					
DEBT	251	39.09	27.15	3.66	160.50
EXP	257	31.79	13.31	1.87	55.48
TAX	261	36.95	5.84	14.94	48.28
Panel C: South countries of EU					
DEBT	135	87.51	33.68	35.51	181.32
EXP	131	39.97	11.10	16.88	63.06
TAX	135	39.75	4.87	27.96	50.29

Table 5.15 below presents the correlation matrix. The higher pair-wise correlation is presented between LLY and PRIVY, followed by TVT and MCAP. According to the results for the control variables and the additional macroeconomic variables for fiscal policy, high correlation is not detected.

Table 5.15: Correlation matrix

Variables	LLY	PRIVY	MCAP	TVT	INFL	FDI	OPEN	DEBT	EXP	TAX
LLY	1.000									
PRIVY	0.792	1.000								
MCAP	0.452	0.551	1.000							
TVT	0.449	0.543	0.801	1.000						
INFL	-0.420	-0.425	-0.401	-0.423	1.000					
FDI	0.0367	0.0038	0.184	0.068	0.025	1.000				
OPEN	0.049	-0.045	-0.065	-0.222	-0.105	0.426	1.000			
DEBT	0.394	0.215	0.059	0.055	0.080	-0.020	-0.137	1.000		
EXP	0.347	0.218	0.012	-0.051	-0.080	0.020	-0.107	0.505	1.000	
TAX	0.028	0.170	0.253	0.298	-0.207	0.008	-0.166	0.214	0.295	1.000

5.4.3 Principal component analysis (PCA)

Many studies in the empirical literature use either M_2 or M_3 as a ratio of GDP to capture the overall size and depth of the financial sector (Savvides, 1995; Khan and Senhadji, 2003; Chuah and Thai, 2004; Samargandi et al., 2015). Also, liquid liabilities of the financial system, including the liabilities of banks, central banks and other financial intermediaries, reflect the financial deepening, which is in turn positively related with financial services (Demetriades and Hussein, 1996; Favara, 2003). Additionally, credit to the private sector as a proportion of GDP is the third most widely used alternative measure of financial development. It accounts for credit granted to the private sector that enables the utilization of funds and their allocation to more efficient and productive activities (Levine et al., 2000; Demetriades and Hussein, 1996; Ang and McKibbin, 2007; Arcand et al., 2015).

In this study, PCA is employed for the construction of two financial development indices to represent the size of both sectors, the bank and the stock market. For the bank index, two indicators are used: liquid Liabilities and credit to private sector, capturing the size of the banking sector. Second, for the stock market index, two additional indicators are used: stock market capitalisation and total value traded, capturing the size of the financial market sector.

Before proceeding with PCA, it is necessary to use stationary data. Bai and Ng (2004) found that when the principal component analysis was applied to levels, all the estimated series were far from the true series. This estimation using the data in levels is not consistent. On the contrary, the constructed indices are robust to stationary assumptions when scores are estimated from first-differenced data. Two financial development variables of each sector are utilized, to reduce them to one index based on the Kaiser's criterion that requires an eigenvalue bigger than unity. Another criterion of retaining a component is if it accounts for a large proportion of variance of the data set. The results for principal component analysis are reported in Tables and below.

Table 5.16 presents the results of the principal component analysis for the bank index. The first component is the only one with an eigenvalue greater than 1 and it explains about 74% of the variation of the dependent variable. The second principal component explains the remaining 26%. Hence, it is clear that the first principal component has the maximum explanatory power. It is used therefore as the financial development bank size (FDB) indicator.

Table 5.16: Principal component analysis for financial bank size index

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.4773	0.9546	0.7386	0.7386
Comp2	0.5227		0.2614	1.000

Table 5.17 presents the results of the principal component analysis of the market index. The first component is the only one with an eigenvalue greater than 1 and it explains about 69.5% of the variation of the dependent variable. The second principal component explains the remaining 30.4%. Hence, again it is clear that the first principal component has the maximum explanatory power. It is used therefore as the financial development market size (FDM) indicator .

Table 5.17: Principal component analysis for financial market size index

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.391	0.7828	0.6957	0.6957
Comp2	0.6086		0.3043	1.000

5.4.4 Model specification

After the creation of two indices, ordinary least squares (OLSs) panel regressions are employed to analyze the effect of different financial development banking and stock market sectors on economic growth, before and after the crisis. According to the Hausman test, panel country-fixed effects models are estimated. Furthermore, the Driscoll and Kraay (1998) estimator is applied, which produces heteroscedasticity-and autocorrelation-consistent standard errors that are robust to cross-sectional and temporal dependence. The benchmark model is:

$$GGDP_{it} = \alpha_0 + \boldsymbol{\beta}' \boldsymbol{FD_{it}} + \boldsymbol{\gamma}' \boldsymbol{X_{it}} + u_{it} \tag{5.2}$$

where the dependent variable is $GGDP_{it}$, measured by the annual percentage growth rate of real GDP at (constant 2010 U.S. dollars), i and t subscripts are defined as $i=1,2,...,26$ EU countries and $t=1990,...,2016$. Then, α_0 denotes the intercept; $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are the vectors of coefficients; $\boldsymbol{FD_{it}}$ is a matrix of financial development indices; $\boldsymbol{X_{it}}$ is a matrix of control variables; u_{it} captures the error term.

Next, it is examined the quality of fiscal policy, which may influence not only the economy but also financial development. It is crucial to investigate the response of financial development measures to the quality of fiscal policy, which plays an essential role in the current and future directions in economic growth. In particular, to examine how the quality of fiscal management changes financial development before and after the crisis, it will be identified the unexpected changes in fiscal policy such that of the government debt and the government size proxied by public spending or tax revenues. To isolate the unexpected changes of these macroeconomic series, an autoregressive time series model of order one is fitted that uses as independent variable observations from previous time steps (one-lag-value) to predict the value at the next time step, and the residuals from the equations, are treated as indicators of the quality of fiscal policy. The assumption behind the AR(1) model is that time series behavior of Y_t is primarily determined by its own value in the preceding period. So what will happen in time t is mainly dependent on what happened in $t-1$. Alternatively, what will happen in $t+1$ will be determined by the behavior of the series in the current time t. In order to guarantee stationarity, it is estimated the first difference of each macroeconomic variable for each country as below:

$$\Delta D\hat{EB}T_t = \hat{\beta}_1 \Delta DEBT_{t-1} + e_t^{DEBT} \tag{5.3}$$

$$\Delta E\hat{X}P_t = \hat{\beta}_2 \Delta EXP_{t-1} + e_t^{EXP} \tag{5.4}$$

$$\Delta T\hat{A}X_t = \hat{\beta}_3 \Delta TAX_{t-1} + e_t^{TAX} \tag{5.5}$$

where $DEBT_t$ is the central government debt, EXP_t is the government expenditures, TAX_t is the tax revenues and stand for the predicted values for time t from its own previous value of time $t-1$. The obtained residuals e_t^{DEBT}, e_t^{EXP} and e_t^{TAX} from the regressions are the unexpected changes in fiscal policy and represent the quality of fiscal policy, which will be used as additional explanatory variables to our regressions.

5.4.5 Estimation results

5.4.5.1 Finance-growth: All countries results

The results from the full panel of countries are reported in Table 5.18. Model (I) includes the financial development measures, while model (II) includes the financial development measures and the control variables. Model (III) includes the financial development measures and their interaction with crisis dummy (Cr0816) as well as the intercept dummy, while model (IV) includes interactions with the control variables as well. Models (V) and (VI) are defined similarly to the ongoing crisis with crisis dummy (Cr0809).

The first two models, present the results from the whole sample period. It is found that the impact of the financial stock market development (FDM) on economic growth is positive and statistically significant, while the impact of the bank sector (FDB) is insignificant. Adding the control variables in model (II) provides negative effect from inflation (INFL) and positive effect from openness (OPEN). Foreign direct investments (FDI) seems to be insignificant.

In models III and IV the ongoing crisis period is examined. In model (III) the results show that before the crisis, the coefficients of both sectors are positive and significant, while after the crisis the coefficient of bank sector becomes significantly negative and the coefficient of the stock market sector is found insignificant. In model (IV), adding control variables the results show that before the crisis the impact of the bank sector on economic growth is insignificant, while the impact of the stock market is positive and significant. After the crisis, the effect of both sectors negatively affected economic growth, which is heavily dominated by the banking sector.

In the last two models (V and VI) the subprime crisis period is examined. In both models, the findings suggest that at regular times, (when the crisis dummy is not included in the models), the stock market sector has a positive and statistically significant effect on economic growth, while the effect of the bank sector is insignificant. During the subprime crisis period, both indices of financial development have a negative and statistically significant effect on economic growth.

From the results concerning the crisis dummies, it is interesting to see that the effect is negative and statistically significant on economic growth in all models. Also, at regular times, the inflation rate has a significant and adverse effect on economic growth and is properly signed, while at stress times, the impact becomes insignificant.

Interestingly, the positive and significant effect of trade openness before crisis remains two years after the financial crisis, with economically meaningful effect size, but becomes insignificant during the ongoing crisis.

The overall findings suggest that the financial development indicators show entirely different performance in crisis periods than in regular periods. In particular, there is strong evidence that the stock market sector prevails in the positive effect at regular periods, whereas the bank sector dominates the adverse effect at stress times. Consequently, the bank sector exhibits high persistence of this adverse effect and may take a long time to return to levels observed before the crisis. A similar situation can also be observed in the stock market, although the effect tends to be insignificant (the negative effect seems to be weak as the significance level becomes lower).

Table 5.18: Full panel

period	whole sample		Ongoing crisis Cr=Cr0816		Subprime crisis Cr=Cr0809	
Variables	model (I)	model (II)	model (III)	model (IV)	model (V)	model (VI)
Constant	2.433***	2.238***	3.364***	3.335***	2.856***	2.859***
	(4.69)	(3.72)	(13.57)	(13.56)	(7.21)	(7.05)
FDB	-0.259	-0.227	0.256**	0.209	0.138	0.113
	(-0.84)	(-0.85)	(2.47)	(1.69)	(0.65)	(0.49)
FDM	0.734***	0.567**	0.365***	0.268**	0.394**	0.384**
	(2.90)	(2.72)	(3.31)	(2.45)	(2.65)	(2.35)
INFL		-0.004*		-0.004***		-0.005*
		(-1.99)		(-3.35)		(-1.94)
FDI		-0.0004		0.0004		0.0006
		(-0.15)		(0.49)		(0.21)
$\Delta OPEN$		0.119**		0.068***		0.015
		(2.22)		(3.09)		(0.41)
Cr			-3.128***	-3.970***	-5.289***	-5.172***
			(-6.63)	(-5.71)	(-3.79)	(-4.22)
*Cr*FDB*			-1.493***	-1.280***	-0.527**	-0.680***
			(-4.99)	(-4.67)	(-2.64)	(-2.92)
*Cr*FDM*			-0.191	-0.383*	-0.748***	-1.080***
			(-0.94)	(-1.93)	(-3.70)	(-4.65)
*Cr*INFL*				0.101		0.245
				(0.81)		(1.55)
*Cr*FDI*				0.005		0.013***
				(1.04)		(2.96)
$Cr*\Delta OPEN$				0.093		0.223***
				(1.74)		(4.40)
R^2	0.05	0.08	0.29	0.36	0.22	0.29
Obs	574	552	574	552	574	552

Note: The dependent variable is economic growth (GGDP). FDB stands for the index of bank sector development and FDM stands for the index for the stock market development. The method of estimation is fixed effects with Driscoll and Kraay (1998) estimator which produces heteroscedasticity-and autocorrelation-consistent standard errors robust to cross-sectional dependence. Numbers in parentheses denote t-statistics. (***), (**), (*) reflect 1%, 5%, 10% levels of significance respectively. The letter Δ denotes the first difference operator used for the variables that were transformed to become stationary. *Cr* is the interaction term and stands for the crisis dummy.

One possible explanation for the negative effect of the banking sector index during the subprime crisis period might be the liquidity trap. Krugman (1988) argued that liquidity trap is the situation when investors have an abnormal preference over liquidity and prefer to keep their assets in the form of cash or demand deposits. Specifically, in a depressed economy, any increase in money supply is unlikely to cause inflation, and there is a decrease in the velocity of circulation. Also, the belief of an adverse event such as deflation and insufficient aggregate demand might be the main reasons that lead consumers to avoid investing in bonds and keep their funds in the form of cash or demand deposits.

A possible explanation for the negative effect of the bank sector eight years after the crisis (ongoing crisis period) might be the ineffectiveness of monetary policy. In particular, it appears that the unconventional monetary policy instruments failed to stimulate the economy. The European Central Bank through the comprehensive program of Quantitative Easing (QE) helped countries that are members of euro, to refinance their sovereign debts at low-interest rates, which may effectively reduce the national debts, but was less effective on the real economy. However, low interest rates do not necessarily mean that consumers will invest. In contrast, they may not want to hold assets like bonds as they prefer to save resources and need to be faced with good prospects. This situation is described in a modern version of Keynesian economics, where the rise of money supply into private banks by a central bank decreases interest rates, but the monetary policy is ineffective.

Another reason for the adverse effect of the bank sector might be the type of credit to private sector. In particular, household credit and enterprise credit have a different impact on economic growth. There is empirical evidence that loans to enterprises enhance economic growth by easing the liquidity constraint on firms, which in turn leads to the formation of new companies and the expansion of existing ones (Levine, 2005). Conversely, the evidence for loans to households, suggests that it either has no effect on medium and long-term economic growth (Beck and Demirguc-Kunt, 2009) or that it even reduces growth. Jappelli and Pagano (1994) argue that higher availability of household credit reduces private savings and economic growth. The over-lending to households created a credit boom that led to a banking crisis. Demirguc and Detragiache (1998) and Kaminsky and Schmukler (2002) argue in their studies that the banking crises are associated with the rapid growth of credit to the private sector.

As the results show, stock market activity sharply declined and has an adverse effect two years after the crisis, which remains during the ongoing crisis period, but tends to be insignificant because of the lower power. Those results may have been caused by the drop in stock prices when the crisis erupted. Another possible reason for these results might be the increase in output. In particular, from 2002 to 2008, there is a rapid growth achieved by European securities markets and the possible explanation might be the newly created currency area of the twelve participating European Union member states, which strengthened the integration of the financial markets across the EU countries. This rapid growth raises the demand for the industry's product, and thus boosts profits for given capital stock. The higher market value of capital attracts investment, and so the capital stock starts to rise. As this is a temporary effect, the permanent result is that investments respond less since firms respond less to a rise in profits when they know they will reverse the increases (Romer, 2012). However, stock market performance is highly volatile and easily affected by global economic conditions.

