UNIVERSITY OF LJUBLJANA

FACULTY OF ECONOMICS

MASTER'S THESIS

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IMPACT OF LEVERAGE ON CONVERGENCE IN MEMBER STATES OF THE EUROPEAN UNION

Ljubljana, October 2018 JAN PORENTA

AUTHORSHIP STATEMENT

The undersigned JAN PORENTA, a student at the University of Ljubljana, Faculty of Economics, (hereafter: FELU), author of this written final work of studies with the title IMPACT OF LEVERAGE ON CONVERGENCE IN MEMBER STATES OF THE EUROPEAN UNION, prepared under supervision of associate professor Vasja Rant, PhD.

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INTRODUCTION

Convergence of gross domestic product (hereinafter GDP) per capita is one of the most important concepts to understand in modern economics. It entails a notion that less developed countries may, given the right circumstances, join the prosperous club. Many convergence stories support this notion – from successes of late industrializers such as Japan and South Korea and more recently even China. After the fall of the iron curtain, central and eastern European countries started to converge again both politically and economically. On the other hand recent global and European financial crises have shown that convergence can sometimes stop and even reverse into divergence. Many studies have contributed to better understanding of the underlying forces that drive or slow down the process of convergence by applying a wide range of methodologies, from simple descriptive techniques to the upmost complicated mathematical and statistical modeling. In addition to academic interests, it is also worth noting that convergence is important not only because of economic implications but also because of social, political and policy making points of view.

This is particularly true in a tightly connected economic and political integration such as the European Union (hereinafter EU). The question of what drives the process of diminishing the inequalities between countries in the EU is relative not just because of increasing relative prosperity of less developed EU member states gives them a better chance to compete in the Single European market but also because economic convergence can create supporting conditions for political convergence and thus easier and faster decision making with higher overall political stability. Relationship between economic, social and political convergence became quite evident after the recent European financial crises when the slowdown or partial reversal of economic convergence enabled increasing popularity of populist political movements in several EU member states (i.e. social and political divergence). Economic convergence is therefore not just an abstract economic phenomenon but also influences the real life politics and social aspects of living in the EU.

One of highly debated factors that may influence the convergence process is the effect of debt. There are a number of studies that argue the negative effect of higher indebtedness on economic growth and while some, like the very influential Reinhart and Rogoff (2010), also propose thresholds from which the linearity of the relationship breaks, there really is just one conclusion that most of them make – higher indebtedness goes along with lower economic growth. The direction of causality however is the part that leaves most economists disagreeing. While many argue that higher debt causes lower economic growth, be it in aggregate or per capita terms, others insist that higher indebtedness in merely a consequence of low growth. These ambiguous relationships between debt and growth have sparked my interest in understanding whether or not debt also influences convergence and if so, how? Do countries with higher indebtedness converge slower or faster than countries with lower indebtedness and is the convergence process itself debt led? Does the form of indebtedness (i.e. public or private debt) matter for convergence? Did the relationship between debt and convergence change after the crises? These research questions are the central interests of my thesis. There are studies such as Barro (1991) exploring the determinants of growth and debt, studies of exploring convergence in United States such as Young, Higgins and Levy (2008), and also studies that explore convergence in the EU such as Simionescu (2014), but quality literature focusing mainly on the effect of indebtedness on convergence is not so easily found. For one, Artelaris, Kallioras, and Petrakos (2015) claim that convergence in the EU was mostly debt led, but that it still requires more research and this is why this thesis offers a valuable contribution in broadening the debate.

This thesis therefore offers answers to four main research questions. The first is, what is the nature of the relationship between debt and growth and do any thresholds exist in the EU? The second question is, whether or not richer countries grow slower and if the convergence is present in the EU? The third question is, whether or not countries with more leverage converge differently (slower or faster) and the fourth question is, whether or not the inequalities between them are diminishing through time? The first chapter offers the literature review on studies ranging from the effect of debt on growth, the determinants of public debt and review on other variables that are also proposed to determine economic growth. The second chapter offers answers to all the questions regarding methodological approach used in this thesis to either model or test the convergence process in multiple forms. Included is a review of convergence related literature, be it beta or sigma convergence in absolute or conditional form. Also included are explanations of more important tests that I performed to ensure the validity of results as much as possible. Third chapter offers all the data description for the data used in this thesis along with all summary statistics and sources. Correlation matrices and statistical tables are used to better explain the bivariate connections between more important variables. This chapter also explores the indebtedness situation for both private and public debt along with graphically establishing the relationship between debt and growth. Continuing the debate on linearity breaking thresholds, fourth chapter offers tests for non-linearities of the effect that debt has on growth in a form of regression models. The main focus of chapter four however is an in depth empirical testing of absolute and conditional beta convergence as defined by Sala-i-Martin (1995), with a special emphasis on the effect that indebtedness has on it. Additionally, sigma convergence is also explored. Fifth chapter offers an overview of my main findings with a comparison of results with other studies and my opinion on those results as well as closing statements.

1 LITERATURE REVIEW

The first thing that I will do in this thesis is to offer a review of literature that influenced me the most when I started to form the methodological approach for my empirical study. First I concentrate on the reasons behind public debt accumulation and then on the connections between indebtedness and economic growth, where I examine both public and private debt along with the role that finance in general has in determining growth. Lastly, I explore the additional growth determining variables. The literature on convergence is reviewed later in chapter two together with an in depth methodology description.

1.1 Determinants of public debt

Public debt to GDP ratio is a function of multiple determinants. In fact, given the large number of possible variables being linked to be the cause of debt and relatively lower number of observations in macroeconomic data, limiting the determinants of debt is of critical importance when trying to understand this relationship without losing excessive degrees of freedom. Many papers find a negative relationship between public debt to GDP ratio and GDP per capita growth rate, however the exact form of the relationship (linear or non-linear) and, in particular, the existence of indebtedness thresholds from which growth is non-linearly diminished is very ambiguous. Swamy (2015) proposed a few determinants that, when put together in a model explained quite a lot of variation in debt – R^2 was ranging from 0.28 up to 0.40 for advanced economies, between 0.63 and 0.75 for emerging economies, between 0.32 and 0.38 for developing economies, between 0.24 and 0.33 for OECD countries and finally almost 0.95 for BRICS countries. The study itself employed a dynamic panel data regression in a form of a GMM model. Regressions were performed on multiple groupings which were either economically based with high income countries being separated from highly indebted low income countries or politically based with governance indicators being the foundation for selection. The dependent variable was the general government gross debt.

The determinants of public debt proposed in Swamy (2015) and their coefficient sign which were statistically significant at 95 percent confidence interval in at least one regressions were:

- Real GDP growth with a negative coefficient
- Final consumption expenditure with a positive coefficient
- Foreign direct investment with a negative coefficient in all but BRICS groupings
- Government expenditure with a positive and negative coefficient depending on the group
- Inflation with a negative coefficient
- Trade openness with a positive coefficient
- Gross fixed capital formation with a positive coefficient
- Real interest rate with a negative coefficient
- Age dependency ratio with a negative coefficient
- Population growth with a positive and negative coefficient depending on the group
- Unemployment with a positive coefficient

The study in addition suggests that quite a lot of variation in public debt can be explained by variation in explanatory variables that are not strictly derived from economics but that their effect can be hard to test since reliable data is very hard to find and it almost always serves merely as a proxy. One problem of the study, however, is that in most cases the causality tests could not confirm one-way causality which means that deterministic nature cannot be fully claimed. Their data comprised macroeconomic variables from World Development Indicators that includes 252 countries ranging from 1980 to 2009. Additionally, the IMF data and Reinhart and Rogoff's dataset on debt to GDP ratios was used. These so called determinants can very well be consequences of higher debt levels. This remains a constant problem since understanding causality would be preferred to the understanding that there is a certain economically logical connection between certain characteristics.

Barro (1979) on the other hand proposed a model of public debt issuing where inflation, overall price level, income growth and government expenditures along with real interest rate and fluctuations in the rate of return on corporate bonds were given as a determinants of public debt. The methodology was at that time brilliant and literature on this issue was then scarce at best. Testing was done via an empirical estimation of a macroeconomic model which was constructed for explaining the variation in public debt stocks. The annual change in debt stock was estimated from collecting data on multiple input variables from which the final explanatory variables were constructed that tried to explain the variation of public debt. These variables and their corresponding relationships with public debt were:

- Expected inflation which was calculated from combining time series data on inflation and the estimated values from equation on GNP deflator. This coefficient had a positive value in a sample on United States data from 1948 and 1976.