5.4.5.2 Finance-growth: Regional results

The results from the regional panels are reported in Table 5.19. It is necessary to divide the full panel of 26 EU countries into smaller regional panels that are more homogeneous in terms of level of financial development. Model (I) includes the financial development measures and the control variables, while Model (II) includes their interaction with crisis dummy (Cr0816) and the intercept dummy as well. Model (III) is defined similarly to the ongoing crisis with the crisis dummy (Cr0809) instead. Models IV to VI and VII to IX are defined similarly to the first three models for the Central-Eastern and Baltic region and South panel respectively.

The first three models, present the results for the North-West subsample. It is found that during the whole sample period (as model I reports), the impact of the stock market sector on economic growth is positive and statistically significant, whereas the impact of the bank sector is significantly negative. In models II and III, at regular times, financial stock market development promoted economic growth, while for the bank sector this is not the case. During the ongoing crisis period, both indices are negative and significant, while in the subprime crisis period the bank sector has an adverse effect on economic growth. The estimated results for the macroeconomic variables show that the negative and significant effect of inflation rate on economic growth at normal periods becomes significantly positive at crisis periods. Also, the positive effect of trade openness at regular periods becomes insignificant at crisis periods.

The next three models (IV to VI) report results for the transition countries. In model IV, where the whole sample period is examined, it is found that the impact of the stock market sector on economic growth is positive and statistically significant, while the impact of the bank sector is insignificant. In models V and VI the findings suggest that at normal times financial bank sector development contributed to economic growth, while the effect of the stock market sector on economic activity is insignificant. During the crisis periods, both financial development indices are negative and statistically significant. The estimated results for the macroeconomic variables show that openness is the only positive and significant driving force of growth during both crisis periods.

The last three models (VII to IX), present the results for the South group of countries. The results show that during the whole sample period and the pre-ongoing crisis period (as the models VII and VIII report), the impact of financial development on economic growth is insignificant, while at normal time as evidenced in model IX, the impact of the bank sector appears to be significantly positive. During the crisis periods, both financial development indices are insignificant. The estimated results for the macroeconomic variables show that the positive and significant effect of openness on economic growth during the pre-ongoing crisis period remains unchanged only for the subprime crisis period.

Table 5.19: Regional panels

Panel	A: North-West EU countries			B: Central-Eastern EU countries			C: South EU countries		
period	whole	ongoing	subprime	whole	ongoing	subprime	whole	ongoing	subprime
		Cr=Cr0816	Cr=Cr0809		Cr=Cr0816	Cr=Cr0809		Cr=Cr0816	Cr=Cr0809
Variables	model I	model II	model III	model IV	model V	model VI	model VII	model VIII	model IX
Constant	2.025**	3.512***	3.089***	2.400**	4.272***	3.584***	0.628	2.959***	1.283
	(2.42)	(12.88)	(7.72)	(2.44)	(6.33)	(5.09)	(0.64)	(5.87)	(1.34)
FDB	-0.745*	-0.122	-0.373	-0.175	0.814**	0.738**	0.459	0.055	0.635*
	(-2.06)	(-0.89)	(-1.09)	(-0.27)	(2.22)	(2.18)	(1.44)	(0.18)	(1.86)
FDM	0.651**	0.509***	0.332*	0.538*	-0.115	0.2.65	0.733	0.030	0.597
	(2.51)	(3.58)	(1.89)	(1.78)	(-0.41)	(0.92)	(1.43)	(0.22)	(1.30)
INFL	-0.043	-0.467***	-0.418***	-0.004	0.0001	0.0003	0.239	-0.076	0.141
	(-0.14)	(-3.26)	(-3.22)	(-0.88)	(0.05)	(0.12)	(1.73)	(-0.71)	(1.06)
FDI	-0.0008	-0.0008	-0.0008	0.119**	0.047	0.084*	-0.015*	0.027	-0.016*
	(-0.40)	(-1.27)	(-0.35)	(2.47)	(1.31)	(2.11)	(-1.94)	(0.39)	(-2.04)
$\Delta OPEN$	0.136***	0.086*	0.126*	0.107	0.031)	-0.027	0.081	0.131***	-0.003
	(3.47)	(2.00)	(2.03)	(1.60)	(0.97)	(-0.61)	(0.93)	(3.98)	(-0.02)
Cr		-3.783***	-4.812***		-5.531***	-1.752		-3.927***	-2.583***
		(-5.81)	(-10.23)		(-4.23)	(-0.61)		(-5.88)	(-3.22)
*Cr*FDB*		-1.564***	-1.362***		-3.095***	-4.662***		0.452	-0.302
		(-4.14)	(-4.44)		(-4.21)	(-10.38)		(1.31)	(-0.77)
*Cr*FDM*		-0.376*	0.059		-0.526*	-0.943*		1.585	0.114
		(-2.03)	(0.24)		(-2.08)	(-1.90)		(1.56)	(0.10)
*Cr*INFL*		0.888**	1.458***		0.170	0.006		0.117	0.329**
		(2.55)	(8.11)		(0.94)	(0.03)		(0.25)	(2.54)
*Cr*FDI*		-0.0004	0.015***		0.035	0.012		-0.033	0.070
		(-0.11)	(5.10)		(0.92)	(0.25)		(-0.47)	(0.83)
$Cr * \Delta OPEN$		0.030	-0.122		0.121**	0.308***		-0.090	0.199*
		(0.42)	(-1.66)		(2.33)	(3.13)		(-0.53)	(2.00)
R^2	0.18	0.43	0.39	0.14	0.49	0.45	0.15	0.55	0.24
obs	225	225	225	208	208	208	119	119	119

Note: See notes Table 5.10.

The findings also provide valuable insights into the financial system of the regions. More specifically, the results at normal periods indicate that North-West countries are more market-oriented, while transition economies appear to be more bank-based. Besides, transition economies present a stronger adverse effect at stress times than the North-West countries, implying that countries with an underdeveloped stock-market make their financial system more fragile. Allen et al. (2012), found in their study that countries with bank-based financial systems may not have a well-developed stock market sector, which is often the case in emerging markets. On the other hand, for countries with market-based financial systems, it is very likely that the banking sector is also well-developed.

Moreover, the effect of the equity market during the crisis periods in North-West and transition countries appears to be different during the subprime crisis period, but in the ongoing crisis period seems to be strongly related in these two regions (since they both report negative and significant results). A possible explanation of this result is that stock market disruptions tend to increase in times of recessions or large shocks, which are often affected through strong linkages and co-movements. Furthermore, in countries with balanced financial system structures, enterprises can more easily shift financing from banks to markets or vice-versa during a crisis. The change of financial channels might explain the results and would confirm the findings of Claessens et al. (2010) and Allen et al. (2012), who found that the financial indicators during a crisis are very different in emerging economies than in developed economies. According to the same authors, in emerging markets, economic recessions are often more costly, and the markets take more time to recover after the crises.

The findings for South panel reveal that financial development does not stimulate economic growth all times being considered, suggesting that in these economies the ability of financial intermediaries to allocate resources is inefficient. A possible explanation of this result might be the weakness of the private sector in generating economic activities as well as the general inefficiency of financial institutions and the dominant role of the public sector in resource allocation. This explanation is also consistent with the argument provided by Nili and Rastad (2007), who found that the weakness of the private sector is associated with an inefficient financial system to allocate resources and the dominant of the public sector. Also, it seems that the entry of these countries in Eurozone weakened the incentive to reduce the public debt.

5.4.5.3 Fiscal policy: All countries results

In Table 5.20, it is repeated the previous empirical estimation strategy adding the indicators of the quality of fiscal policy as explanatory variables in the regressions. Model (I) includes the financial development measures, control variables, public debt (DEBT) as proxy for the fiscal policy and their interaction with crisis dummy (Cr0816) as well as the intercept dummy. In model (II) is also included the government expenditures (EXP) and its interaction with crisis dummy (Cr0816), while in model (III) is added the taxrevenues (TAX) and its interaction with crisis dummy (Cr0816) as well. Models (IV) to (VI) are defined similarly to the ongoing crisis with crisis dummy (Cr0809).

In models I to III the ongoing crisis period is examined. The results show that during the pre-crisis period, the coefficients of both financial development indices are positive and significant even after have been added the control variables for the quality of fiscal policy. During the ongoing crisis period, the coefficients of both financial development indices are negative and significant However, the results for the bank sector before the crisis are statistically stronger compared to our main estimation, while after the crisis, the findings are quite similar to the main results (Table 5.18 model IV).

In models IV to VI, where the subprime crisis period is examined, the results show that at normal periods, the coefficients of the bank sector are insignificant, while the coefficients of the stock market sector are positive and significant. During the subprime crisis period, both financial development indices are negative and significant. However, the results for the subprime crisis models remain unchanged regarding the signs and significance levels compared to the main estimations.

Table 5.20: Full panel

period	Ongoing crisis Cr=Cr0816			Subprime crisis Cr=Cr0809		
Variables	model (I)	model (II)	model (III)	model (IV)	model (V)	model (VI)
Constant	3.292***	3.343***	3.332***	2.815***	2.843***	2.863***
	(15.98)	(16.40)	(16.64)	(8.25)	(8.11)	(8.79)
FDB	0.269***	0.273***	0.304***	0.226	0.251	0.255
	(3.96)	(3.77)	(3.46)	(1.22)	(1.35)	(1.45)
FDM	0.222**	0.207*	0.209**	0.251*	0.236*	0.269**
	(2.26)	(2.11)	(2.20)	(2.04)	(1.93)	(2.48)
INFL	-0.004***	-0.005**	-0.005**	-0.004*	-0.005**	-0.005**
	(-3.25)	(-2.90)	(-2.65)	(-1.87)	(-2.23)	(-2.51)
FDI	0.0008	0.0008	0.0007	0.001	0.001	0.002
	(1.04)	(1.08)	(0.92)	(0.67)	(0.65)	(0.82)
$\Delta OPEN$	0.036	0.032	0.028	-0.003	-0.004	-0.012
	(1.56)	(1.38)	(1.28)	(-0.12)	(-0.17)	(-0.45)
e^{DEBT}	-0.140***	-0.126***	-0.132***	-0.220***	-0.204***	-0.208***
	(-4.01)	(-4.83)	(-4.76)	(-4.46)	(-4.69)	(-4.40)
e^{EXP}		-0.087	-0.074		-0.273***	-0.211***
		(-0.85)	(-0.79)		(-3.37)	(-3.41)
e^{TAX}			-0.048			-0.225*
			(-1.10)			(-1.81)
Cr	-3.232***	-3.312***	-3.189***	-1.940	-1.191	-1.224
	(-7.43)	(-7.79)	(-7.41)	(-1.45)	(-1.62)	(-1.26)
*Cr*FDB*	-0.915***	-0.907***	-0.925***	-0.880***	-1.270***	-1.349***
	(-4.91)	(-4.56)	(-5.62)	(-4.33)	(-3.34)	(-5.77)
*Cr*FDM*	-0.475***	-0.540***	-0.344*	-0.599**	-0.720**	-0.628***
	(-3.07)	(-3.18)	(-1.82)	(-2.64)	(-2.85)	(-3.43)
*Cr*INFL*	0.114	0.106	0.094	0.076	6 0.055	-0.012
	(1.12)	(1.03)	(0.98)	(0.46)	(0.43)	(-0.09)
*Cr*FDI*	0.006	0.006	0.006	0.025***	0.023***	0.034***
	(1.22)	(1.24)	(1.14)	(3.29)	(3.56)	(4.17)
$Cr{*}\Delta OPEN$	0.092*	0.097**	0.095**	0.187***	0.194***	0.190***
	(2.11)	(2.37)	(2.23)	(4.84)	(5.41)	(4.79)
$Cr * e^{DEBT}$	-0.193**	-0.155	-0.146	-0.258**	-0.227***	-0.279***
	(-2.15)	(-1.73)	(-1.63)	(-2.88)	(-3.20)	(-4.26)
$Cr * e^{EXP}$		-0.156	-0.105		-0.103	-0.0658
		(-1.32)	(-1.04)		(-1.36)	(-1.08)
$Cr * e^{TAX}$			-0.803***			-1.033***
			(-4.57)			(-6.56)
R^2	0.05	0.08	0.29	0.36	0.22	0.29
Obs	530	524	522	530	524	522

Note: See notes Table 5.10.

The proxies for the quality of fiscal policy, however, enter the regression with negative signs and have not enhanced the economic activity all periods being considered. In particular, public debt is significantly negative at regular periods as well as two years after the crash and tends to be insignificant eight years after the financial crisis. Splitting the government size into public spending and tax revenues, enter the regressions with negative and insignificant results at regular periods, and the adverse effect of tax revenues remains eight years after the crisis.

As mentioned above, one possible explanation for the negative and significant effect of debt on economic growth, at regular periods, might be the lack of incentives for countries that became members of Eurozone to reduce the public debt. However, after the sharp recession and the sudden fall in output, the debt-to-GDP ratio increases and pressure is caused to governments to offer a sovereign risk premium for their debt to be sold. When this happens, the cost of debt rises further, making default even more likely. Thus, it is necessary for governments to impose fiscal limits, namely, upper limits to tax revenues and lower limits to public spending in order to avoid default. Such fiscal performance implies expected future primary fiscal surpluses to make the public debt sustainable.

Moreover, the significant negative effect of debt on the economy continued in 2008 and 2009; and eight years after the crash becomes insignificant, thus confirming the assumption above that the quantitative ease effectively reduced the sovereign debt for Eurozone countries, but the monetary policy was ineffective on the real economy. Furthermore, after 2008, it can easily be noticed that simultaneously with the reduction of government debt, taxes have negatively affected the economy, implying that the effectiveness of the undertaken austerity measures by policymakers did not deliver the expectations of investors. Hence, the different tax rates over time and the time-inconsistency problem that arises from the difference between ex-ante and ex-post savings and capital tax rates might be the possible explanation of the negative results of the stock market index during the crisis periods.

The results are consistent with the existing findings, which argue that surprising changes may not constitute good policy. Also, the unanticipated rise of government spending through higher taxes as well as higher debt burden may have long-term consequences which are far more worse than the short-term increase of GDP (Mountford and Uhlig, 2009). Therefore, it is assumed that the increase in debt always hinders the economic activity and the impact may be sufficiently strong enough not only at stress times but also, during the normal periods.

5.4.5.4 Fiscal policy: Regional results

In Table 5.21 are reported the results for the three subsamples of countries. For each subsample, two models are used. In the first two models, the North-West group of countries is examined. Model (I) examines the ongoing crisis period and includes the financial development measures, the control variables, the variables of fiscal policy and their interaction with crisis dummy (Cr0816) and the intercept dummy as well. Model (II) is defined similarly to the ongoing crisis with the crisis dummy (Cr0809) instead. Models III to IV and V to VI are defined similarly to the first two models for the Central-Eastern and Baltic region and South panel respectively.

Table 5.21: Regional panels

Panel	A: North-West EU countries		B: Central-Eastern EU countries		C: South EU countries	
period	ongoing crisis	subprime crisis	ongoing crisis	subprime crisis	ongoing crisis	subprime crisis
	Cr=Cr0816	Cr=Cr0809	Cr=Cr0816	Cr=Cr0809	Cr=Cr0816	Cr=Cr0809
Variables	model I	model II	model III	model IV	model V	model VI
Constant	2.901***	2.519***	4.201***	3.466***	3.722***	1.552**
	(8.14)	(5.89)	(5.24)	(5.09)	(7.01)	(2.55)
FDB	-0.073	-0.160	0.888**	0.835**	0.244	0.737***
	(-0.93)	(-1.00)	(2.38)	(2.63)	(1.07)	(3.17)
FDM	0.368***	0.189	-0.084	0.265	0.058	0.557*
	(4.50)	(1.55)	(-0.36)	(0.99)	(0.50)	(2.07)
INFL	-0.175	-0.157	-0.0008	0.0006	-0.357*	0.098
	(-1.24)	(-1.41)	(-0.29)	(0.25)	(-1.99)	(0.56)
FDI	0.00001	0.0005	0.060	0.094**	0.00006	-0.013**
	(0.03)	(0.25)	(1.27)	(2.26)	(0.00)	(-2.79)
$\Delta OPEN$	0.062**	0.114**	0.004	-0.041	0.0389	-0.112
	(2.41)	(2.62)	(0.13)	(-1.03)	(0.87)	(-1.39)
e^{DEBT}	-0.180***	-0.224***	-0.079*	-0.161**	-0.158***	-0.210***
	(-6.93)	(-5.05)	(-2.11)	(-2.79)	(-6.03)	(-6.79)
e^{EXP}	-0.112	-0.161*	-0.115	-0.050	-0.0269	-0.131*
	(-1.06)	(-2.18)	(-1.01)	(-0.50)	(-0.40)	(-2.22)
e^{TAX}	-0.086	-0.546*	-0.009	-0.088	0.081	-0.301
	(-1.19)	(-1.89)	(-0.16)	(-0.86)	(0.45)	(-1.04)
Cr	-2.710***	-1.414***	-3.878***	2.176	-4.454***	-0.577
	(-5.91)	(-3.60)	(-4.52)	(1.36)	(-6.24)	(-0.62)
*Cr*FDB*	-0.703**	-0.210	-2.217***	-3.299***	0.015	2.633
	(-2.36)	(-0.43)	(-5.51)	(-3.39)	(0.07)	(1.02)
*Cr*FDM*	-0.284	0.300*	0.087	0.353	1.722*	7.081
	(-1.79)	(1.93)	(0.31)	(1.22)	(2.11)	(1.33)
*Cr*INFL*	0.714***	0.575***	0.137	-0.184*	0.546	-0.432
	(3.55)	(4.78)	(1.42)	(-1.96)	(1.77)	(-1.53)
*Cr*FDI*	0.0007	0.018***	0.038	0.074	-0.007	0.366
	(0.16)	(7.73)	(0.64)	(1.50)	(-0.14)	(0.84)
$Cr * \Delta OPEN$	0.062	-0.106**	0.068	0.062	0.042	1.017
	(1.10)	(-2.37)	(1.56)	(0.98)	(0.36)	(1.48)
$Cr * e^{DEBT}$	-0.083	0.032	-0.438*	-1.075***	0.009	1.273
	(-0.98)	(0.60)	(-2.05)	(-10.17)	(0.12)	(1.13)
$Cr * e^{EXP}$	-0.057	-0.660***	0.157	0.306	0.084	0.726
	(-0.37)	(-5.17)	(0.98)	(1.04)	(1.27)	(1.34)
$Cr * e^{TAX}$	-1.041*	1.422***	-0.712**	-1.392***	-1.155***	0.591
	(-1.91)	(3.57)	(-2.41)	(-6.48)	(-4.39)	(0.53)
R^2	0.68	0.66	0.57	0.60	0.75	0.58
obs	217	217	195	195	110	110

Note: See notes Table 5.10.

The results in model (I) show that during the pre-ongoing crisis period the stock market sector has a positive and significant effect on economic activity, while during the ongoing crisis is found an adverse effect of the bank sector on economic growth. In model (II), where the subprime crisis period is examined, during the regular time, there is no impact of financial development on economic growth, while at stress time it appears that stock market enhanced economic activity.

In models (III) and (IV), where the transition economies are examined, there is a positive and significant effect of the bank sector on economic growth at normal times, which becomes significantly negative at stress times. The effect of the stock market sector is insignificant all periods being considered.

The last two models present the results for the South region, and in model (V), it is found that during the pre-ongoing crisis period the coefficients of both sectors are insignificant, while during the ongoing crisis period the stock market enhanced economic growth. On the other hand, in model (VI), where the subprime crisis period is examined, during the normal period both sectors contributed to economic growth with the bank sector to prevail in this positive effect, but two years after the crisis there is no impact of financial development on economic growth.

Next, turning to the results of the proxies for fiscal policy, the results reveal that the adverse effect of debt on economic growth at normal times across all regions remains unchanged at crisis periods for the transition economies, but becomes insignificant for the remaining panels. There is also substantial evidence that at normal periods taxes are insignificant, while at crisis periods become significantly negative.

Additionally, after the proxies for fiscal policy have been added in models, and when the models do not include the crisis dummy (normal periods), it can easily be observed that the coefficients of the financial development indices do not alter, thus confirming the main findings in regional panels (Table 5.19). However, the impact of the bank and market sectors in the South region becomes stronger when the subprime crisis model is examined. During the crisis periods, there is substantial evidence that there is a trade-off between the coefficients of the financial development indices and proxies of fiscal performance, as the power of the adverse effect of the bank sector seems to be weaker, while any significant adverse effect of the stock market index becomes insignificant or significantly positive. However, this is not the case for banks in transition economies.

The findings reveal that the effect of public debt becomes insignificant eight years after the crisis, while for taxes this is not the case. A possible explanation of these results might be the implementation of the unconventional measures of monetary policy whereby the ECB refinanced the sovereign debts of countries that are members of Eurozone. Hence, the findings confirm the assumption that the quantitative ease programme has not enhanced the economic activity and the monetary policy was ineffective.

5.4.5.5 Additional discussion of results

The figure 5.1 show the mean of the FDB index (on the left) that is constructed from the of the original variables liquid liabilities (LLY) and credit to private sector (PRIVY) (on the right). Also, it can be easily observed from the right graph that both indicators have an upward trend from 1995 to 2008 and reached at levels close to 100% of GDP, which is twice as much of 1995. Over the period 2008-2016, liquid liabilities are moving around 91%, while credit to private sector fell from 104% to 86%.

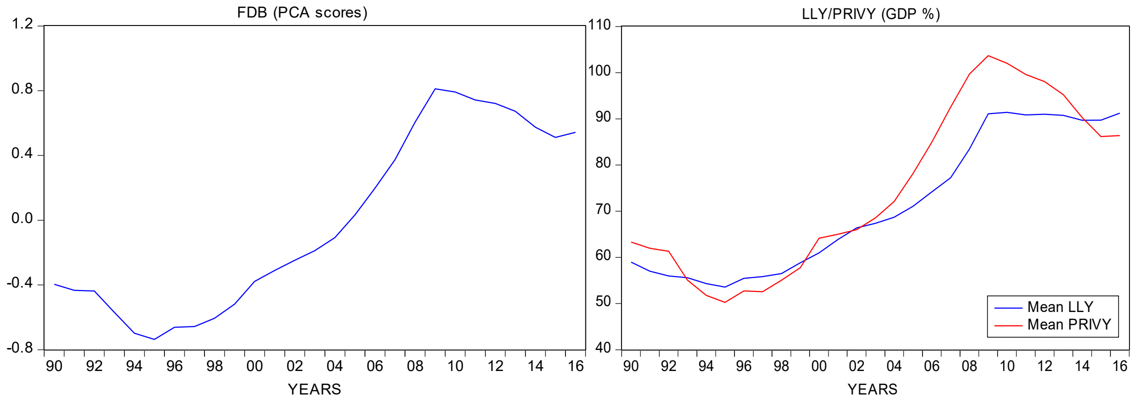


Figure 5.1: FDB index from LLY and PRIVY

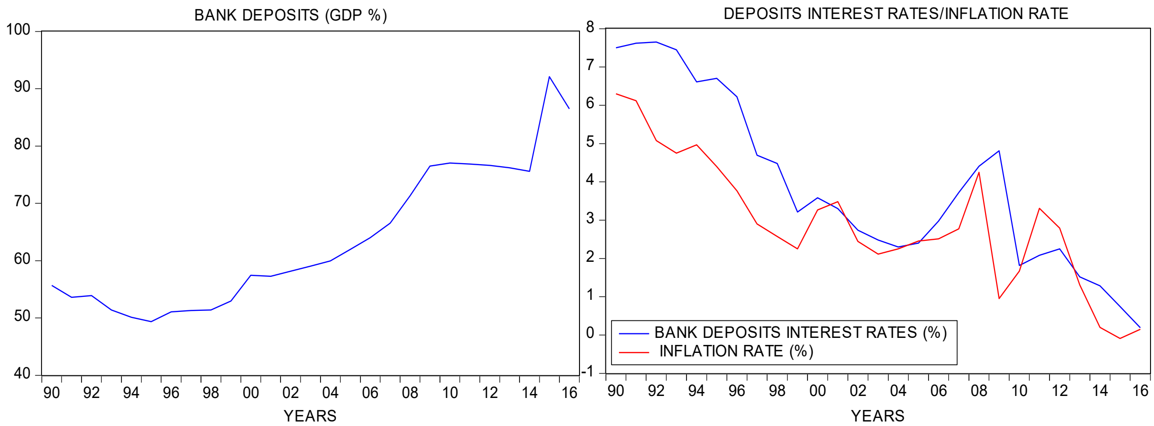


Figure 5.2: Bank deposits, deposits interest rate and inflation rate

The figure 5.2 show the mean of the bank deposits (on the left) and the deposits interest rates combined with the inflation rate (on the right). It is remarkable that while liquid liabilities and credit to private sector increases, deposit and inflation rate decline from approximately 6-7% in 1990 to 2% in 2016. The belief of an adverse event such as deflation and insufficient aggregate demand might be one of the main reasons that led consumers to avoid investing in bonds and keep their funds in deposits. Krugman (1988) argued that liquidity trap is the situation when investors have an abnormal preference over liquidity and prefer to keep their asset in the form of cash or demand deposit. This situation is described also in a modern version of Keynesian economics, where the rise of money into the private banks by a central bank decreases interest rates but the monetary policy is ineffective. The common characteristics of a liquidity trap are low-interest rates (close to zero) and ineffective monetary policy. Thus, in a depressed economy (liquidity trap) is unlikely to cause inflation and there is a decrease in the velocity of circulation.

Another possible explanation for this result might be the condition of the economy and the growth in productivity (the Long Run Aggregate Supply LRAS). The growth of real output is supposed to increase at the same rate of money supply. Figure 5.3 below gives a clearer picture of this interpretation.

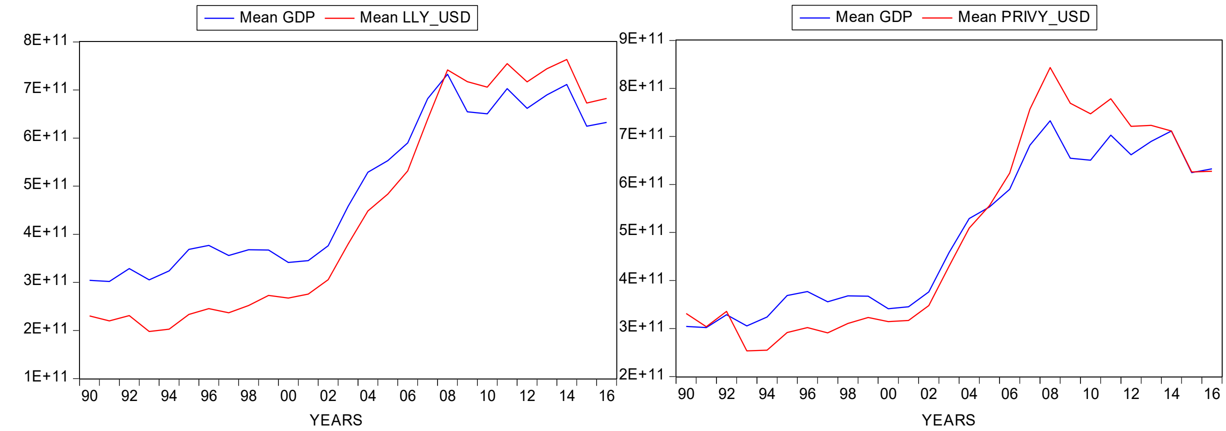


Figure 5.3: The means of GDP, LLY and PRIVY in USD

The left figure above shows the average of real output *(GDP)* and the money supply (LLY), both expressed in US Dollars (USD), while the right figure the real output and the credit to private sector (PRIVY) in US Dollars as well. As illustrated from the graphs, before 2008, when the size relative to the economy is increasing, the growth of real output is not increasing at the same rate. From 2008 to 2016 GDP is moving along with the liquid liabilities, but with the money circulation being greater than the real output. On the right graph, it is obvious that the over-lending after 2008 fell dramatically converging to GDP.

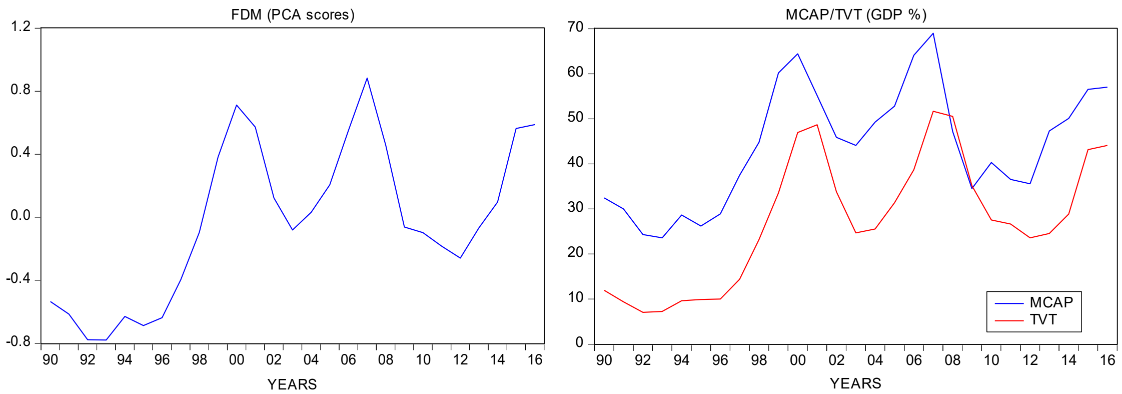


Figure 5.4: FDM index from MCAP and TVT

The figure 5.4 show the mean of the FDM index (on the left) that is constructed from the original variables MCAP and TVT (on the right). Also, the right graph shows that the size of the stock market proxied by stock market capitalization (MCAP) and total value traded (TVT), have upward and downward trends showing that are highly volatile. Around the turn of 2000, it was a period of massive growth in the use and adoption of the internet, and spending on technology was volatile. Also, it was a historic period of excessive speculation and the dot-com bubble occurred. After suffering losses, retail investors transitioned their investment portfolios to more cautious positions, their operational mentality completely changed, which in turn led western markets to a structural change in the market component of financial development. As growth in the information technology sector stabilized, companies consolidated; gained market share and the stock market development led to a faster growth rate, thus explaining the positive impact of financial stock market development over the pre 2008 period's results.