- Estimated after-tax nominal rate of return on corporate bonds with a positive coefficient in all sub sample regressions.

- Ratio of estimated deviation of current real federal expenditures from normal (given estimation from inputting the initial indebtedness) over the average of public debt over a whole year. This ratio had a positive coefficient.

- Ratio of normal government spending multiplied by the deviation of current GNP level from normal GNP level (given the initial indebtedness) over average debt stock in a given year. This ratio had a negative regression coefficient.

The dependent variable was the change in nominal debt stock from the previous year. This study obtained high R^2 values which were partly obtained by adding a lagged dependent variable into the regression. Additionally, the study suggests that the level of debt is not important in determining the fluctuations of indebtedness which is actually a view that is also shared by Swamy (2015). The simple fact that many economists agree on remains that debt accumulation is by no means a stochastic process but rather a deterministic one. Debt accumulation is affected by or better said connected with (since causality remains a problem) all major components of GDP equation (GDP = C+I+G+(EX-IM)) and also some social and demographic characteristics.

Additionally, Kalimeris (2011) suggests that there is a circular process happening since trade related problems have a negative effect on indebtedness and then indebtedness has a negative effect on trade. Also mentioned as determinants of debt are long term interest rates and government deficits where again a sort of a circular effect is pointed out.

1.2 Connection between debt and growth

The debate on whether or not indebtedness affects economic growth or is just a product of it spans over decades. To understand whether or not it also effects convergence one must first understand the connections between debt, growth and prosperity in a given country. If richer countries can bear more public and private debt to GDP and there exists a negative connection between debt and growth it could be claimed that debt is one of the factors that enable the process of convergence. In this part I first offer an in depth literature overview on the topic and explain the approach with which I will conduct my own study in chapter four as I go along.

1.2.1 Is the average growth lowered non-linearly with increasing public debt ratio?

Perhaps the most important and controversial paper which really popularized the debate on non-linearity of indebtedness and growth relationship was Reinhart and Rogoff (2010). Their dataset comprised of a wide selection of 44 countries including United States and observations spanning almost two hundred years. This resulted in over 3700 annual observations which suffices to say that the authors covered a wide spectrum of political systems, economic systems, and economy characteristics. Findings and results that they published were obtained by comparing different levels of debt to GDP and growth rates in corresponding periods. The main findings of their study can be summarized as following:

- The relation between government debt to GDP ratios and GDP growth is week for low levels of debt to GDP, that is for debt levels under 90 percent of GDP.
- Above 90 percent of debt to GDP the median growth rates fall by one percentage point and average growth rates fall considerably more.
- These thresholds are similar for advanced and emerging economies.
- For emerging markets, the external debt denominated in foreign currency has a much lower threshold of around 60 percent. Above 60 percent growth declines by about 2 percentage points and when 90 percent threshold is reached growth rates are roughly cut in half.
- There is no link between inflation and public debt levels for advanced economies as a group but there is a link for emerging economies – more debt in those economies is accompanied by higher inflation.

What was also offered in this study was the explanation as to why their 90 and 60 percent thresholds make sense. They argue that when countries reach this historically determined threshold their risk premia rise quickly. As a result, countries are therefore forced to make some difficult tradeoffs. If a highly indebted countries wish to maintain the investors' interests, they are forced to accept some restrictive fiscal policy measures to reduce their risk premia and this may lead to lower growth levels. This view is rejected by Krugman (2010) who claims that there is absolutely no proof of higher debt having a direct effect on growth and that the 90 percent threshold can also be a consequence of reverse causality, implying that debt is merely a result of lower growth that may in turn be a consequence of completely other processes.

The methodology approach of Reinhart and Rogoff (2010) was rather simple and perhaps led to misleading results since no matter how careful the data preparation was, just comparing averages of debt ratios and growth rates excludes all possibilities for controlling other very important factors which may and do affect economic growth. In other words, this method leads to the assumption that only debt to GDP ratios are important for growth rate and that they explain majority if not all of the fluctuations in growth. Also important to note is the problem of possible spurious relationship also mentioned in Krugman (2010) which is perhaps best illustrated with a simple example from Vigen (2015): per capita cheese consumption in the United States for instance correlates with the number of people who died by becoming tangled in their bed sheets with a coefficient of 0.947. Despite impressive correlation coefficient, this is of course not a causal relationship. The same spuriousness level can hardly be attributed to Reinhart and Rogoff conclusions but it nevertheless illustrates the need for testing their key conclusion econometrically by controlling for other important growth determining variables, which is also what I will do in this thesis. On the other hand, Kumar and Woo (2010) performed a parametric assessment with a regression based on a panel data approach with country specific fixed effects being taken into the account. They controlled for usual growth accounting variables such as trade openness, initial GDP per capita level, inflation, financial depth, years of schooling etc. Their dataset included 38 countries from advanced to emerging economies with a population over 5 million in the period from 1970 to 2007. I adopted a similar approach in chapter four but with a different set of growth accounting control variables. Their results suggest that an increase of public debt to GDP of 10 percentage points on average associates with a decrease in growth of GDP per capita by around 0.2 to 0.3 percentage points, depending on the model form and estimation model used. As far as nonlinearities go they performed the test with interaction indicator variables and public debt brackets where they mostly could not find the statistically significant differences. They nevertheless concluded that a possibility of nonlinear relationship may exist since a 10 percent increase (not 10 percentage point increase) in public debt to GDP is more harmful to growth when debt levels are high. This is a completely logical conclusion and is in my opinion not a basis for non-linearity claim since a 10 percent increase when debt to GDP is at 50 means 5 percentage points while a 10 percent increase when debt is at 90 means 9 percentage points of increase. They do provide some evidence that the impact of debt on growth in advanced economies tends to be smaller than that in the less developed economies claiming a more robust economic processes in the former. In my opinion the study by Kumar and Woo (2010) offers the most complete empirical approach to study the effect of debt on GDP per capita growth and this is why I decided that I will merge this econometric approach with convergence testing in chapter four, but as I mentioned already, a different set of control variables will be added as well as additional public indebtedness brackets with an extra one for over 120 percent of public debt to GDP.

Later in 2013 a PhD student Thomas Herndon tried to replicate the study from Reinhart and Rogoff (2010) and failed to produce similar results. Even though criticism of Reinhart and Rogoff persisted for a few years with economists disagreeing about possible reverse causality and mechanism through which they stated and explained a negative effect of high indebtedness on growth, there still existed no doubt in their data handling and measuring proficiency. Ash, Herndon and Pollin (2013) study changed that significantly. What they found was that Reinhart and Rogoff's study suffered from a severe coding error in the spreadsheet enabling exclusion of 5 countries - Australia, Austria, Canada, Belgium and Denmark from analysis all together. Even more problematic was the fact that also selective exclusion for available data in addition to coding error happened. For instance, the exclusion of available data for Greece, Spain, Portugal and New Zealand for certain periods which could have had a profound effect on summary statistics. Another big choice that did not make sense was Reinhart and Rogoff's selection of treating summary statistics. They had a panel of data for the over 90 percent of debt to GDP and they calculated the average growth of each country in all selected periods and then averaged the averages for all countries. Combined with the missing available data, this gave the opportunity for major over and under estimation of averages. While The United Kingdom had 19 years' worth of data in the above 90 percent debt ratio category with an average of 2.4 percent of GDP growth per year. The United States appeared only for 4 years in the above 90 percent debt ratio category and they averaged negative GDP growth of -2 percent per year. The same weight was put on 4 years' worth of data as on 19 years' worth in the United Kingdom case. This was an obvious mistake since the data should be averaged all together and combined with selective exclusion of available data and the coding errors in the excel spreadsheet, the estimates robustness diminished.

Ash, Herndon and Pollin (2013) calculated the Reinhart and Rogoff (2010) study again and with the correct methodology and weighting scheme, the results proved to be significantly different from the ones originally published by Reinhart and Rogoff. First they found the selection of debt ratio brackets (0 to 30 percent, 30 to 60 percent, 60 to 90 percent and 90 to 120 percent of debt to GDP) to be arbitrary since no real economic logic supported them and neither was one offered in the original study itself. In addition, averages were also miscalculated. For the 0 to 30 percent of debt to GDP bracket Reinhart and Rogoff stated 4.1 percent of average annual GDP growth, while the correct number was 4.2. Similarly, the difference for 30 to 60 percent bracket (average of 2.9 percent of GDP growth by Reinhart and Rogoff and the correct number of 3.1) and 60 to 90 percent bracket (average of 3.4 percent of GDP growth for Reinhart and Rogoff and the correct number of 3.2) also showed a small difference which was nothing to be overly dramatic about. The problem, however, was that while Reinhart and Rogoff calculated the average annual growth of GDP for countries with above 90 percent debt to GDP at -0.1, the correct number of 2.2 differed significantly. This means that although the above 90 percent category suffered from minor average GDP growth reduction from previous category, it was not even close to being as prominent as Reinhart and Rogoff (2010) stated.