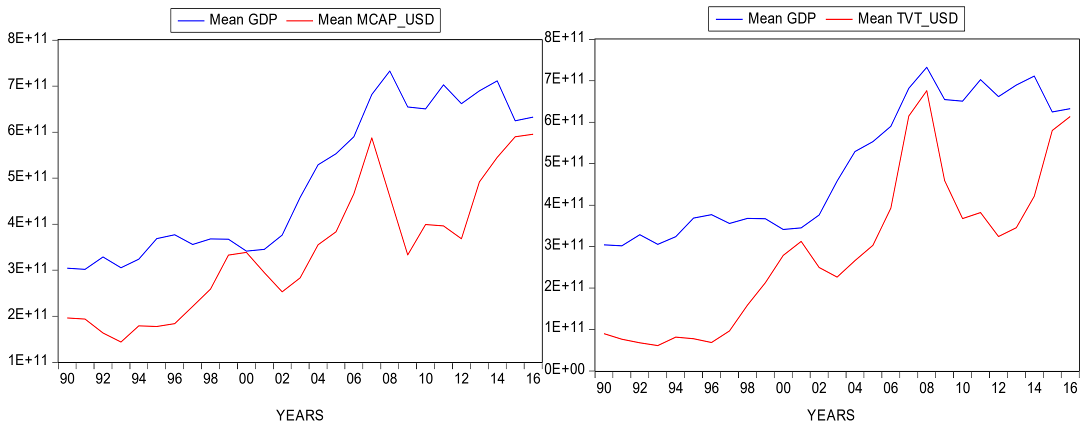


Figure 5.5: GDP, MCAP and TVT

The left graph of the figure 5.5 shows the average of real output *(GDP)* and the stock market capitalization (MCAP), both expressed in US Dollars (USD), while the right figure the real output and the total value traded (TVT). As illustrated from the graphs, over the period 2002 to 2008, when the size of the stock market is increasing, the growth of real output is increasing at the same rate. From 2008 to 2016 GDP is moving steadily, being greater than the size of the stock market which fell. However, by the end of 2015 the size of stock market recovered converging to the GDP.

The figure 5.6 shows that the economic growth contracted in 2008 and reached approximately to 0% and 4.6% in 2009.

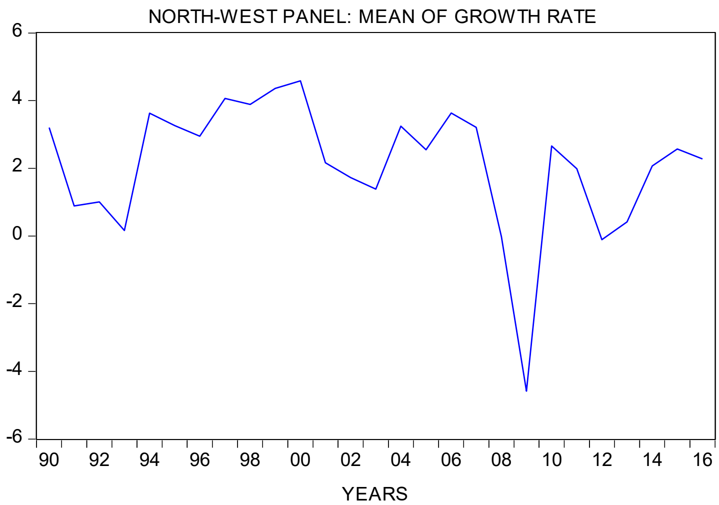


Figure 5.6: Growth rate of North-West countries

After the subprime crisis period, quickly recovered and in 2010 reached to 2.7%, but never reached at the pre-crisis levels (2.3% in 2016).

The figure 5.7 shows that the economic growth contracted in 2008 and fell from 7.2% in 2007 to 2.4% in 2008 and in 2009 reached at -7.7%. After the subprime crisis period recovered and in 2010 reached to 1%. Obviously, the economic growth has never recovered to the pre-crisis levels (similarly to North-west panel, 2.2% in 2016).

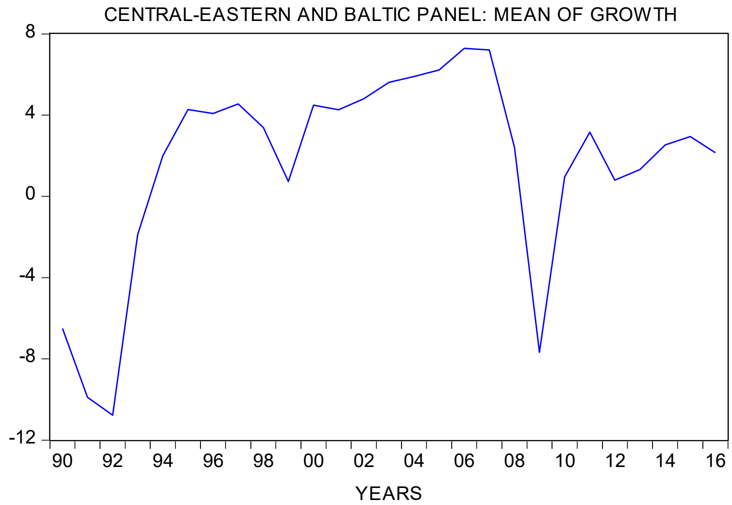


Figure 5.7: Growth rate of Central-Eastern and Baltic countries

The figure 5.8 shows that the economic growth contracted in 2008 and fell from 3.2% in 2007 to 0.8% in 2008 and in 2009 reached at -3.6%. Unlike the other regions in 2012 presented deeper recession reaching -4.0% and until 2014 was running at a negative rate of economic growth. Similarly to the other regions, the economic growth has never recovered to the pre-crisis levels (2.2% in 2016).

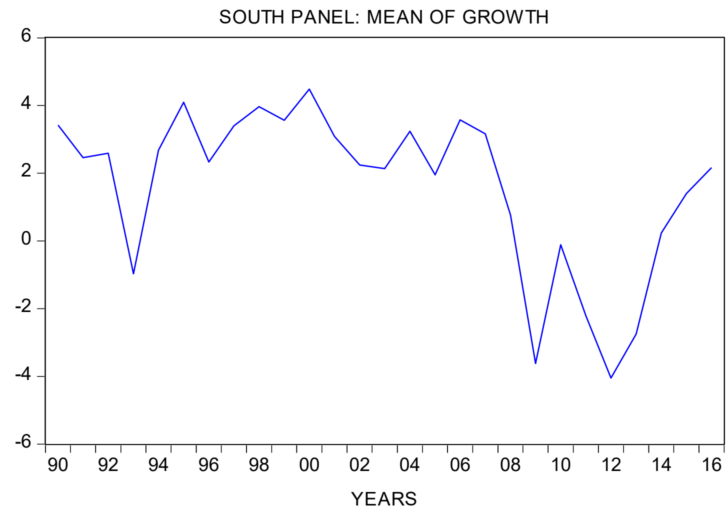


Figure 5.8: Growth rate of South countries

5.4.5.6 Summarised results

Table 5.22 summarizes results for the effect of financial development (broken down to banking sector and market sector) to economic growth. For the ongoing crisis (2008-2016 in the sample) we observe that for the full sample of countries before the crisis markets have a positive effect on the economy, which is reversed fully after the crisis with the banking sector effect being the most disrupting. When we examine the North-West region, the results are quite similar suggesting again that the banking sector was the one that caused growth to suffer after 2008; while markets are the financial system that promoted heavily growth before the crisis. For the Central East region the picture is reversed since the banking sector here seems to be the driving force of growth before the crisis as well as the one that hindered growth after 2008 till 2016. For the South region the results are insignificant for both banks and markets; suggesting clearly that it was different forces that led to economic growth before the crisis and the recession after the crisis.

For the subprime crisis (2008-2009 only), for the full sample of countries we see that markets were the driving force at normal periods and both markets and banks had a large negative effect during the crisis period. When it comes to North-West, markets are important at regular periods, and during crisis it was the banking sector that led to the recession of GDP. For the Central East region it is the opposite, banks are heavily important during the normal periods, while during crisis both banks and markets brought recession, but this was heavily dominated by the banking sector. For the South region again while banks seem to be significant drivers of growth at normal time, during crisis it was mainly other factors (than banks and markets) that led to the recession.

Table 5.22: Summary results of financial development and growth during crisis

Countries		All		North-West		Transition		South	
Period		Before	After	Before	After	Before	After	Before	After
Tables		Table 3(IV)		Table 4(II)		Table 4(V)		Table 4(VIII)	
ongoing	FDB	+	-(***)	-	-(***)	+(**)	-(***)	+	+
	FDM	+(**)	-(*)	+(***)	-(*)	-	-(*)	+	+
Period		normal	stress	normal	stress	normal	sterss	normal	stress
Tables		Table 3(IV)		Table 4(II)		Table 4(V)		Table 4(VIII)	
subprime	FDB	+	-(***)	-	-(***)	+(**)	-(***)	+(*)	-
	FDM	+(**)	-(***)	+(*)	+	+	-(*)	+	+

Table 5.23 presents summary results for the effect of financial development on economic growth in conjunction with the possible effect of fiscal policy. For the ongoing crisis, we observe that for the full sample of countries, before the crisis, banks and markets have a positive effect on growth, whereas public debt has negatively affected the economy.

After the crisis banks, markets and taxes have a negative effect on the economy with the banks and taxes being the most detrimental. When the North-West panel is examined, the results for fiscal policy are quite similar both periods being considered; while after the crisis stock market contributed to GDP before crisis and banks negatively affected the economy. For the transition economies, public debt has a negative effect on economy both periods, while taxes have a greater negative impact on the economy during crisis. However, the banking sector is the driving force of growth before the crisis, which is fully reversed after the crisis. For the South region, public debt has a negative effect on economy before the crisis, while taxes was the one that caused growth to suffer after 2008; however, banks and markets are insignificant before crisis, while markets contributed to growth after the crisis.

Table 5.23: Summary results of for the role of fiscal policy

Countries		All		North-West		Transition		South	
Period		Before	After	Before	After	Before	After	Before	After
Tables		Table 5(III)		Table 6(I)		Table 6(III)		Table 6(V)	
ongoing	FDB	+(***)	-(***)	-	-(**)	+(**)	-(***)	+	+
	FDM	+(**)	-(*)	+(***)	-	-	+	+	+(*)
	e^{DEBT}	-(***)	-	-(***)	-	-(*)	-(*)	-(***)	+
	e^{EXP}	-	-	-	-	-	+	-	+
	e^{TAX}	-	-(***)	-	-(*)	-	(-)**	+	-(***)
Period		normal	stress	normal	stress	normal	stress	normal	stress
Tables		Table 5(VI)		Table 6(II)		Table 6(IV)		Table 6(VI)	
subprime	FDB	+	-(***)	-	-	+(**)	-(***)	+(***)	+
	FDM	+(**)	-(***)	+	+(*)	+	+	+(*)	+
	e^{DEBT}	-(***)	-(***)	-(***)	+	-(**)	-(***)	-(***)	+
	e^{EXP}	-(***)	-	-(*)	-(***)	-	+	-(*)	+
	e^{TAX}	-(*)	-(***)	-(*)	+(***)	-	-(***)	-	+

For the subprime crisis, for the full sample of countries, we see that during the normal periods fiscal policy indicators had a negative effect on economy, while the stock market sector is the driving force on growth. At stress time, both financial sectors, public debt and taxes negatively affected economic growth. When it comes to North-West, fiscal policy hindered economic activity during the regular periods, while in years 2008-2009, tax revenues and markets contributed to the economy. However, the negative effect of government spending at normal times becomes stronger at stress time. For Central-Eastern region, at normal periods, public debt had a negative effect on economy, while the bank sector is heavily important. During the subprime crisis period, public debt, taxes and banks adversely affected economic growth. For the South region, at regular periods, public debt and spending had a negative effect on economy, while both financial sectors seem to be driving forces of growth. At stress time, neither fiscal policy nor financial system affected growth.

5.4.6 Conclusions

In this study is used a panel dataset on 26 EU countries over the period 1990-2016 to examine the link between financial development and economic growth in view of the recent financial crisis. Considering the major role of bank and market sectors, principal component analysis is employed for the construction of two new aggregate financial development indices thus capturing the overall size of financial development.

The overall findings for the finance-growth relationship before and after the crisis, suggest that at normal times financial development promoted economic growth with the stock market sector prevailing in this positive effect, while in crisis periods financial development hindered economic activity with the bank sector dominating in this negative effect. Also, the negative effect of banks on growth and the weakness of stock markets to restrain the economy from the recession exhibit high persistence eight years after the occurrence of financial crisis and do not return to the situation as was at regular periods. However, since stock markets facilitate the access of investors to financial resources, measures that possibly could implemented and generate positive effect on economic growth in case of recessions are: (i) sound macro-economic policy to enforce the stock market performance (ii) timely implementation of Quantitative Ease for stimulating efficient investments through lower interest rates, and stimulate growth through accumulation of funds in less volatile stocks (e.g Healthcare, Real Estate, Precious metals).

The findings for the effect of financial development on economic growth in conjunction with the effect of fiscal policy suggest that at normal times financial development was a driving force of growth and both sectors are heavily important, while in crisis periods financial development negatively affected the economy with banks dominating in this negative effect. Additionally, the significant negative effect of debt on the economy continued in the subprime crisis period; and eight years after the crash was insignificant, thus confirming the assumption that the quantitative ease effectively reduced the sovereign debt for Eurozone countries, but the monetary policy was ineffective on the real economy. Hence, banks and other institutions held more government bonds to enhance the governments'credibility not to default, and the ability of intermediaries to invest on assets was limited.

Furthermore, the negative results of the stock market index during the crisis periods, confirm the ineffectiveness of the undertaken austerity measures by policymakers, which did not deliver the expectations of investors and the time-inconsistency problem raised from the difference between ex-ante and ex-post savings and capital tax rates. Thus, the findings have important implications for the quality of fiscal policy and regulators need to pay more attention to the optimal tax policy as well as time-consistent policy. Policy makers must keep the tax rates constant over time or to find the least distorting mix of taxes to finance the public spending.

The results from the regional panels show that the impact of financial development varies across the countries due to heterogeneous nature of economic structures, financial markets, and so on. The financial system of the North-West panel tends to be increasingly market based as the economy develops, while in transition economies, the banking sector seems to be more efficient than the market sector which remains below the corresponding ones of the more developed EU countries. In South countries financial development seems to be inefficient. However, the results uncover that countries with their financial systems being market-oriented suffered less from the recession and recovered more quickly compared with countries that are bank-based. On the other hand, bank-based countries suffered from a deeper recession and required more time to recover from economic downturns after the financial crisis. Therefore, it can be inferred that transition economies should focus on the adoption of euro along with the new regulations, which can enforce the financial system, while South countries should focus on the implementation of policies to make their financial system more efficient. Indeed, one might argue that joining the euro would enhance their exposure to global risks and, hence, would render their financial system more susceptible to external shocks. However, this is supported theoretically by the optimum currency area (large integrated labour market, flexibility of pricing and wages and mobility of capital), and is achieved lower volatility of exchange rates, benefits for portfolio diversification across industries rather than countries and removal of trade barriers. Also, integration within EU is likely to align the business cycles. In practice, the problem of asymmetric shocks is alleviated as long as factors of production can move between countries.

Finally, the results of this study provide new insights into the finance-growth nexus during the recent crisis. The important implication is that financial development failed to play a safeguarding role for economic growth in a homogeneous group of countries such that of EU. Also, a general conclusion that can be drawn from the results confirm the initial assumption that the crisis is ongoing and the refinancing of the public debt led to a repression policy. Appropriate policies should be undertaken from policymakers to improve regulatory and supervisory framework to advance the financial system, allow financial institutions to hold small amount of their own countries government bonds and take into consideration the benefits of the market-oriented policies. However, further investigation needs to be undertaken to find the best strategy for the refinancing the public debt and find a possible threshold effect of the debt-growth relationship.

Nevethelss, both studies, study 1 and 2 have potential limitations. The standard panel models, such as fixed effects and random effects models have some shortcomings. For instance, the fixed effect model, assumes that the estimator has common slopes and variance but country-specific intercepts. Particularly for two-way fixed effects estimation, both cross-sectional and time effects can be observed through the introduction of dummy variables, and this estimator faces a problem because of the loss of the degree of freedom (Baltagi, 2008).

Another disadvantage of the static panel approaches is that they are unable to capture the dynamic nature of data, which is a fundamental issue in empirical research. Additionally, as Loayza and Rancière (2006) argue, static panel estimators do not take the advantage by distinguishing between the short-and the long-run relationships. However, many economic relationships are dynamic in nature, and one of the advantages of the panel data is that they allow understanding the dynamics adjustments or the long-run tendencies. These dynamic relationships are characterised by the presence of a lagged dependent variable among the regressors and through the next sections dynamic panel models are employed to study the short and long-run economic relationships encountered in the data.

However, concerning the previous literature, where the panel data methods are employed, the findings refute the prior research of Pradhan et al. (2016), Anwar and Cooray (2012), Muhammad et al. (2016) and Ductor and Grechyna (2014); Durusu-Ciftci et al. (2017), who found a positive finance-growth relationship with the causality effect to be unidirectional from financial development to economic growth. As the main advantage of these studies was the investigation of the long run finance-growth nexus, their prime objective was to examine the impact of financial development on economic growth, without being considered the crisis effect and the behaviour of two sectors (banking vs stock market) of the financial system before/after the stress time, as being considered in the current sub-study. On the other hand, the findings have corroborated the research of Claessens et al. (2010) and Allen et al. (2012) who documented that recessions and disruptions in underdeveloped stock markets of transition economies, are often more costly, and it takes more time to recover. Nevertheless, the current sub-study extends the knowledge to the literature for the finance-growth relationship at normal times and at stress times as well as whether the bank or the market sector prevails in any positive or negative impact on economic growth before and after the crisis. Furthermore, after the financial crisis, many EU countries experienced high public debts as a share of GDP, and the financial crisis was converted to a debt crisis. Hence, one of the main contributions of the current sub-study is also that examines together with the financial development, the quality of fiscal policy before and after the financial crisis. This allows investigating the response of the financial development measures to the quality of fiscal policy, which plays an essential role in economic growth.

5.5 Study 3: Finance and growth. A dynamic panel data analysis

5.5.1 Introduction

In the empirical literature, a considerable number of studies focused on exploring the dynamic relationship between financial development and economic growth using panel datasets and the results do not provide substantial evidence supporting the view that financial development promoted economic growth (Menyah et al., 2014; Ductor and Grechyna, 2014; Caporale et al., 2015; Ayadi et al., 2015; Swamy and Dharani, 2018).

However, these studies employed GMM dynamic panel estimates and ignore the integration and cointegration properties of the data. More recent studies examined the dynamic impact of financial development on economic growth using the panel ARDL model that have not been widely used, and the results show that finance has a positive and a homogenous effect on growth in the long-run, whereas in the short-run the impact is negative (Loayza and Rancière, 2006; Samargandi et al., 2015; Sohag et al., 2015).

On the above discussion, this study provides new evidence on the finance-growth relationship employing panel ARDL model on the face of the recent crisis. Specifically, through the model it is investigated the short and long-run impact of financial development on economic growth using two indices for banks and markets before and after the crisis. The contribution of this study is described in the introduction chapter (See Chapter 1, contribution of the research).

Prior to the estimation of the short and long-run relationships from the dynamic heterogenous panels, a cointegrating relationship needs to be confirmed. The motivation is linked primarily with the need to test for the presence of long-run relationships among integrated variables. The following section describes the dataset, while section 3 reports the results from the panel cointegration tests. Section 4 presents the model specification, section 4 provides the empirical results and discussion, while section 5 concludes.

5.5.2 Data

The current study is also based on a panel dataset covering 26 EU countries over the period 1990-2016 and similarly to the previous study, uses the bank and stock market indices as financial development measures. The variables used in the study and descriptive statistics are provided in the Table 5.24 below.

Table 5.24: Descriptive statistics

Statistics	GGDP	LLY	PRIVY	MCAP	TVT	CPI	FDI	OPEN
Mean	1.889	71.42	74.99	45.02	28.18	81.02	9.483	92.12
Max.	11.88	258.0	261.4	238.8	242.9	114.8	734.0	221.1
Min.	-34.90	7.867	7.089	0.025	0.000	0.03	-43.46	33.00
St.D.	4.340	37.42	45.15	38.31	37.77	24.88	42.26	37.80
Obs	696	688	681	623	606	688	637	702

Note: *GGDP* is the the annual percentage growth rate of GDP. *LLY* is the ratio of liquid liabilities to GDP. *PRIVY* is the credit to private sector to GDP. *MCAP* is the stock market capitalisation to GDP. *TVT* is the stock market total value traded to GDP. *CPI* is the the consumer price index and is used as proxy of the inflation rate. *FDI* is the net inflows of foreign direct investments to GDP. *OPEN* is the trade openness.

5.5.3 Panel cointegration tests

Before proceeding to the tests, it is essential to ensure that the regression variables are α priori integrated of the same order.[1] However, when a linear combination of several I(1) series is stationary, they are said to be integrated and this cointegration implies that the I(1) series are in a long-run equilibrium and they move together, although the group of them can wander arbitrarily.

However, to find whether the bank or the market sector or both have a long-run relationship with economic growth the following three models are used: The first two models (I and II), examine the long-run relationship between the real output, banking and market sector respectively, while their long-run relationship along with control variables is tested in the model (III).

$$Y_{it} = \alpha_{1i} + \boldsymbol{\beta_{1i} FDB_{it}} + \boldsymbol{\epsilon_{1it}} \quad \text{Model (I)}$$

$$Y_{it} = \alpha_{2i} + \boldsymbol{\beta_{2i} FDM_{it}} + \boldsymbol{\epsilon_{2it}} \quad \text{Model (II)}$$

$$Y_{it} = \gamma_i + \boldsymbol{\delta_{1i} FDB_{it}} + \boldsymbol{\delta_{2i} FDM_{it}} + \boldsymbol{\delta_{3i} CPI_{it}} + \boldsymbol{\delta_{4i} OPEN_{it}} + \boldsymbol{u_{it}} \quad \text{Model (III)}$$

where Y_{it} is real output *(GDP)* in country i and year t, α_{1i}, α_{2i} and γ_i are the panel specific means, β_s and δ_s are the cointegrating parameters and depending on the type of the cointegration test may vary or be the same across all panels.[2] FDB_{it} and FDM_{it} are the financial development indices for bank and market sectors respectively.[3] Additionally, more cointegrating relations are investigated involving the macroeconomic variables *CPI and OPEN*, where *CPI* is the consumer price index and is the proxy of inflation rate,

[1] See further details in Chapter 4.5

[2] The tests derived in Kao (1999) assume a cointegrating vector that is the same across all panels, which restricts $\boldsymbol{\beta_i} = \boldsymbol{\beta}$

[3] Here FDB_{it} and FDM_{it} are obtained after principal component analysis in levels in order to be integrated of order one.

while *OPEN* stands for trade openness. Each variable is integrated of order one and for this purpose *GDP and CPI* are expressed as an index number (2010=100). It is worth noticing that net foreign direct investments (FDI) is I(0) and is not included in the tests.

Next, it is investigated the long-run relationship between economic growth and financial development through the panel cointegration analysis. More specifically, it examines the existence of the long-run equilibrium among variables and to this purpose Kao (1999), Pedroni (1999) and Westerlund (2005) cointegration tests are applied on the three models above (I, II and III).

5.5.3.1 Kao test

The first type of cointegration test is Kao's test where the null hypothesis is the absence of cointegration. The results in Table 5.25 show that all test statistics reject the null hypothesis of no cointegration in favour of the alternative hypothesis of the existence of a cointegration across all panels.

Table 5.25: Kao residual cointegration test results

Test	Model I t-statistics	Model II t-statistics	Model III t-statistics
Modified Dickey-Fuller	2.589***	3.102***	-2.839***
Dickey-Fuller	2.123**	2.983***	-2.426***
Augmented Dickey-Fuller	2.443***	1.736**	-3.438***
Unadjusted-Modified Dickey-Fuller	-6.559***	2.844***	-2.741***
Unadjusted-Dickey-Fuller	-4.793***	2.612***	-2.380***

Notes: ***Signifies rejection of the null hypothesis of no cointegration at 1% level of significance, while ** at 5%. The maximum number of lags for ADF test is (2), and is selected using Akaike Info Criteria (AIC). Bartlett Kernel with Newey and West automatic lag selection chose an average of 1.5 lags across all panels to correct for serial correlation. The AR parameter is the same for all panels.

5.5.3.2 Pedroni test

The second type of panel cointegration test is the Pedroni test, where the null hypothesis is the absence of cointegration, while the alternative is that all panels are cointegrated. The test assumes panel-specific cointegrating vectors (β_s and δ_s represent panel-specific cointegration parameters) and this heterogeneity distinguishes Pedroni tests from Kao tests. Another difference is that the Pedroni test allows for the autoregressive (AR) coefficient to vary over panels, while the Kao tests assumed the same AR parameter. The panel-specific AR coefficients are the default options in Pedroni's test, while a second option restricts the AR coefficients to be the same over panels.

Table 5.26 reports the results for the Pedroni test. There are two parts of statistical results. In the first part, the three test statistics refer to the tests based on panel-specific

AR parameters (between-dimension tests), while in the second part, the four test statistics, refer to the tests based on the same AR parameter (within-dimension tests). Most of the estimate results indicate that the null of no cointegration can be rejected. Thus, similarly to Kao's test results, the long-run relationship between the examined variables is confirmed. However, there are some exceptional results that are not significant, and this can be caused by the different relationships between output and financial development and other macroeconomic variables in these countries.

Table 5.26: Pedroni residual cointegration test results

Test	Model I t-statistics	Model II t-statistics	Model III t-statistics
Between group		Panel-specific AR parameter	
Modified Phillips-Perron t	1.059	5.005***	4.010***
Phillips-Perron t	-2.006**	5.762***	2.704***
ADF-t Statistic	-7.367****	5.647***	2.289**
Within group		Common AR parameter	
Modified variance ratio	-1.782**	-3.426***	-4.025***
Modified Phillips-Perron t	-0.322	3.165***	3.758***
Phillips-Perron t	-2.974***	3.636***	0.921
ADF-t Statistic	-7.827***	3.663***	-2.685***

Notes: ***Signifies rejection of the null hypothesis of no cointegration at 1% level of significance, while ** at 5%. The maximum number of lags for ADF test is (4), and is selected using Akaike Info Criteria (AIC). Bartlett Kernel with Newey and West automatic lag selection chose an average of (4) lags across all panels to correct for serial correlation. The AR parameter is the same for all panels.

5.5.3.3 Westerlund test

The third type of panel cointegration test is the Westerlund cointegration test, and Table 5.27 reports the results.

Table 5.27: Westerlund cointegration test results

Test	Model I t-statistics	Model II t-statistics	Model III t-statistics
	Alternative hypothesis: Some panels are cointegrated		
Variance ratio	-1.643**	3.362***	-2.814***
	Alternative hypothesis: All panels are cointegrated		
Variance ratio	-3.807***	-2.067**	-1.838**

Notes: ***Signifies rejection of the null hypothesis of no cointegration at 1% level of significance, while ** at 5%. The maximum number of lags for ADF test is (2), and is selected using Akaike Info Criteria (AIC). Bartlett Kernel with Newey and West automatic lag selection chose an average of 1.5 lags across all panels to correct for serial correlation. The AR parameter is the same for all panels.

The null hypothesis is the same as in Kao's and Pedroni's tests. There are two parts of statistical results. In the first part, the tests are based on panel-specific AR parameters and test the null hypothesis of no cointegration under the alternative that some panels are cointegrated. In the second part, the tests are based on a model in which the AR parameter is the same over the panels. Also, similarly to Pedroni tests, this test assumes panel-specific cointegrating vectors. The estimate results of the variance ratio statistic reject the null hypothesis of no cointegration, implying that all panels are cointegrated.

Overall, the estimates of cointegration tests conclude that economic growth, banking and market sector development along with macroeconomic variables have a long-run equilibrium in EU countries. The next section of the study examines the short and long-run relationship between financial development and economic growth.