While a more consistent and unbiased method was used in Ash, Herndon and Pollin (2013), their study still failed to control for other economic factors and determinants of GDP growth. They even admit that their critique is non parametric in nature and does not allow for controlling for additional factors. I replicate the results with similar methodology and data on the EU with the correct weighting methods in chapter four.

In 2014 another study surfaced which tried to estimate the effect of debt to GDP ratio on GDP growth. By using the newly constructed dataset from IMF's Fiscal Affairs Department, Pescatori, Sandri and Simon (2014) opted to find out whether or not there exists a certain magic threshold of debt to GDP that once crossed it implies a non-linear growth reduction. They were not able to find any evidence of this threshold existing but nevertheless managed to prove that the debt trajectory is quite important in understanding growth. Additional conclusion was that higher debt could be associated with higher volatility of output. They, however, acknowledged the negative relation between higher debt to GDP ratios and GDP growth, but no threshold of linearity was found. The sample that they used showed that moving past 90 percent of debt to GDP really does bring the growth rates down but in a linear fashion. An explanation is offered for the 90 percent being a point from which the effect of debt on growth starts to turn into a negative spectrum and it is a little bit different from the one given in Reinhart and Rogoff (2010). They argue that exceeding the 90 percent level increases the risk of all sorts of financial distress that reduces growth or that some important variable that effects both growth and debt is omitted and therefore causality should not be overstated.

When analyzing the lagged effect of crossing the threshold of 90 percent of debt to GDP they could not find any sort of evidence of 90 percent or even some other threshold existing. Even after looking at the relationship between the debt level and GDP growth after 1 year, 5 years and 10 years and they still could not find any thresholds so they finally concluded that there are none. What is very interesting for the purpose of determining the effect of high indebtedness levels was the discovery that volatility or the dispersion of growth rates increases when debt to GDP increases.

Other studies covering the same subject are perhaps a little more advanced in methodological approach such as Baum, Checherita and Rother (2010), where a quadratic short term relationship with a negative leading coefficient was discovered between debt and growth but no long term effect was mentioned. Short term effect was explained with two distinct indebtedness ranges with the first being 67 percent of GDP indebtedness up to which the effect of extra debt accumulation has positive but short lasting effect on growth and the other was 95 percent from which extra debt has a negative short term effect. Checherita and Rother (2010) also test the effect of public debt on growth econometrically in the form of conditional convergence equation based on a panel data approach. They employ system and difference GMM estimation and they also find the same quadratic relationship between debt and growth in the long run. The data in both studies differ in time periods and selection of the country sample from the Euro Area. This is an interesting way of testing and I will also add a quadratic estimation as a form of robustness check when testing for conditional beta convergence in chapter four. Panizza and Presbitero (2014) even test for a causal directional effect but they could not find a robust one-way causality, since estimates of causality changed in direction form one model specification to the other. On the other hand, Eberhardt and Presbitero (2015) investigate the debt ratio thresholds in a panel of data and claim to have not been able to find any thresholds and non-linearities. They further argue that indebtedness has a different coefficient in many of countries and therefore any policy making based on results from aggregated sample estimates could be seriously misleading.

One thing is certain - the connection between indebtedness and economic growth is a negative one at first glance and studies that argue the effect to be quadratic are scarce and very specific in both time horizon and country selection part of the data. The main question is if the linearity breaks when a certain threshold of public or private debt to GDP is reached and also do the thresholds if they indeed exist slow down the convergence process at all? All of the mentioned studies have helped me form an analytical approach to empirical modeling which will be presented in chapter four. Besides the connection between growth and debt, the convergence is also tested with an emphasis on the effect that indebtedness has on it. Following Kumar and Woo (2010), I will employ interaction indicator variables as a mean for testing non-linearities and I will also augment this approach for testing the effect of indebtedness on convergence estimates. Also of interest is whether or not all the relationships mentioned (linearity, negative connection, volatility increases etc.) indeed hold on the EU data.

1.2.2 Does finance matter with debt and growth and why?

Bloch and Fall (2015) warn that the general government gross debt or public debt is not the only measure of financial sustainability and neither is it the only factor worth considering when growth is in question, since many times inconsistency of methodologies used to calculate the debt are different across countries and even periods, which could lead to confusion in the data before analysis even starts. Because the importance of public debt has been discussed heavily in recent years and because literature on this topic is nowadays anything but scarce, the question of the role that finance plays stands out. Levin (1997) argues that financial systems matter to growth through 5 major channels, specifically for lowering risk with making trading and hedging easier, providing better and more efficient resource allocation, making monitoring of managers and corporate control easier through easier access to information, mobilization of savings into investments and boosting exchange of goods and services through lowering the transaction costs. King and Levin (1993) claim, that finance matters with growth since financial depth, percentage of credit allocated to private firms and similar indicators of development of financial sector correlate positively and significantly with growth, capital accumulation and also efficiency of resource allocation. This is consistent with Schumpeterian view of finance. What is perhaps the most interesting is the claim that King and Levin (1993) make about levels for indicating the development of financial sector being a good predictor for growth for the next 10 to 30 years. However, the question of whether or not a well-developed financial sector is a consequence of growth or its determinant, remains.

Arcand, Berkez and Panizza (2015) for instance argue that there is no significant correlation between the size of the financial sector and growth for countries with big financial sectors. The claim is made, that when the size of the financial sector relative to GDP reaches 80 to 100 percent, an increase of that relative size associates with lower growth and a negative overall impact on growth but that lower ratios actually have a positive effect on growth when they are increased. This relationship is incredibly similar to that of Baum, Checherita and Rother (2010) but instead of studying the impact that debt has on growth, the size of the financial sector is used. This can also be interpreted as a foundation for a claim that the finance and indebtedness are indeed highly related economic characteristics. The main conclusion of the study is that there again exists some sort of quadratic relationship between the size of the financial sector and growth with a negative lead coefficient. Again, as with almost all econometric studies in economics, causality is not claimed, but a notion that smaller financial sectors can possibly benefit growth in some countries dependent on current size is interesting. Another meaningful explanation of the relationship is offered and that is the fact that volatility of growth is higher in countries with bigger financial sectors which brings higher probability of large financial crashes.

1.2.3 How does private debt effect growth

Private sector debt is actually the indebtedness of non-financial corporations, households and non-profit institutions serving households. There are numerous papers published indicating that there exists an optimal capital structure between debt and equity on a firm level. The debate was fierce since the first paper - Modigliani and Miller (1958) stormed with an idea that under perfect capital market assumptions the optimum does not exist and that value of an indebted company is the same as the value of company financed only with equity. Modigliani and Miller (1963) offered a correction paper adding that under perfect capital market conditions and with the presence of corporate or private taxes the relationship between them determines the optimal structure which is either no debt or 99.99% indebtedness. In addition, there are multiple econometrically based papers proving that when perfect capital market assumptions are released the optimal capital structure may very well exist. Binsbergen, Graham and Yang (2010) proposed an instrumental variable approach of determining the cost of being over or underleveraged. The main conclusion was that being over the optimal debt level costs more than being under the level but that being outside optimal structure means higher costs than necessary for a firm to have. This approach is not useful for the purpose of my analysis since determining optimal debt level would be incredibly difficult on the level of an economy, when economists do not even agree on the extent of the effect that indebtedness has on growth. Neither could the direction of causation be drawn, but the question of whether or not the private sector debt aside from public debt has an effect on growth and also convergence, still remains. After all, many economists argue that external financing in the form of debt is actually more efficient than internal financing since it forces a firm to allocate its resources more efficiently. Therefore, an overall boost of efficiency comes with high debt levels on a corporate level, so the effect of private debt could be even more ambiguous than public debt. Stiglitz (1972) showed that there is no perfect capital market assumptions that would in reality hold and his work shows that increasing debt to equity ratio in a firm actually increases the risk of bankruptcy. Additionally, he argues that the costs of bankruptcy are actually not negligible and that firms also take that into account when choosing their financing decisions (i.e. debt or equity). Stiglitz (1982) showed that also asymmetry of information plays a major role in firms financing structures. For instance, if the manager of a firm is willing to sell his or her equity share, then this manager signals the disbelief in the valuation of the share. The prices of shares may drop because of that and the value of a firm can be greatly affected because of that. Stiglitz (1972) also argues that firms with very high debt to equity ratios performed differently and that they usually take different investment decisions with respect to both risk and profitability. Firms financing decisions matter and thus private debt matters in firm value. One single firm value is generally not as important for economic growth, but when aggregated and looked from the perspective of the whole corporate sector, I can safely claim that then the value of a firm is an important concept. Because of the role that private debt plays in those valuations there is a strong possibility that private debt to GDP ratio also has an effect on growth.

The Great Recession offered us a great opportunity to study the behavior of economic subjects in the periods of financial distress. Later, in chapter four, I will include private debt into models for testing convergence, but a sample estimate will only draw data from movement of private debt to GDP ratio, which after 2008 in the EU declined because of credit crunch and it cannot fully explain why growth might be affected. If the credit crunch was the reason firms behaved very differently, not just in a way of obtaining financing for their investments or projects but also in a way they chose specific projects, then this is an important factor when considering the effect that private debt movement indirectly exerts on growth through altering the managerial decisions. Campello, Graham and Harvey (2010) found out that financially constrained firms, because of the credit crunch and overall credit shortage in 2008, behaved differently than non-constrained ones. For instance, constrained firms planned to reduce employment, technology spending, capital investment, marketing expenditures and dividend payments by much more than non-constrained firms. These results hold regardless of geographical selection (United States, Europe, Asia) and serve as a basis for a claim that since private indebtedness declined because of credit crunch, there exists an effect on growth. Private debt to GDP cannot capture this full effect and neither is it the only cause for this altered firm behavior. Nevertheless, it plays a major role. What is also important, is the notion in Campello, Giambona, Graham and Harvey (2011) that firms in times of credit shortage tend to swap external financing for internal which in practice means that they have to decide between savings and investment and they also tend to operate more with cash. Needless to say, this brings a decline in both savings and investments and therefore a possibility of recession, which when aggregated can turn into a strongly negative effect on growth.

1.2.4 Additional determinants of growth

There are numerous variables that were through the history of economic thought said to be the determinants of growth. The truth is that there is no easy way of addressing the simultaneous causality bias, because a certain economy is usually better described in circular motions than in linear directions. Some determinants of growth may well be consequences and this is why Acemoglu (2008) strictly separates fundamental causes and correlates to growth. As correlates to growth he mentions factors such as investment to GDP ratio, investments in physical and human capital, average years of schooling and similar but as fundamental causes to growth he actually mentions four rather unorthodox characteristics: luck, geographical differences, institutional differences and cultural differences. I cannot really empirically test luck, geographical or even cultural differences in EU, but I can include a proxy for institutional differences. World Bank's database on World Governance Indicators (WGI) includes the estimates for six dimensions of governance – voice and accountability, political stability, lack of violence, government effectiveness, regulatory quality, rule of law and control of corruption. These variables will serve me as a proxy for institutional quality. On the other hand, Glaeser, La Porta and Lopez-de-Silanes (2004) find that institutions are not really a determinant, but rather a consequence of growth and that human capital is much more relevant when explaining growth.

Barro (1991) links school enrollment rates in primary and secondary schools as a proxy for human capital, Gumus and Celikay (2015) proposed research and development expenditures to GDP to be positively correlated with growth in the long run but not so much in the short run. Barro (1996) Evans (2000), Cocris, Stoica and Sârbu (2017) and many others emphasize the importance of foreign direct investment (hereinafter FDI) and find positive and significant effect of an increase of FDI on growth. Konstantinos, Sondermann, and Vansteenkiste (2017) again agree with the positive influence of FDI on growth, but nevertheless warn that FDI is a deterministic process which is heavily influenced by economic structures such as tax codes, labor costs, and also current GDP values. The point here is, that the relationships especially in parametric sense are very difficult to estimate correctly since the effect is not only direct but also circular. Additionally, trade openness can also play a major role in determining growth. A completely correct effect of trade openness on growth is again almost impossible to estimate, since trade openness is (as mentioned in Swamy (2015)) determinant of indebtedness and indebtedness also has an effect on growth. There is, however, a notion in Fetahi-Vehapi and Petkovski (2015), that trade benefits bigger countries, countries with more FDI's and countries with higher gross fixed capital formation significantly more. There is also another part of the story to tell since Rodriguez (2007) finds no statistically significant relationship between trade openness and growth. From this, a conclusion can be made that a lot of growth determining variables in regressions are positively related, not only conditional on other variables but also conditional on model specification.

In the neoclassical growth models popularized by Solow (1956), savings rate, capital accumulation and population growth are mentioned as important contributors to economic growth. In this thesis I included many variables that come from growth accounting exercises into my growth regressions in chapter four, as a control to mitigate the excluded variable bias when modeling convergence and the effect of indebtedness on it.

2 RESEARCH METHODOLOGY

Apart from econometric modeling and hypothesis testing, also graphical methods will be used to present the data and additional summary statistics will be offered in a form of tables to better understand the structure and intention of the empirical investigation. In this chapter I define all the methodological challenges and estimation processes that will be used in this thesis.

2.1 Absolute beta convergence

Beta convergence was defined in Sala-i-Martin (1995), where a definition was given in terms of absolute beta convergence, which exists if poor economies tend to grow faster than rich ones. To replicate this in a simple, but informative example, I will define the first second and third models which will later be estimated econometrically in equation (1) and (2) and (3) respectively.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \varepsilon_{it} \quad (1)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \varepsilon_{it} \quad (2)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 GROWTH_{it-n} + \varepsilon_{it} \quad (3)$$

GROWTH is the annual growth rate of GDP per capita, lnGDPpc is logarithm of GDP per capita. The rule for determining whether or not there is presence of absolute beta convergence will be determined by the sign of β_2 – if the sign is negative that means that wealthier economies on average grow slower than less wealthy economies, which implies unconditional or absolute beta convergence, but if the sign is positive then wealthier economies would on average grow faster, meaning no absolute beta convergence but rather a conclusion of a presence of a divergence process between countries. Sala-i-Martin (1995) finds a statistically significant divergence on global level but statistically significant convergence when a similar and more coherent economic environments are investigated within. For instance, he finds absolute convergence in Europe, Asia, the United States and OECD countries so I expect to find a negative and statistically significant estimate for β_2 in EU in my analysis.

2.2 Conditional beta convergence

Conditional beta convergence differs from absolute beta convergence in a sense that for conditional beta convergence testing the effect of those variables that determine the steady state of certain economy should also be controlled for. Allowing countries to have different steady states is important for the ability to test conditional beta convergence as noted in Sala-i-Martin (1995). A steady state or the state towards which an economy should converge to is determined by many different variables. Barro (1991) shows multiple determinants of growth and therefore conditional convergence control factors as well. As was noted, there are 4 major determinants that should be controlled for when testing for conditional beta convergence. First is the technology level, second is the human capital level, third is population (labor) and last is the capital level. To control for each, economists have used many proxy variables such as population growth rate, savings rate, fertility, teacher to student ratios, levels of education indicators, PhD students per 1000 people, trade openness, machines per 1000 workers, gross fixed capital formation and so forth. When all the control variables that according to economic reasoning affect growth of an economy are taken into account and when the effects of steady state determinants are filtered out from logarithm of GDP per capita, only then can conditional beta convergence be discussed. To illustrate the difference between conditional and absolute convergence, 3 additional model forms must be taken into account shown in the equations (4), (5) and (6). Conditional convergence exists if there is still a negative and statistically significant estimate of β_2, even when additional steady state controlling variables found in the matrix X_{it} are included in a model. For one, Artelaris, Kallioras and Petrakos (2015) acknowledge the absolute convergence in the EU, but claim that the convergence was debt led and when public debt was used as a control variable, the positive estimate for β_2 emerged in that study signaling the conditional divergence. I discuss this claim further in chapter four, since the effect of public debt on convergence rate is one of my main research questions in this thesis and I test whether or not the convergence itself is indeed debt led.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + X_{it}'\gamma + \varepsilon_{it} \quad (4)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + X_{it}'\gamma + \varepsilon_{it} \quad (5)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 GROWTH_{it-n} + X_{it}'\gamma + \varepsilon_{it} \quad (6)$$