5.5.4 Model specification

Based on Pesaran et al. (1999), the dynamic heterogeneous panel regression can be incorporated into the error correction model using the autoregressive distributed lag ARDL(p,q) technique as below:

$$\begin{aligned}\boldsymbol{\Delta GGDP_{i,t}} &= \sum_{\boldsymbol{j=1}}^{\boldsymbol{p-1}} \boldsymbol{\gamma_j^i \Delta GGDP_{i,t-j}} + \sum_{\boldsymbol{j=0}}^{\boldsymbol{q-1}} \boldsymbol{\delta_j^i \Delta X_{i,t-j}} \\ &\quad + \boldsymbol{\phi^i}[\boldsymbol{GGDP_{i,t-1}} - \boldsymbol{\beta_0^i} + \boldsymbol{\beta_1^i X_{i,t-1}}] + \boldsymbol{\epsilon_{i,t}} \end{aligned} \tag{5.6}$$

where $\boldsymbol{GGDP}$ is the GDP growth rate, $\boldsymbol{X}$ is a matrix of independent variables including financial development indices **FDB** and **FDM**, $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ represent the vectors of the short-term coefficients of lagged dependent and independent variables respectively, $\boldsymbol{\beta_s}$ are the vectors of the long run coefficients and $\boldsymbol{\phi}$ is the of speed of adjustment to the long-run equilibrium. The subscripts i and t represent country and time indices respectively, while p is the lag of the dependent variable and q is the lag of independent variables. The term in the square brackets of Eqn.(1) contains the long-run growth regression, which is derived from the following equation:

$$\boldsymbol{GGDP_{i,t}} = \boldsymbol{\beta_0^i} + \boldsymbol{\beta_1^i X_{i,t}} + \boldsymbol{u_{i,t}} \tag{5.7}$$

Eqn.(1) can be estimated by three different estimators: The first is the mean group (MG) model of Pesaran and Smith (1995). The main characteristic of this method is that it does not impose any restriction and allows for all coefficients to vary and be heterogeneous in the long-run and short-run. The second is the pooled mean group (PMG) estimator developed by Pesaran et al. (1999), where the short-run coefficients, the intercepts as well as the speed of adjustment to the long-run equilibrium values can be heterogeneous (different for each country), while the long-run slope coefficients are restricted to be homogeneous across countries. The third, is the dynamic fixed effect (DFE) estimator, which is very similar to the PMG estimator and imposes restrictions on the slope coefficient and error variances to be equal across all countries in the long run. The DFE model further restricts the speed of adjustment coefficient and the short-run coefficient to be equal too. Pesaran and Smith (1995) and Pesaran et al. (1999) present the autoregressive distributed lag (ARDL) model in error correction form as a new cointegration test and showed that panel ARDL can be used with different orders of integration irrespectively of whether the variables are I(0) or I(1) or a mixture of the two. This is the main advantage of panel ARDL models and makes the panel unit root tests unnecessary.

5.5.5 Estimation results

5.5.5.1 Full sample period: All countries results

Table 5.28 reports the results of PMG, MG and DFE estimation, along with the Hausman tests to measure the efficiency and consistency among them. According to the PMG estimator, the results indicate that the financial bank sector development (FDB) has a significantly negative impact on economic growth in the long and short run, while under the MG assumption the long and short run coefficients are insignificant. The DFE model, in turn, suggests a significantly negative effect of FDB on growth in the long-run, but insignificant in the short-run.

Turning now to the results for the financial stock market development (FDM), according to the PMG estimator the short run coefficient is insignificant and becomes significantly positive in the long run. Furthermore, the MG estimator suggests insignificant long and short run coefficients, while under the DFE assumption the short run coefficient is insignificant and becomes significantly positive in the long run.

The negative sign of error correction coefficients and their significance levels, satisfy the main requirement of validity, consistency, and efficiency of a long run relationship among the variables of interest and confirms the results from the panel cointegration tests that there is a long-run equilibrium. Also, it is worth noticing that in PMG the speed of adjustment is 53%, indicating how quickly the model comes to equilibrium. However, the speed of adjustment estimates from each model implies significantly different short run dynamics (comparing $\hat{\phi} = -0.529$ for PMG, $\hat{\phi} = -0.842$ for MG and $\hat{\phi} = -0.490$ for DFE).

Interestingly, the estimated long and short-run parameters of inflation, as proxied by the consumer price index (CPI), are significantly negative, as expected. On the other hand, the estimated coefficients for trade openness (OPEN) are significantly positive across all models in the short run, while in the long run are significantly positive under the PMG and DFE approaches. However, the positive and significant effect of foreign direct investment (FDI) appears in the short run under the PMG approach, whereas according to the

PMG and DFE estimators, the long run coefficients are significantly negative, but they have not economically meaningful effect size.

Finally, The Hausman test examines the validity of the long-run homogeneity restriction across countries. Specifically, it tests the null hypothesis of no systematic differences between the coefficients of PMG and MG firstly and secondly between PMG and DFE, in order to measure the efficiency and consistency among them. According to the corresponding p-values of the coefficients in last rows of the table, the test fails to reject the null hypothesis that there is long run homogeneity restriction, and in the short run is allowed to be country-specific. Thus, PMG is a more efficient estimator than either MG or DFE. Therefore the interpretation of the results will focus on the PMG approach.

Table 5.28: Full sample period: All countries

variable	Pooled Mean Group		Mean Group		Dynamic fixed effects	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
long-run coefficients						
FDB	-0.344***	(-3.18)	21.04	(1.10)	-0.861***	(-3.12)
FDM	0.734***	(6.73)	-20.46	(-1.30)	0.480*	(1.86)
INFL	-0.088***	(-5.64)	-2.370**	(-2.64)	-0.114***	(-5.23)
FDI	-0.001***	(-0.88)	0.432	(0.42)	-0.003***	(-0.49)
OPEN	0.034**	(2.56)	2.256	(1.27)	0.070***	(2.95)
short-run coefficients						
ECT	-0.529***	(-7.78)	-0.842***	(-10.41)	-0.490***	(-11.58)
ΔFDB	-0.534**	(-2.59)	-0.575	(-1.65)	-0.200	(-1.51)
ΔFDM	-0.726	(-0.83)	1.504	(1.23)	0.061	(0.52)
ΔCPI	-0.292**	(-2.57)	-0.355*	(-1.82)	-0.197***	(-3.34)
ΔFDI	0.169**	(2.09)	-0.066	(-1.00)	0.003	(0.89)
$\Delta OPEN$	0.196***	(7.34)	0.116**	(2.34)	0.164***	(8.09)
Intercept	3.997***	(9.20)	5.110	(0.92)	3.070***	(3.72)
N	527		527		527	
Hausman test			0.21^a		4.21^b	
p-values			0.976		0.519	

Notes:* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is *GDP* growth. The lag structure is ARDL(1,1,1,1,1) and the order of variables is: *GDP* growth, financial development bank index, financial development market index, consumer price index, trade openness. ^{a} PMG is more efficient than MG under null hypothesis and the calculated statistic is 0.21. ^{b} PMG is more efficient than DFE under null hypothesis and the calculated statistic is 4.21. Both statistics are χ^2 distributed.

The findings suggest that there is overwhelming evidence of a negative relationship between financial development of the bank sector and economic growth, indicating that big and fast-growing financial bank sector creates a financial boom, which is not in general growth enhancing. The higher financial intermediation may have adverse effects if the financial system is liberalized and allowed to operate under a weak regulatory environment. Also, the results of this study are in line with Sundararajan et al. (1991), Easterly and Kraay (2000), and Ang and McKibbin (2007), who find that any monetary and credit expansion along with a lack of regulatory control and monitoring from the banks, may result in ineffective mobilization of savings and allocation of funds to inappropriate selection of projects, which in turn, has an adverse effect of financial development on economic growth.

Also, the results suggest a positive relationship between financial development of the stock market sector and economic growth. As discussed in section 5.4.5, the reason might be the newly created currency area (euro area) and the integration of the financial markets across the EU countries. This process of integration coincided with the trends towards globalization and securitization as well as the expanded privatization and the entry of foreign investors. However, integration within EU is likely to align the business cycles. In practice, the problem of asymmetric shocks is alleviated if factors of production can move between countries. Also, joining euro does not imply large welfare losses from asymmetric business cycles.

5.5.5.2 Full sample period: Regional results

Turning now to regional panels, it is examined to what extent the above findings vary, by re-estimating the three different estimators in the dynamic panel framework. The results are reported in Table 5.29. Models I to III present the results for the North-West panel. Models IV to VI present the results for the Central-Eastern and Baltic region and models VII to IX report the results for the South group of countries. Also, models (I), (IV),(VII) account the results for the PMG estimator, models (II), (V),(VIII) account the results for the MG estimator, and (III), (VI),(IX) account the results for the DFE.

For the North-West group of countries, according to the PMG and DFE estimators, it is found that the long run coefficients of the bank index are highly significant with negative sign, whereas the long run coefficients of the stock market are significantly positive. However, under the MG assumption the long run coefficients of both indices are insignificant. In the short run, the coefficient of the bank index is found negative and statistically significant with PMG estimator, while under MG and DFE assumptions are insignificant.

For the transition economies, according to the PMG estimator, it is found that the long run coefficients of bank and market indices are positive and statistically significant, while under the MG and DFE approaches are insignificant. In the short run, the coefficients of the bank index are negative and significant under the PMG and MG assumptions, while under the DFE estimator is insignificant. The short-run estimated coefficients for the stock market index are insignificant all models being considered.

The results for the South panel, show that under the PMG assumption the long run coefficient for the bank index is insignificant, while for the market index is significantly positive. According to the MG and DFE estimators, the long run coefficients for both indices are insignificant. In the short run, the coefficients of the bank index are significantly negative under the MG and DFE approaches, while according to the PMG estimator is insignificant. The short-run estimated coefficients for the stock market index are insignificant all models being considered.

Table 5.29: Full sample period: Regional panels

Countries	North-West			Central-Eastern and Baltic			South		
Estimators	PMG	MG	DFE	PMG	MG	DFE	PMG	MG	DFE
Models	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
long run coefficients									
FDB	-0.481***	-7.736	-1.164***	0.812*	-1.465	-1.065	-0.438	0.976	0.373
	(-3.70)	(-1.18)	(-4.38)	(1.98)	(-0.81)	(-1.43)	(-1.26)	(0.68)	(0.63)
FDM	0.900***	2.890	0.369*	0.718***	-4.685	0.956	1.202**	-0.316	0.327
	(7.27)	(1.25)	(1.77)	(2.76)	(-1.16)	(1.43)	(2.09)	(-0.21)	(0.50)
CPI	-0.043*	0.560	-0.144***	-0.052*	-0.172	-0.097**	-0.190***	-0.247***	-0.137***
	(-1.97)	(0.81)	(-4.08)	(-1.82)	(-0.95)	(-2.57)	(-4.86)	(-4.40)	(-2.99)
FDI	-0.001	-0.039	-0.0004	-0.049	1.415	0.079	-0.064***	1.979	-0.148**
	(-0.88)	(-0.16)	(-0.10)	(-1.12)	(1.49)	(0.67)	(-2.70)	(1.19)	(-2.31)
OPEN	0.001	-0.552	0.094***	-0.001	0.003	0.049	-0.142***	-0.229	0.018
	(0.05)	(-0.86)	(3.07)	(-0.05)	(0.01)	(1.21)	(-2.895)	(-0.79)	(0.23)
short run coefficients									
ECT	-0.750***	-0.807***	-0.740***	-0.426***	-0.904***	-0.468***	-0.307**	-0.582***	-0.367***
	(-7.85)	(-5.86)	(-9.55)	(-4.54)	(-6.27)	(-6.78)	(-2.22)	(-4.10)	(-4.24)
ΔFDB	-0.436**	0.123	0.265	-0.788**	-1.215**	-0.387	-0.367	-0.477***	-0.466*
	(-2.07)	(0.27)	(1.51)	(-2.39)	(-2.20)	(-1.53)	(-1.10)	(-2.81)	(-1.85)
ΔFDM	0.075	1.724	0.208	-1.743	0.526	-0.256	0.050	0.171	0.139
	(0.34)	(1.27)	(1.37)	(-1.19)	(0.48)	(-0.97)	(0.25)	(0.64)	(0.67)
ΔCPI	-0.148	-0.367	0.025	-0.499***	-0.483*	-0.286***	-0.632**	-0.739	-0.406**
	(-0.77)	(-0.85)	(0.16)	(-2.84)	(-1.97)	(-3.00)	(-2.17)	(-1.51)	(-2.23)
ΔFDI	0.050	-0.041	0.0008	0.224**	-0.130	0.020	0.266	0.010	0.032***
	(1.53)	(-0.91)	(0.24)	(2.05)	(-0.72)	(0.40)	(0.65)	(0.04)	(2.89)
$\Delta OPEN$	0.184***	0.166**	0.129***	0.218***	-0.028	0.157***	0.265***	0.336***	0.181***
	(4.85)	(2.47)	(3.71)	(4.50)	(-0.43)	(4.63)	(3.07)	(2.66)	(3.84)
Intercept	4.525***	1.802	4.747***	4.359***	-1.516	3.194**	10.91**	14.30**	5.250**
	(8.40)	(0.21)	(3.32)	(4.85)	(-0.14)	(2.14)	(2.19)	(2.44)	(2.45)
N	216	216	216	197	197	197	114	114	114
H-test		1.39^a	33.39^b		0.71^c	4.31^d		1.50^e	8.91^f
p-val.		0.925	0.000		0.982	0.506		0.913	0.112

Notes:* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is *GDP* growth. The lag structure is ARDL(1,1,1,1) and the order of variables is: *GDP* growth, financial development bank index, financial development market index, consumer price index, trade openness. ^{a} PMG is more efficient than MG under null hypothesis and the calculated statistic is 1.39. ^{b} DFE is more efficient than PMG under null hypothesis and the calculated statistic is 33.39. ^{c} PMG is more efficient than MG under null hypothesis and the calculated statistic is 0.71. ^{d}PMG is more efficient than DFE under null hypothesis and the calculated statistic is 4.31. ^{e} PMG is more efficient than MG under null hypothesis and the calculated statistic is 1.50. ^{f} DFE is more efficient than PMG under null hypothesis and the calculated statistic is 8.91. The test statistic is found negative and the results of this test are obtained by the alternative covariance matrix (Hausman, 1985). All statistics are χ^2 distributed.

Finally, the Hausman tests suggest that the regressors have homogeneous short and long run effects on growth in the North-West and South regions, thus DFE model is more efficient model than PMG and MG. For the transition panel, the regressors have homogeneous long run effects but heterogeneous short run effects on growth, thus PMG is more efficient model than MG and DFE.

The findings provide valuable insights into the relationship between financial development and economic growth across the three regions. Specifically, the results show that there is short and long run equilibrium as indicated by the statistically significant and negative coefficients of the error correction term. Thus, the coefficients of one period lag-residual in North-West countries is -0.740 meaning that system corrects its previous disequilibrium at a speed of 74% annually to reach the steady state.

However, the speed of adjustment between the short run and the long run equilibrium for North-West countries appears to be faster than the other group of countries, implying that it may take longer time for the disequilibrium to be reduced for transition economies and South countries. Nevertheless, the results undermine the notion that financial development has a positive and significant long run effect on economic growth and the effect of the financial crisis will be examined in the following section.

5.5.5.3 Ongoing crisis: All countries results

Next, the study examines the dynamic relationship between financial development and economic growth for the full sample of countries including a dummy that has the value 1 for the 2008-2016, splitting the sample to periods before and after the crisis. This can also be viewed as a hypothesis that the crisis is ongoing. Table 5.30 reports the results of PMG, MG and DFE estimation along with the Hausman test. Across all models, the Hausman tests fail to reject the short and long run homogeneity restrictions, thus emphasis will be based on the DFE model for interpreting the results.