2.3 Methodology for model estimation

The main tool and workhorse of this thesis, as far as empirical methodology is concerned, will be linear regression. There are a few functional forms that I will consider during modeling and they range in complexity and purpose. The first functional form is represented in equation (1) and (4) for absolute and conditional beta convergence respectively. It is a simple linear model which is in matrix form best represented in the equation (7) with dependent variable column vector on the left hand side and explanatory variables matrix X with β (a column vector of coefficients) and ε (a column vector of orthogonal shocks). The estimation method that I will use to obtain the coefficient estimates is the ordinary least squares (hereinafter OLS). Both, the model form and estimation procedure will be done as defined by Greene (2000). The vector of estimates itself is obtained by calculating the vector b with the expression in the equation (7.1).

$$Y = X\beta + \varepsilon \tag{7}$$

$$b = (X'X)^{-1} X'Y \tag{7.1}$$

The next functional form of the model will be a static panel data structure, which was as far as convergence purposes are concerned, already explored in economic literature such as Islam (1995), where panel data estimation of convergence yielded quite different results to just using pooled OLS structure. The functional forms for this static panel data structure are represented by equations (2) and (5) for absolute and conditional beta convergence respectively, and in equation (8) for a general panel data model. The OLS estimation would in the presence of country specific fixed or random effects yield biased and inconsistent results, so two main transformations are possible. The first one is the within transformation, which should be used if testing reveals the presence of fixed effects in the model. The corresponding equation is shown in the equation (8.1). If, on the other hand, testing indicates the presence of random effects, the corresponding transformation of the model is shown in the equation (8.2) where θ denotes a part of the time mean that will be deducted from each observation value. Both transformations and functional forms for static panel data model are taken from Greene (2000). Subscript i denotes a specific country and subscript t a specific time period. Country specific constant (fixed or random effects) are denoted as α_i.

$$y_{it} = \alpha_i + X_{it}'\beta + \varepsilon_{it} \tag{8}$$

$$(y_{it} - \overline{y}_i) = (X_{it} - \overline{X}_i)'\beta + (\varepsilon_{it} - \overline{\varepsilon}_i) \tag{8.1}$$

$$\left(y_{it} - \theta\overline{y}_i\right) = (1 - \theta)\alpha_i + (X_{it} - \theta\overline{X}_i)'\beta + (\varepsilon_{it} - \theta\overline{\varepsilon}_i) \tag{8.2}$$

The last functional form is the dynamic panel data with a lagged independent variable as part of the right hand side which is in general form represented in the equation (9) and in empirical forms (3) and (6) for absolute and conditional beta convergence respectively. The benefit of dynamic panel data is nicely explained in Greene (2000) and in Arellano and Bond (1991) where they state, that since dependent lagged variable enters the model as explanatory variable or better said an instrument where all the information about history is already included in this lag and therefore the effect of explanatory variables in time t is cleansed of all previous effects and includes only the current effect. Estimation will be done with Arellano-Bond GMM estimator as described in Arellano and Bond (1991) and not with any of the before mentioned estimators, since including a lagged value in the panel data model violates the strict exogeneity assumption and therefore those estimators would yield biased and inconsistent results. This method also provides an effective tool for getting rid of endogeneity problem. Which is a common problem with macroeconomic data.

$$y_{it}=\alpha_i+ X_{it}'\beta+y_{it-n}'\delta+ \varepsilon_{it} \tag{9}$$

Testing for disturbances in the model such as multicollinearity, heteroscedasticity and autocorrelation will be done as in Greene (2000) and Mills and Petterson (2009). Multicollinearity will be addressed with either omitting the variable with VIF factor higher than 10 or combining variables together. Heteroscedasticity, on the other hand will be dealt with model transformation when tests will reveal a definite form and with application of robust standard errors when a definitive form will not exist. For testing whether or not random effects are present in the model, I will use Breusch-Pagan LM test as defined in Breusch and Pagan (1979 and 1980). The test statistic will be calculated as in equation (10) which comes from Greene (2000). If LM exceeds the critical value from χ^2 distribution, an assumption can be made that the null hypothesis of variance of α_i being equal to zero does not hold and that random effects are indeed present in the model and therefore transformation (8.1) or (8.2) should be applied.

$$LM = \frac{nT}{2(T-1)}\left(\frac{\sum_{i=1}^{n}\left(\sum_{t=1}^{T} e_{it}\right)^2}{\sum_{i=1}^{n}\sum_{t=1}^{T} e_{it}^2} - 1\right)^2 \tag{10}$$

To determine if these effects are random or fixed I will use the Hausman test proposed in Hausman (1978). The null hypothesis of that test is that the covariance between α_i and x_{it} is equal to zero. The test operates under the fact that if a model has random effects present, then both transformations (8.1) and (8.2) will give consistent estimators, but (8.2) will be more efficient. If, however, the model has fixed effects present (the assumption here is that cov (α_i, x_{it}) is not equal to zero), then only (8.1) will be consistent. This is formally shown in Greene (2000). So the logic of the test is simple – if estimates β_{FE} which comes from performing OLS estimation on the transformed model in (8.1) are different enough from β_{RE} which comes from performing OLS estimation on the transformed model in (8.2), then the most consistent model is fixed effects model and within transformation from (8.1) should be used and vice versa. The statistic used for determining whether or not estimates are different enough to use within transformation is taken from Hausman (1978) and shown in the equation (11). If the value of W statistic exceeds the critical value from χ^2 distribution, an assumption can be made that the best and most consistent model is the fixed effects model.

$$W = (\beta_{FE} - \beta_{RE})'(Var(\beta_{FE}) - Var(\beta_{RE}))^{-1}(\beta_{FE} - \beta_{RE}) \quad (11)$$

As far as dynamic model specification tests go Arellano and Bond (1991) suggests that one should use Sargan-Hansen test for over-identifying restrictions and Arellano-Bond test for autocorrelation of order one and two. Sargan-Hansen test operates under the null hypothesis that over-identifying restrictions are valid in the model, so the desired result is actually not rejecting the null. Arellano-Bond tests for autocorrelation of order two is desired to not reject the null hypothesis of no presence of autocorrelation. Autocorrelation of first order is present in the model by construction. This model form and estimation process is extremely sensitive to the selection of number of lags and also to the selection of instruments used to counter the endogeneity problem. Modeling with this method should therefore be carefully constructed, so that all the tests mentioned show the desired model specification rather than the desired result.

2.4 Sigma convergence

Sigma convergence was in Barro and Sala-i-Martin (1991) defined as decreasing variation of dispersion in income levels. In his study, the standard deviation (hence the name sigma convergence) of logarithm of GDP per capita was used to determine whether or not countries converge in a sense of sigma. If the standard deviation of logarithm of GDP per capita is decreasing through time, then it can be claimed that sigma convergence exists. O'Neill and Kermn (2004) studied the sigma convergence with the addition of GINI coefficient – they note that sigma convergence is present when this coefficient is decreasing and thus lowering both income inequality within countries and dispersion in income levels between countries. Simionescu (2014) notes that coefficient of variation of logarithm of GDP per capita is also important and that it may show a more coherent indicator than just using the standard deviation.

When constructing a sample for sigma convergence, I noticed that by default, all of these methods remove the country specific dimension of the panel data and thus rendering it so that only time series structure is present. Since my data sample includes observations for the period from 1995 to 2017 (a complete data description can be found in chapter three), this means that only 23 possible observations remain. The bare minimum for any conclusive econometric modeling and testing of hypothesis is to at least have 30 observations so that the t distribution is well defined. The estimation can still be performed, but testing of coefficients is not so reliable. This is the reason as to why I will not attempt to model sigma convergence and will rather resort to the graphical method of analysis. In addition to un-weighted sample analysis, I will also use a weighting scheme, so that the importance of specific observation will be determined by the population share that a specific country has in the whole population of all 28 countries of EU. A similar weighting scheme was done in Simionescu (2014), where sigma convergence during 2000 and 2012 was found in EU 28, so I expect a similar result.

3 DATA DESCRIPTION

For the purpose of the empirical investigation in this thesis I gathered data on numerous economic, demographic and governance indicating variables for 28 countries currently part of the EU ranging in time from 1995 to 2017. This panel of data offers multiple possibilities for analysis, be it time series, panel data or cross sectional modeling forms. The data and its descriptive statistics will be represented in this chapter for the purpose of understanding the empirical testing and input data from chapter four, where absolute, conditional and beta convergence along with sigma convergence will be modeled. Every figure or table in this thesis is my own work which is based on the analysis of data in this chapter. Sources are Eurostat (2018), World Bank (2018), and IMF (2018) databases. Since this thesis is oriented more on the effect that indebtedness has on convergence, I will also present movement of debt to GDP ratio in chosen period for each country. The break in dynamics after 2008 is clearly seen in almost every country, proving that The Great Recession had a profound effect on disturbing both public and private finance structures.