Focusing on the results at normal pre-crisis periods (where the crisis dummy is not included as interaction term), the short run coefficient of banks (-0.241) is significantly negative, while in the long run becomes insignificant (0.081). The short and long run coefficients of the stock market are insignificant (-0.011, 0.132 respectively). During the ongoing crisis period, one year after the crisis the coefficient of banks is positive and insignificant (0.138), which becomes significantly negative eight years after the crash with a meaningful effect size (-2.078). Likewise, the coefficients of the stock market are found insignificant in the short and long run (0.253, -0.048).

The conclusion drawn according to the main results, is that the financial development did not contribute to economic activity in the short and long run before and after the crisis. Also, the results reveal that from the insignificant effect at normal period to the negative association at the ongoing crisis period becomes easily perceived that eight years after the crisis the banking system evolves significantly in a worst way compared to the pre-crisis period. The analysis, therefore confirms the initial findings in the main results, and one of the principal effects that led to the financial crisis might be the credit expansion and the over-lending at normal periods without tight lending conditions. However, looking specifically at terms of bank loans before the crisis, less collateral were provided as a proportion of loans.

Table 5.30: Full sample period: All countries

variable	Pooled Mean Group		Mean Group		Dynamic fixed effects	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
			short-run pre-crisis period			
ECT	-0.570***	(-7.76)	-0.984***	(-9.01)	-0.663***	(-15.53)
ΔFDB	-0.561**	(-2.08)	-0.208	(-0.31)	-0.241*	(-1.73)
ΔFDM	0.382	(0.37)	2.812	(1.31)	-0.011	(-0.09)
ΔCPI	-0.348***	(-3.24)	-0.720***	(-2.84)	-0.152***	(-2.73)
$\Delta OPEN$	0.094***	(2.82)	0.018	(0.47)	0.110***	(5.62)
			long-run pre-crisis period			
FDB	-0.228***	(-3.20)	-1.621	(-1.44)	0.081	(0.31)
FDM	0.507***	(5.49)	-4.602	(-0.90)	0.132	(0.63)
CPI	-0.022	(-1.61)	-0.041	(-0.87)	-0.016	(-0.86)
$OPEN$	0.013	(1.31)	0.302***	(2.97)	0.082***	(4.64)
			short-run ongoing-crisis period			
$\Delta Cr * FDB$	1.728**	(2.27)	0.647	(0.53)	0.138	(0.62)
$\Delta Cr * FDM$	-6.045	(-1.06)	-1.923	(-1.33)	0.253	(1.14)
$\Delta Cr * CPI$	-0.237***	(-2.65)	-0.230*	(-1.83)	-0.0008	(-0.05)
$\Delta Cr * OPEN$	0.204**	(2.55)	0.229**	(2.06)	0.020	(1.43)
			long-run ongoing-crisis period			
$Cr * FDB$	-1.397***	(-7.28)	-0.368	(-0.17)	-2.078***	(-5.10)
$Cr * FDM$	0.625***	(2.77)	0.964	(1.04)	-0.048	(-0.12)
$Cr * CPI$	-0.010*	(-1.66)	0.405*	(1.78)	-0.030***	(-2.73)
$Cr * OPEN$	0.0007	(0.18)	-0.407**	(-1.99)	-0.021**	(-2.11)
constant	2.621***	(9.23)	-10.62	(-1.38)	-1.268	(-1.26)
N	548		548		548	
Hausman test			0.29^a		4.79^b	
p-values			0.976		0.780	

Notes:* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is *GDP* growth. The lag structure is ARDL(1,1,1,1) and the order of variables is: *GDP* growth, financial development bank index, financial development market index, consumer price index, trade openness. [a] PMG is more efficient than MG under null hypothesis and the calculated statistic is 0.29. [b] DFE is more efficient than PMG under null hypothesis and the calculated statistic is 41.23. Both statistics are χ^2 distributed.

5.5.5.4 Ongoing crisis: Regional results

Next, it is explored to what extent the above findings vary, by re-estimating the PMG, MG and DFE models for the three regional panels. The results are reported in Table 5.31. Models I to III present the results for the North-West panel. Models IV to VI present the results for the Central-Eastern and Baltic region and models VII to IX report the results for the South group of countries. Also, models (I), (IV),(VII) account the results for the PMG estimator, models (II), (V),(VIII) account the results for the MG estimator, and (III), (VI),(IX) account the results for the DFE. Again, across all subsamples, the Hausman tests fail to reject the long and short run homogeneity restrictions at the conventional levels of significance, thus supporting that the DFE is the efficient model and gives consistent results. Hence, emphasis will be based on the DFE model for interpreting the results.

First, it is examined the North-West group of countries. The results of DFE estimator show that before the crisis the short and long run coefficients for the bank index are insignificant. During the ongoing crisis and in the short run, banks affected positively the economy, while in the long run the the effect is significantly negative. For the stock market index, the results show that before the crisis, markets positively affected the economic growth in the long-run, while during the ongoing crisis period this is the case only in the short-run.

Table 5.31: Ongoing crisis: Regional panels

Countries		North-West			Central-Eastern and Baltic			South	
	PMG	MG	DFE	PMG	MG	DFE	PMG	MG	DFE
Variables	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
				short-run pre-crisis period					
ECT	-0.792***	-1.057***	-0.892***	-0.668***	-0.890***	-0.714***	-0.790***	-1.222***	-0.482***
	(-5.57)	(-7.17)	(-12.62)	(-4.29)	(-3.14)	(-9.39)	(-5.11)	(-13.80)	(-5.33)
ΔFDB	-0.349	0.450	-0.0264	-0.181	-1.359	-0.236	-0.598**	0.213	-1.106***
	(-1.14)	(1.36)	(-0.15)	(-0.37)	(-0.85)	(-1.03)	(-2.49)	(0.71)	(-3.70)
ΔFDM	-0.175**	-0.398	-0.0657	-0.913	0.613	-0.120	-0.163	-0.180	-0.0411
	(-2.54)	(-1.56)	(-0.38)	(-0.66)	(0.21)	(-0.44)	(-1.52)	(-0.51)	(-0.21)
ΔCPI	-0.435**	-0.538	-0.213	-0.0624	-1.272**	-0.149*	-0.419**	-0.547	-0.584***
	(-2.21)	(-1.34)	(-1.47)	(-0.60)	(-2.14)	(-1.78)	(-1.99)	(-0.87)	(-3.38)
$\Delta OPEN$	0.126***	0.0981**	0.0901***	-0.0103	-0.0863*	0.0426	0.135***	0.117	0.158***
	(3.97)	(2.42)	(2.88)	(-0.18)	(-1.88)	(1.35)	(2.88)	(1.04)	(3.10)
				long-run pre-crisis period					
FDB	-0.303***	-0.489	0.0730	-0.342***	-7.540*	0.288	-0.0158	-0.891***	1.123
	(-3.86)	(-0.78)	(0.31)	(-4.11)	(-1.73)	(0.62)	(-0.05)	(-3.15)	(1.46)
FDM	0.587***	0.820**	0.368**	0.734***	1.112	-0.102	0.211	0.181	0.0597
	(5.63)	(2.19)	(2.01)	(4.92)	(0.17)	(-0.23)	(1.09)	(0.40)	(0.13)
CPI	-0.0332*	-0.0811	-0.0971***	-0.0507***	0.151	0.0236	0.0474***	-0.0564	-0.00584
	(-1.79)	(-1.06)	(-2.76)	(-3.71)	(0.85)	(0.92)	(2.73)	(-1.32)	(-0.14)
OPEN	0.0170	0.209*	0.106***	0.132***	0.579***	0.0719***	0.0307	0.187	-0.0883
	(1.37)	(1.84)	(4.41)	(10.27)	(2.79)	(2.66)	(1.27)	(1.47)	(-1.22)
				short-run ongoing-crisis period					
$\Delta Cr * FDB$	-0.875	0.317	0.515*	0.120	3.924	-0.0849	0.493	-4.075**	1.144***
	(-0.49)	(0.40)	(1.83)	(0.11)	(1.55)	(-0.14)	(0.31)	(-2.56)	(2.61)
$\Delta Cr * FDM$	-1.330	-0.279	0.510**	-9.524	-2.448	0.320	0.848	-3.054	-0.0335
	(-0.98)	(-1.04)	(1.99)	(-1.07)	(-1.25)	(0.68)	(0.37)	(-0.81)	(-0.05)
$\Delta Cr * CPI$	-0.0581	-0.419*	0.0374*	-0.491***	-0.416***	-0.0504	0.151	0.316	-0.0179
	(-0.72)	(-1.93)	(1.69)	(-4.57)	(-3.24)	(-1.37)	(1.22)	(1.06)	(-0.59)
$\Delta Cr * OPEN$	0.0811	0.399**	-0.0183	0.409***	0.412***	0.0793***	-0.153	-0.362	0.0437
	(0.99)	(2.32)	(-0.96)	(5.22)	(4.14)	(2.85)	(-1.21)	(-0.81)	(1.05)
				long-run ongoing-crisis period					
$Cr * FDB$	-1.527***	-3.207	-2.528***	-0.0978	2.808	-4.136***	0.252	0.886	-1.205
	(-6.29)	(-1.02)	(-6.54)	(-0.17)	(1.42)	(-4.52)	(0.55)	(0.75)	(-1.13)
$Cr * FDM$	0.858***	0.0364	-0.395	1.617*	0.303	0.412	1.395*	4.024	3.732*
	(3.38)	(0.10)	(-1.31)	(1.66)	(0.49)	(0.42)	(1.65)	(1.07)	(1.89)
$Cr * CPI$	0.00111	0.394	-0.00263	0.0329***	0.985*	-0.0330	-0.0837***	0.179	0.00334
	(0.17)	(0.87)	(-0.24)	(2.73)	(1.80)	(-1.20)	(-4.39)	(0.59)	(0.10)
$Cr * OPEN$	-0.00484	-0.324	-0.0219**	-0.0755***	-1.011*	-0.0421*	0.0318	-0.299	-0.0714
	(-1.10)	(-0.81)	(-2.36)	(-8.32)	(-1.92)	(-1.84)	(1.47)	(-0.65)	(-1.63)
constant	3.580***	-3.673	1.793	-2.472***	-24.42*	-2.078	-1.197	-0.731	5.787**
	(8.98)	(-0.31)	(0.96)	(-2.67)	(-1.91)	(-1.28)	(-1.21)	(-0.10)	(2.34)
N	234	234		199	199		115	115	
H-test		0.15[a]	10.98[b]		15.69[c]	37.56[d]		46.49[e]	3.50[f]
p-value		1.000	0.000		0.047	0.000		0.000	0.899

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is *GDP* growth. The lag structure is ARDL(1,1,1,1) and the order of variables is: *GDP* growth, financial development bank index, financial development market index, consumer price index, trade openness. [a] PMG is more efficient than MG under null hypothesis and the calculated statistic is 0.15. [b] DFE is more efficient than PMG under null hypothesis and the calculated statistic is 10.98. [c] MG is more efficient than PMG under null hypothesis and the calculated statistic is 15.69. [d] DFE is more efficient than MG under null hypothesis and the calculated statistic is 37.56. [e] PMG is more efficient than MG under null hypothesis and the calculated statistic is 46.49. [f] DFE is more efficient than PMG under null hypothesis and the calculated statistic is 3.50. For [d] and [f], the test statistic is found negative and the results of this test are obtained by the alternative covariance matrix (Hausman, 1985). All statistics are χ^2 distributed.

Second, the transition economies are examined. The DFE estimator suggests insignificant results for the bank sector before the crisis in the short and long-run. The insignificant effect of banks on growth remains one year after the crisis, while eight years after the crisis, the effect becomes significantly negative. Regarding the stock market index, the results suggest insignificant coefficients all periods being considered.

Turning now to the results of the South group of countries, before the crisis the short run estimated coefficient for the bank index is significantly negative, while in the long run is insignificant. One year after the crisis period, the effect of banks on growth is significantly positive, while in the long run is insignificant. The stock market coefficients are insignificant before the crisis, while after the crisis appears to be significantly positive in the long run.

5.5.6 Summarized results

Table 5.32 summarizes the results for the dynamic panel effect of banks and stock markets on economic growth. It is found for the full panel of countries that before the crisis, financial development did not contribute to the economic growth, and banks have a negative effect on growth only in the short run. After the crisis, financial development did not promote the economic activity, with the banking sector effect being significantly negative.

Table 5.32: Summary results of financial development and growth during crisis

Countries		All		North-West		Transition		South	
Period		short	long	short	long	short	long	short	long
Tables		Table 5.31(PMG)		Table 5.32(PMG)		Table 5.32(DFE)		Table 5.32(PMG)	
before	FDB	-(*)	+	-	+	-	+	-(***)	+
	FDM	-	+	-	+(**)	-	-	-	+
Period		short	long	short	long	short	long	short	long
after	FDB	+	-(***)	+(*)	-(***)	-	-(***)	+(***)	-
	FDM	+	-	+(**)	-	+	+	-	+(*)

When the North-West panel is examined, the results suggest that stock markets promoted heavily growth before the crisis. After the crisis, both sectors stimulated the economy for one year (short-run), which is fully reversed in the long run with the banking sector being the most disrupting. For the Central-Eastern and Baltic region, the results are insignificant for both banks and markets before the crisis, while after 2008 banks negatively affected the economy. For the South panel, banks and markets are insignificant before the crisis in the long run, while markets contributed to growth after the crisis. Similarly to the North-West region, banks stimulated the economy one year after the crisis.

5.5.7 Conclusions

The study employs heterogeneous dynamic panels to examine the link between financial development and economic growth in view of the financial crisis. To estimate the long-run relationships the panel error correction-based autoregressive distributed lag ARDL(p,q) model is employed, which offers three different test: namely, mean group (MG), pooled mean group (PMG) and dynamic fixed effects (DFE) estimators. Also, two aggregate financial development indices are used, thus capturing the overall size of financial development for the bank and market sectors.

The overall findings suggest that before the crisis, banks negatively affected the economy, while only the markets of the North-West countries promoted economic growth. After the crisis, there is an overwhelming evidence that banks hindered economic activity, while for markets there is weak evidence of positive effect on economic growth only in South countries. Interestingly, the results reveal that one year after the crisis (short-run) banks contributed to economic growth.

However, comparing to the results of the previous study (Table 5.22), we observe that banks negatively affected the economy eight years after the crisis, and the banking sector evolves significantly in a worse way compared to the pre-crisis period. Another important implication confirmed in this study, is that the North-West panel of countries is heavily relied on the stock market sector implying that the financial system in these countries is more market based. Also, one year after the crisis, banks stimulated the economy and provide new insights into the banking system. Given that the failure of many banks was imminent, governments launched a massive bailout package to support banks in distress and prevent from a wide scale of financial collapse.

According to the results in the previous study, the assumption for the prime and exact reasons for the inverse relationship between financial bank sector development and growth is the over-lending and the credit expansion along with a lack of regulatory control and monitoring from the banks. However, the findings of the study have potential importance for the financial regulation to bring efficiency in the short and long run. Any project for stimulating economic growth and productivity via increased finance appears to have less of an impact, possibly owing to deficiencies and weaknesses in frameworks.