3.1 Economic variables

Real GDP: this variable includes GDP measured at constant 2010 prices in millions of EUR. Real GDP growth rate was also calculated from this data and this will serve as a dependent variable when modeling conditional beta convergence in chapter four. The source for this data is Eurostat (2018) database. Data is available from 1995 to 2017.

Real GDP per capita: this variable includes GDP per capita measured at constant 2010 prices in EUR. Real GDP per capita growth rate was also calculated from this data and it will serve as an alternative dependent variable when modeling conditional beta convergence in chapter four. The source for this data is Eurostat (2018) database. Real GDP per capita will also be used as an explanatory variable measuring country development levels when testing the unconditional beta convergence. Data is available from 1995 to 2017.

GDP per capita gap to the European Union (EU28) average: this variable measures the GDP per capita gap that a certain country has, to the average of a set of countries that at the moment hold European membership. For instance, in 2004 the EU did not contain 28 countries but the average GDP per capita is still calculated for all 28 countries. Gap is measured in EUR. Values were calculated from real GDP per capita data from Eurostat (2018) database. Data include entries for all 28 EU countries from 1995 to 2017.

Public debt to GDP: public debt to GDP ratio expressed as percentage of public debt to GDP will be used as one of indicators of indebtedness in modeling beta convergence in chapter four. Data is expressed in percent for all 28 EU countries from 1995 to 2017. The data is combined from Eurostat database and World Bank (2018) database.

Private debt to GDP: private debt to GDP ratio expressed as percentage of private debt to GDP will be used as one of indicators of indebtedness in modeling beta convergence in chapter four. Data is expressed in percent for all 28 EU countries from 1995 to 2017. The data is from the Eurostat (2018) database. Together with public debt to GDP, this indicator will serve to calculate the derivative indebtedness indicator total debt to GDP.

Foreign direct investments net inflows: this variable measures FDI net inflows measured in 2010 prices. Data for this variable is gathered from the World Bank (2018) dataset and is measured in millions of United States dollars. Data was collected for all available years from 1995 to 2017 and for all 28 EU countries.

Inflation: this variable includes values for inflation for all 28 EU countries from 1995 to 2017 based on the consumer price index (HICP). Data is gathered in percent. Source for this data is the Eurostat (2018) and IMF (2018) database. The data in this variable will mostly be used for transformation of other variables into 2010 constant prices.

Import and export: these two variables represent the imports and exports of goods and services measured in millions of EUR and in constant 2010 prices. This variable will serve to calculate the measure of trade openness as a share of GDP calculated as (Import+Export)/Real GDP and trade openness per capita calculated as (Import+Export)/population. Source of the data is the Eurostat (2018) database and includes entries for all 28 EU countries from 1995 to 2017.

Gross fixed capital formation: this variable measures annual gross investment in constant 2010 prices. The data for all 28 EU countries from 1995 to 2017 is gathered from Eurostat (2018) and is in millions of EUR. Gross fixed capital formation per capita will also be calculated from this data and it will also serve as a proxy for development of a certain country in a given year.

Nominal productivity per hour worked as a percentage of EU 28: this variable serves as a proxy for labor pool characteristics. Data is expressed in percent and gathered for all 28 EU countries from 1995 to 2017. The source is the Eurostat (2018) database.

Research and development to GDP: this variable partially measures, how high the predisposition for investing in high technology in a given country is. Data is represented from 1995 to 2017 for all 28 EU countries. The source of the data is the World Development Indicators database from World Bank (2018).

Gross savings to GDP: this variable measures the national gross savings rate expressed as a percentage of GDP. This variable is in neoclassical models present for controlling the steady state of the economy. Data is represented from 1995 to 2017 for all 28 EU countries.

The source of the data is the combination of the World Development Indicators database form World Bank (2018) and Eurostat (2018) database.

Unemployment: data on unemployment was gathered from Eurostat (2018) and the classification used was that of International Labor Organization. Entries are presented as percent of the total labor force and range from 1995 to 2017 for all 28 EU countries.

3.2 Demographic variables

Population growth rate: data on population growth was calculated from population numbers represented in World Bank (2018) database. Growth rate was calculated for all 28 EU countries from 1995 to 2017 and is presented as percent. Population growth rate was in neoclassical models usually used as one of steady state determining variables.

Table 1: Summary statistics for economic and demographic variables dataset

Variable	N	Mean	Std. dev.	Min	Max
Real GDP (millions of Eur)	638	437558.60	664876.70	5391.60	2918822.00
Real GDP growth rate (%)	610	2.63	3.47	-15.00	26.00
Real GDP pc (Eur)	631	23130.74	15302.44	2800.00	84400.00
Real GDP pc growth rate (%)	603	2.41	3.58	-14.60	24.80
Real GDP pc gap to EU28 (Eur)	631	-1329.95	15152.87	-21400.00	58200.00
FDI net inflows (millions of US dollars)	628	21900.00	54100.00	-31100.00	734000.00
Inflation (%)	639	5.44	38.80	-9.68	958.50
Imports (millions of Eur)	644	148940.60	208561.30	1626.20	1294306.00
Exports (millions of Eur	644	156026.60	226483.40	1430.00	1541471.00
Trade openness (% of Real GDP)	638	99.87	65.28	19.11	480.93
Gross fixed capital formation (millions of Eur)	638	90361.37	133825.70	825.20	591208.40
Government expenditures to GDP (%)	638	44.80	6.68	26.10	65.10
Gross savings to GDP (%)	638	21.67	5.45	4.87	39.84
Public debt to GDP (%)	632	55.82	32.68	3.70	180.80
Private debt to GDP (%)	613	124.18	70.23	10.00	354.90
Nominal productivity (ratio from EU28 average)	624	90.81	37.39	21.90	192.00
Research and development to real GDP (%)	580	1.40	0.85	0.20	3.91
Unemployment (%)	600	8.94	4.26	1.90	27.50
Population growth (%)	644	0.16	0.88	-4.00	3.00

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 1 shows the basic descriptive statistics for the variables mentioned above. These variables represent economic and demographic aspects of the data used in addition to World Governance Indicators found in chapter 3.3. Empirical testing for conditional beta convergence will be done using this data. Data was gathered for all 28 countries that currently hold membership in the EU and for a time span from 1995 to 2017. There are also some missing values since not all values for all variables could be obtained for each and every year and every country. Number of observations column in part shows this problem which was partially taken care by gathering data from multiple sources. Another problem of gathering the data from multiple sources is the possible measurement error and different methodology across sources. While acknowledging this issue, it should also be noted that measurement error, if present, can lead to biased estimates in empirical modeling and testing. Since a certain excluded variable bias would, at least in this case, by far exceed the only possible measurement error bias, I decided to still include data from different sources and combine it to minimize the omitted variable bias as much as I am able to. Additionally there is a certain coherence in standards of obtaining the data inside the EU, but since not all countries were included in the EU for the whole period from 1995 to 2017, I decided to acknowledge this possibility.

3.3 World Governance Indicators

In addition to economic and demographic variables, I also collected data on governance indicators. Acemoglu (2008) describes institutional differences as one of four major debt determinants and I will use governance indicators as a proxy for the quality of institutional environment. Source for all the data used for World Governance Indicators and additional indicators derived from them, is the World Bank (2017) database on World Governance Indicators. These indicators are based on 30 different sources from public sector statistics to private sector surveys.

Voice and accountability: this indicator reflects the perception of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of press and expression. It is a proxy for democratic quality. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance meaning higher democratic quality. The indicator is based on combining and weighting multiple indicators.

Political stability and absence of violence or terrorism: this indicator reflects the perception of the likelihood of political instability and politically motivated violence, such as violent protests and terrorism. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance, which translates to higher stability and lower presence of violence or terrorism. The indicator is based on combining and weighting multiple indicators.

Government effectiveness: this indicator reflects the perception of the quality of the civil service and the degree of its independence from political pressures. Besides that, it measures the quality of policy formulation and the perception of government credibility to implement such policies. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance, which signals higher perception of government effectiveness. The indicator is based on combining and weighting multiple indicators.

Regulatory quality: this indicator reflects the perception of government ability to develop and implement policies that soundly regulate and at the same time promote private sector development. It measures the quality of regulative legislation as a whole. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance, which means better regulatory quality and at the same time less restrictive environment for companies to thrive in. The indicator is based on combining and weighting multiple indicators.

Rule of law: this indicator reflects the perception of belief in legal system as a whole. This includes the extent to which agents abide the rules of society, be it quality of contract enforcement, property rights, court operations and similar legislative efforts. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance, which signals a sound legal system. The indicator is based on combining and weighting multiple indicators.

Control of corruption: this indicator reflects the perception of government success in preventing corruption in both private and public sectors. Data covers 28 countries in the period from 1996 to 2016. The indicator ranges from -2.5 to 2.5, with a higher value representing better governance performance, which signals better government control of corruption and prevention of spreading the corruption. The indicator is based on combining and weighting multiple indicators.

Combined governance indicator: thus far all indicators come from the World Governance Indicators database of the World Bank. For modeling purposes it should be noted that all of them are correlated with each other, with correlation coefficients ranging from 0.55 to 0.95. Coefficients are positive and all have statistically significant values at negligible levels as shown in Table 3. This can cause multicollinearity problems in empirical models, so I decided to combine all 6 indicators into a combined governance indicator, which will serve as a proxy for governance quality as a whole. Combined governance indicator is obtained by summing all 6 indicators for each country in each year and then dividing it with 6, thus calculating the average of all indicators. The approach is simple and might not be fully representative, but it will nevertheless help to remove at least a portion of excluded variable bias that is at least in part present in every econometric model in existence today. This composite indicator will be used in modeling convergence in chapter four. Table 2 shows the summary statistics for World Governance Indicators in 28 countries which are currently part of the EU with data ranging from 1996 to 2016. Also added are the combined governance indicator statistics where the striking similarity can be observed even in aggregate terms between indicators.

Table 3 shows the correlation matrix for the World Governance Indicators in 28 countries currently part of the EU with data ranging from 1996 to 2016. It can be seen that all are moderately to highly positively correlated with a negligible p value, indicating the need for combined governance indicator shown in Table 2. For instance the estimate for rule of law (higher is better) is correlated with government efficiency (higher is better) with a coefficient of 0.9387. Rule of law and control of corruption are also very highly and positively correlated with a coefficient of 0.9488.

Table 2: Summary statistics for World Governance Indicators in the European Union

Indicator	Mean	Std.dev.	Min	Max
Voice and accountability	1.12	0.34	-0.29	1.80
Political stability	0.81	0.43	-0.47	1.76
Government effectiveness	1.15	0.64	-0.57	2.35
Regulatory quality	1.19	0.45	-0.18	2.10
Rule of law	1.12	0.63	-0.63	2.10
Control of corruption	1.04	0.80	-0.62	2.47
Combined governance indicator	1.07	0.51	-0.25	1.97

Source: own work based on data from World Bank (2017)

Table 3: Correlation matrix for World Governance Indicators in the European Union

	Voice and accountability	Political stability	Government effectiveness	Regulator quality	Rule of law	Control of corruption
Voice and accountability	1.0000					
Political stability	0.6149 (0.000)	1.0000				
Government effectiveness	0.8978 (0.000)	0.5772 (0.000)	1.0000			
Regulatory quality	0.8730 (0.000)	0.5516 (0.000)	0.8697 (0.000)	1.0000		
Rule of law	0.9333 (0.000)	0.5966 (0.000)	0.9387 (0.000)	0.9020 (0.000)	1.0000	
Control of corruption	0.9130 (0.000)	0.5610 (0.000)	0.9459 (0.000)	0.8862 (0.000)	0.9488 (0.000)	1.0000

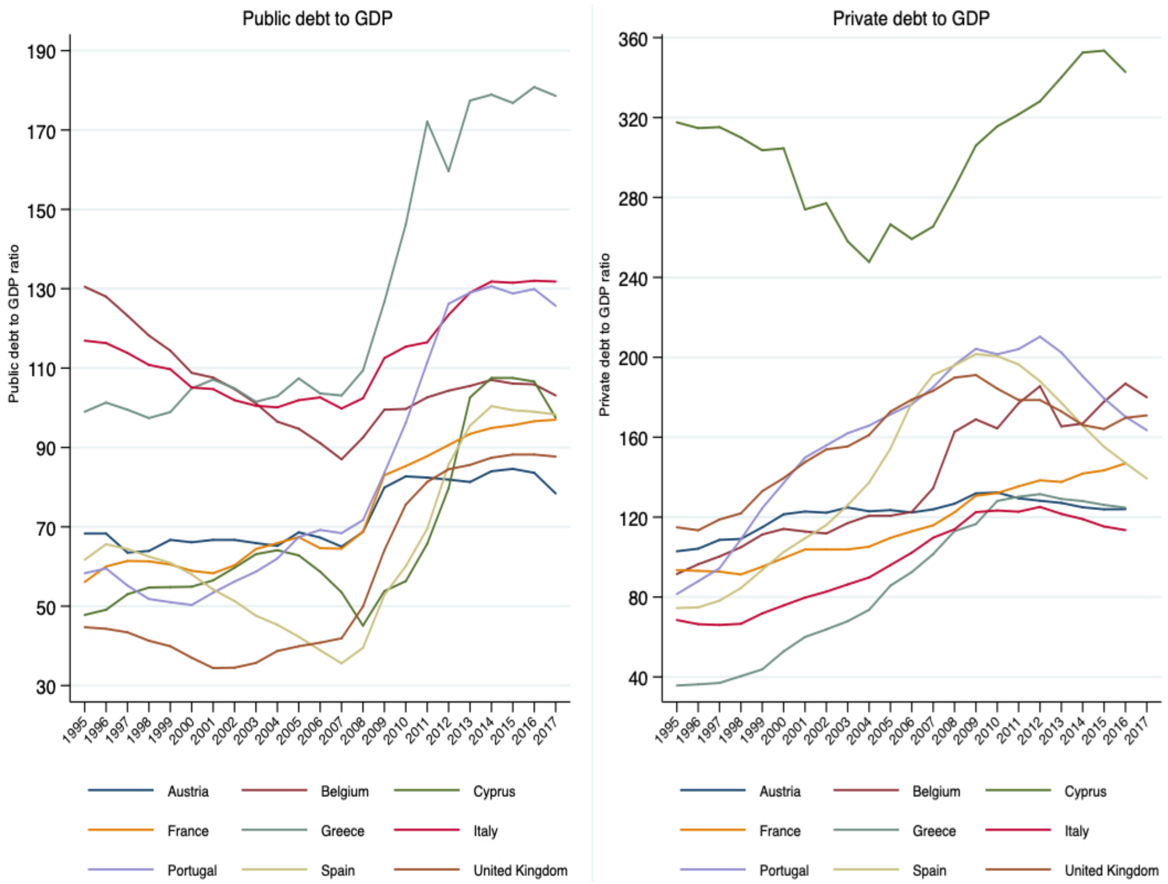
Note: significance values in parenthesis

Source: own work based on data from World Bank (2017)

3.4 Overview of public indebtedness in the European Union

The Great Recession although being a very difficult process offered a wonderful opportunity to study the public debt movement since volatility increased quite a bit following 2007. After 2009, the private sector got into a credit crunch since banks became very conservative in their decisions to lend money. Firm value decreased quite significantly on the level of corporate sector and the probability of bankruptcy increased significantly. This is a very important notion and a reason why also private along with public indebtedness should be considered in growth accounting exercises. For the purpose of better understanding the situation and movements in public and private debt to GDP through the years of selected sample, I now offer an overview of that movement before an investigation of relationship of debt in accordance to economic growth will begin. I divided countries into three groups with respect to public debt to GDP ratio that they had in 2017. Figure 1, Figure 2 and Figure 3 present this analysis for countries in upper, middle and lower brackets of public debt to GDP in 2017.