The results of the Hausman tests for the regional panels show that the dynamic fixed effects estimator is more efficient, implying that these groups are more homogeneous than the full panel of countries, as the slope coefficients are homogeneous across all countries in the long run and the short-run. Therefore, the overall results for the subsamples are more conclusive and provide a new insight that the impact of financial development varies across European economies due to the heterogeneous nature of the economic structure, institutional quality and financial market.

The results are important for policymakers in terms of optimizing the structure of the financial system. Also, appropriate measures, financial regulation and supervision remain essential to reduce the systemic risk and promote the financial systems stability. Moreover, the results reveal that the post-crisis economic growth recovery was so weak and the financial system has not enhanced the economic activity. This might be due to the subsequent European debt crisis, and the debt overhang makes the economy more vulnerable to future shocks. However, the priority is to understand the causes and to design an appropriate policy response. Nevertheless, the fundamental question might be why financial development did not contributed to economic growth eight years after the crisis, and further research should shed more light on the possible threshold effects of the finance-growth relationship.

The central point of this study is the finance-growth relationship in the long and short run. The findings contradict the common assumption that financial development plays a significant role in fostering growth and are not in line with King and Levine (1993a), Levine et al. (2000), Seetanah (2009), Christopoulos and Tsionas (2004) and Loayza and Rancière (2006) among others, who found positive effects of financial development on growth. However, the results are in line with Arcand et al. (2015) and Narayan and Narayan (2013), who found a negative long run effect of finance on growth.

More specifically, concerning the previous literature where the panel data methods are employed, the findings refute the prior research of Pradhan et al. (2016) and Anwar and Cooray (2012) who provided a significant contribution to the field. As the prime objective of these studies was to examine only the long-run equilibrium and the causality effects of financial development on economic growth, the current sub-study investigates not only the long run, but also the short run for both periods, before and after the crisis the crisis in 2008, by employing a more advanced econometric dynamic model. Furthermore, it extends the literature providing empirical evidence because of the financial crisis using the longest period, according to the availability of data, thus leading to more consistent results. On the other dimension, the findings of the current sub-study have corroborated the research of Narayan and Narayan (2013) and Samargandi et al. (2015), and extend the empirical literature regarding to the behaviour of two sectors of the economy, banking and equity, during both; the pre-and post-crisis periods, as well as for the short and long-term, which has not been addressed before. The impact of the financial development bank and market sectors in the short and long run may have important policy implications. If there is clear evidence that more financial banking or stock market development promotes or hinders economic activity, then policymakers should propose new regulations accordingly.

Chapter Six

Conclusions

This chapter focuses on summarizing the main findings and the policy implications obtained from the empirical analysis of each study in the previous chapter. The chapter is organised as follows: The first section provides an overview of the main findings, including policy implications. The second section discusses the drawbacks of the study and outlines avenues for further research.

6.1 Main findings and policy implications

The fundamental research question analysed in this thesis concerned the impact of financial development on economic growth before and after the crisis. The thesis focused on three issues:

(1) The relationship between financial development and economic growth during the recent crisis.

(2) The impact of banks and stock markets on economic growth as well as the role of the fiscal policy in the link between finance and growth.

(3) The short and long-run impact of financial development on economic growth before and after the crisis.

6.1.1 Study 1

The first study provided new evidence concerning the finance-growth relationship for the EU countries over the period 1990-2016. The primary objective was based on the impact of financial development on economic growth before and after the crisis. It was examined two different phases of crisis periods; the sub-prime crisis period (2008-2009), and the ongoing crisis period (2008-2016). Panel fixed effects estimates were employed using Driscoll Kraay (1998) standard errors estimates that are robust to disturbances being heteroscedastic-autocorrelated and cross-sectional dependence.

6.1.1.1 Main findings

The initial results demonstrate that before the crisis and at regular periods, financial development positively affected the economy, while during the crisis periods finance did not contribute to the economic activity. Also, considering a homogeneous panel such that of EU, where common regulations are implemented, the empirical results from the regional panels reveal that the finance-growth relationship is heterogeneous and varies across countries over time. Hence, the findings confirm the assumption of the panel heterogeneity because of the differences in levels of financial development.

One of the most remarkable outcomes that contributes to our knowledge is that in years 2008 and 2009 the ratio of commercial bank assets (BTOT) was significantly positive with a meaningful economic size. The relative importance of this finding is that the Deposit Guarantee Scheme, which is an EU legislation that protects bank deposits in case of bank failure, prevented the mass withdrawal of deposits. Hence, the capital adequacy kept the stability of the financial system as well as the economy in permissible growth level that did not lead to collapse.

Another noteworthy contribution is the relative importance of the results of the stock market. The findings suggest that at stress times, a higher trading volume is not accompanied by higher liquidity in the stock market or vice-versa; and the higher activity and liquidity are not accompanied by higher stock market capitalization. These results imply a reduced ability or willingness of stock market participants to act as investors (because of their doubt about the direction of the stock market), and thus hedging on specified securities tends to increase as well as share prices fell. The fall in stock prices reflected real economic problems and contributed to the economic slowdown.

6.1.1.2 Policy implications

Regarding the indicators of the bank sector, the primary implication is that policymakers need to take into account the benefits of Deposit Guarantee Scheme and implement financial policies to preserve the trust in the banking system from depositors seeking to withdraw their savings simultaneously at times of financial stress. In this stage of economic development across EU countries, the attention should be paid on new procedures for creating a more transparent, unified, and safer market risk for banks. More specifically, the implementation of common rules and regulatory standards for supervision; the treating of national and cross-border banking activities equally; and the early intervention if banks face problems to help prevent them from collapsing, might be tools to create a more reliable and efficient banking system. However, a further discussion for stronger and more consistent protection of retail depositors on a European level should be taken into consideration.

Regarding the indicators of the stock markets, the findings for the regular periods show that the higher activity and liquidity facilitated the financing of investments in the real economy, while the financial crisis has shown that a sudden lack of liquidity can occur during the time of stress. The primary implication is that the higher liquidity levels were not sustainable for the long term, and the existing rules for the financial market failed as shortcomings were exposed in the wake of the financial crisis. This may be a challenge for further financial integration efforts in the EU, and a more robust regulatory framework is needed even though the consequences are unintended.

6.1.2 Study 2

The second study used the same panel dataset as the first study and provided new evidence of the finance-growth relationship, of which sector prevails in the positive or negative effect on economic growth before and after the crisis. The primary objective was based on the impact of banks and stock markets on economic growth before and after the crisis. Considering that the financial crisis was converted to a debt crisis, the study also examined the role of the fiscal policy in the link between finance and growth. The principal component analysis was employed for the construction of two new aggregate financial development indices thus capturing the overall size of financial development.

6.1.2.1 Main findings

The empirical results extended our knowledge and suggested that at regular times financial development promoted economic growth with the stock market sector prevailing in this positive effect, while in crisis periods financial development hindered economic activity with the bank sector dominating in this adverse effect. Also, the study demonstrated the relative importance of the two sectors of the financial system, which have different effects on economic growth following each relevant period, before and after the crisis. More specifically, the negative effect of banks on growth and the weakness of stock markets to restrain the economy from the recession exhibit high persistence eight years after the occurrence of the financial crisis and do not return to the situation as was at regular periods.

The findings for the effect of financial development on economic growth in conjunction with the effect of fiscal policy suggest that at normal times financial development was a driving force of growth and both sectors are heavily important, while in crisis periods financial development negatively affected the economy with banks dominating in this negative effect. Additionally, a noteworthy contribution is that the significant negative effect of debt on the economy continued in the subprime crisis period; and eight years after the crash was insignificant, thus confirming the assumption that the quantitative ease effectively reduced the sovereign debt for Eurozone countries, but the monetary policy was ineffective on the real economy. Hence, banks and other institutions held more government bonds to enhance the governments' credibility not to default, and the ability of intermediaries to invest in assets was limited. On the other hand, the negative effect of taxes seems to have the most detrimental effect on growth eight years after the crash.

The results from the regional panels show that the impact of financial development varies across the countries due to the heterogeneous nature of economic structures, financial markets, and so on. Therefore, the regional results confirm the initial findings of the previous study about the panel heterogeneity. Also, the results suggest that the financial system of the North-West panel tends to be increasingly market-based as the economy develops, while in transition economies, the banking sector seems to be more efficient than the market sector which remains below the corresponding ones of the more developed EU countries. In South countries, financial development seems to be inefficient.

However, the relative importance of the results from the first two studies that contribute to our knowledge is that financial development failed to play a safeguarding role for economic growth during the crisis periods in a homogeneous group of countries such that of EU. Adding the role of fiscal policy, the results confirm the initial assumption that the crisis is ongoing and the refinancing of the public debt led to a repression policy. Finally, the degree of international trade openness in the economy of a country show that the more the country is exposed to international trade the higher economic activity since trade openness is the only positive driving force in economic growth during a time of stress.

6.1.2.2 Policy implications

The primary implication of the results from the second study is that regulators need to pay attention to the framework of the financial system and allow financial institutions to hold a small amount of their own countries government bonds. Also, the undertaken austerity measures by policymakers were ineffective and did not deliver the expectations of investors and the time-inconsistency problem raised from the difference between ex-ante and ex-post savings and capital tax rates. Thus, the findings have important implications for the quality of fiscal policy, and regulators need to focus more on the optimal tax policy as well as time-consistent policy. Policymakers must keep the tax rates constant overtime or find the least distorting mix of taxes to finance public spending.

Another outcome of primary importance for policymakers is that countries with higher levels of financial stock market development (North-West), suffered less from the recession and recovered more quickly compared with countries that have higher levels of financial bank sector development (Central-Eastern and Baltic). Therefore, it can be inferred that policymakers in transition economies should focus on the adoption of Euro along with the new regulations, which can enforce the financial system, while South countries should focus on the implementation of policies to make their financial system more efficient. Hence, appropriate policies should be undertaken from policymakers, taking into consideration the benefits that can be attributed to the development of the stock markets, since the allocation of resources for productive opportunities contribute to economic development.

6.1.3 Study 3

The third study used the indices of banks and markets from the previous study and provided new evidence of the dynamic impact of financial development on economic growth employing a panel heterogeneous data analysis of the EU economies. The primary objective was based on the short and long-run effect of banks and stock markets on economic growth for the full sample period as well as before and after the crisis. To estimate the short and long-run relationships the panel ARDL(p,q) model was employed, which offers three different tests: namely, mean group (MG), pooled mean group (PMG) and dynamic fixed effects (DFE) estimators.

6.1.3.1 Main findings

The findings suggest that for the full sample period financial bank sector development negatively affected economic growth in the short and long run, while the financial stock market development was the driving force of the economy only in the long-run. When the full panel is examined before the crisis period, both banks and stock markets had no impact on economic growth. After 2008, there is overwhelming evidence that financial development negatively affected the economy, with the bank sector being the most disrupting. Also, the findings reveal that eight years after the crisis, the banking sector evolves significantly in a worse way compared to the pre-crisis period.

The regional results provided clear evidence that the financial system in the North-West panel is more market based, and confirms the findings of the previous studies. For transition economies and South region, it is not confirmed that were bank-based, implying that the financial system in these countries was inefficient. Also, one year after the crisis, the banks of the North-West and South countries stimulated the economy and provide new insights into the banking system at stress times. More specifically, given that the failure of many banks was imminent, governments launched a massive bailout package to support banks in distress and prevent from a wide scale of financial collapse.

The central point of this study was the finance-growth relationship in the long and short run. The findings contradict the common assumption that financial development plays a significant role in fostering growth and are not in line with King and Levine (1993a), Levine et al. (2000), Seetanah (2009), Christopoulos and Tsionas (2004) and Loayza and Rancière (2006) among others, who found positive effects of financial development on growth. However, the results are in line with Arcand et al. (2015) and Narayan and Narayan (2013), who found a negative long-run effect of finance on growth.

6.1.3.2 Policy implications

The primary implication for the inverse relationship between financial bank sector development and growth is the over-lending and the credit expansion, along with a lack of regulatory control and monitoring from the banks. However, the results have potential importance for the financial regulation to bring efficiency in the short and long run. Any project for stimulating economic growth and productivity via increased finance appears to have less of an impact, possibly owing to deficiencies and weaknesses in frameworks.

The results are of potential importance to policymakers in terms of optimizing the structure of the financial system. Also, appropriate measures, financial regulation, and supervision remain essential to reduce systemic risk and promote the financial systems stability. Moreover, the results reveal that the post-crisis economic growth recovery was so weak, and the financial system has not enhanced economic activity. This might be due to the subsequent European debt crisis, and the low-interest rates have made higher debts, and the debt overhang makes the economy more vulnerable to future shocks. Hence, the fundamental question might be why economic growth has become so debt-dependent, and policymakers should take into account possible threshold effects of government debt on economic growth.

6.2 Limitations of the study and recommendations for further research

This study employed the aggregate level of data for empirical analyses. However, disaggregated data for the bank and market-level could also be highly beneficial in achieving an understanding of the nature of the relationship established between finance and growth .

One of the significant issues frequently emphasised in the finance-growth literature concerns the measures related to the financial development. The study employed several measures related the size (or financial depth) and efficiency of financial institutions and stock markets. However, future research should aim to re-examine the same issues, utilising measures related to the stability and the degree of access to financial institutions and markets, reflecting the diverse aspects of a financial system.

Another limitation of this study is the unavailability of up-to-date data as well as more frequenting data. More specifically, recently, the availability of data for the employed dataset in this study was until 2016. Besides, given that the availability of data is on an annual basis, the research concern a limited number of observations and the inclusion of control variables results in the consumption of degrees of freedom. On the other hand, the exclusion of the control variables could lead to issues related to the omitted variables and thus bias the empirical results. Hence, the increased future availability of data may expand the empirical analysis by enabling the inclusion of an increased number of control variables. Further research could also re-investigate the finance-growth relationship because of crisis in conjunction with the increased availability of data in the future.

A further limitation of this study relates to the extent of the empirical analysis. A more in-depth analysis of the financial system has the potential to provide an understanding of the factors behind the weakness to contribute to economic growth and understand the heterogeneity. In particular, future research should find possible threshold effects of the finance-growth relationship employing measures from both financial sectors the banking and the stock market. Finally, considering the ineffective monetary policy, further investigation needs to be undertaken to find the best strategy for the refinancing the public debt during the abnormal periods.

The final limitation of the current study is the issue of European stock market integration, which is of considerable importance to both investors and the economy as a whole. Since the late 1990s, to achieve a higher degree of integration in EU, a series of exchange mergers have led to the evolution of two pan-European stock exchanges, the Euronext and the Office Max-OMX-(each of which later successively merged with US stock exchanges). Future research might be interesting to consider a further investigation of the performance of those exchange groupings in response to the conventional and unconventional measures of monetary policy as well as the evolution of foreign (presumably institutional) investors participation in European markets.

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