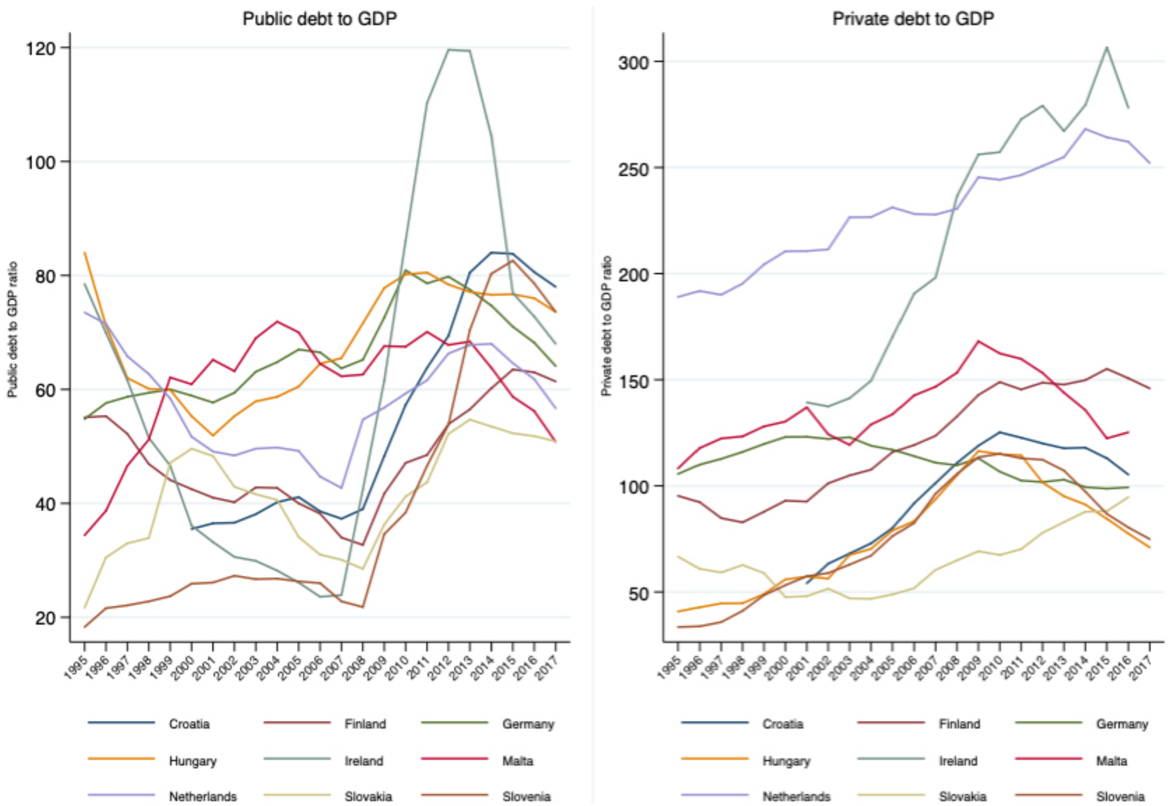
Figure 1: Public and private debt to GDP ratio from 1995 to 2017. Countries with high public debt to GDP ratio in 2017



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 1 presents the trend of movement for both public and private debt to GDP ratio from 1995 to 2017. The countries that are represented in this figure are chosen because their public debt to GDP ratios in 2017 belonged to the upper third in the EU. The graph on the left shows the movement of public debt to GDP ratios. As expected, Portugal, Italy, Greece and Spain appear in this group. It can be observed that after 2008 ratios grew quite considerably. For instance Cyprus more than doubled the ratio of public indebtedness in just 5 years following 2008. From approximately 2013 onwards, the public debt to GDP ratios stabilized and after 2015, a trend of decrease followed in a few countries. The graph on the right side of Figure 1 shows the movement of private debt to GDP ratios in the same country selection set. A very interesting dynamics occur in every country except Cyprus and France – the ratios were rising up until approximately 2009 and after that the private credit crunch is nicely visible, since the ratios started to fall. During crisis, the shortage of private debt got replaced by public debt. As far as private indebtedness goes, Cyprus leads quite significantly. Their private debt to GDP ratios were in the period from 1995 to 2017 between 245 and 355 percent. Interestingly enough, there is no credit crunch clearly visible in the data for Cyprus and France since they exhibited increasing private debt to GDP ratios from 2008 on, while the ratio in France is increasing for the whole period from 1995 to 2017.

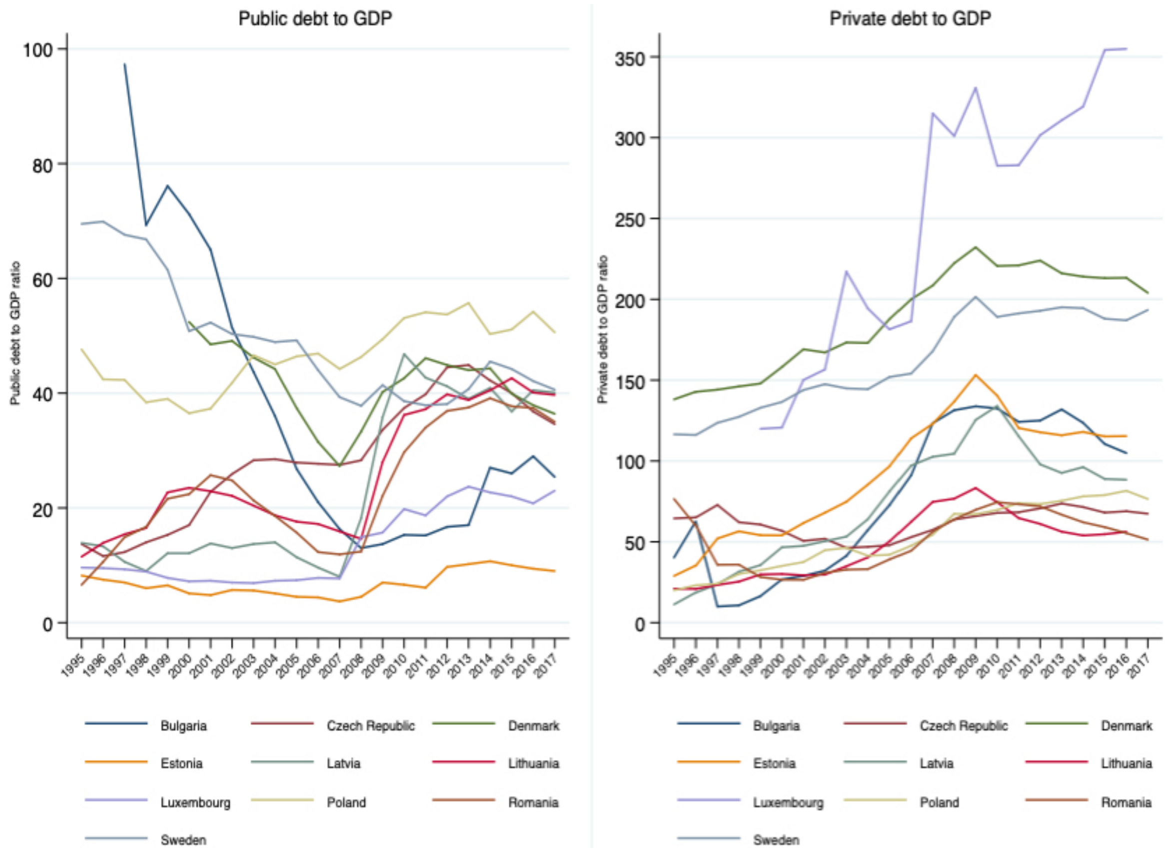
Figure 2: Public and private debt to GDP ratio from 1995 to 2017. Countries with medium public debt to GDP ratio in 2017



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 2 presents the trend of movement for both public and private debt to GDP ratio from 1995 to 2017. The countries that are represented in this figure are chosen because their public debt to GDP ratios in 2017 belonged to the middle third in the EU. The graph on the left hand side shows the movement of public debt to GDP ratios and the movements, although still mainly following the increase of public debt to GDP ratios after 2008, are not so coherent anymore. Malta for instance seems not to be affected by crisis nearly as much as Croatia, Slovenia, Ireland and Finland. Mentioned countries follow the trends also seen in Figure 1. The interesting part is, that countries in this group seem to have more volatile movements of public debt to GDP – Slovenia for example increased the public debt to GDP ratio by almost a factor of a four in just 6 years following 2008, and in the same period Ireland increased it by almost a factor of five. Ireland for example first had a major banking crisis which was followed by an increase of public debt in order to help the banking sector survive. There are number of reasons behind the indebtedness movement for each country, but the movement of ratios as a whole, rather that the analysis of causes is the primary interest of this thesis. After 2013, in most countries a relatively fast (compared to Figure 1) reduction of public debt to GDP followed. On the right hand side, the graph shows the private debt to GDP ratios for the same countries. Credit crunch after 2009 is much more distinct in this country set, than that showed in Figure 1. On average, the lack of private credit supply was again compensated with increasing public debt.

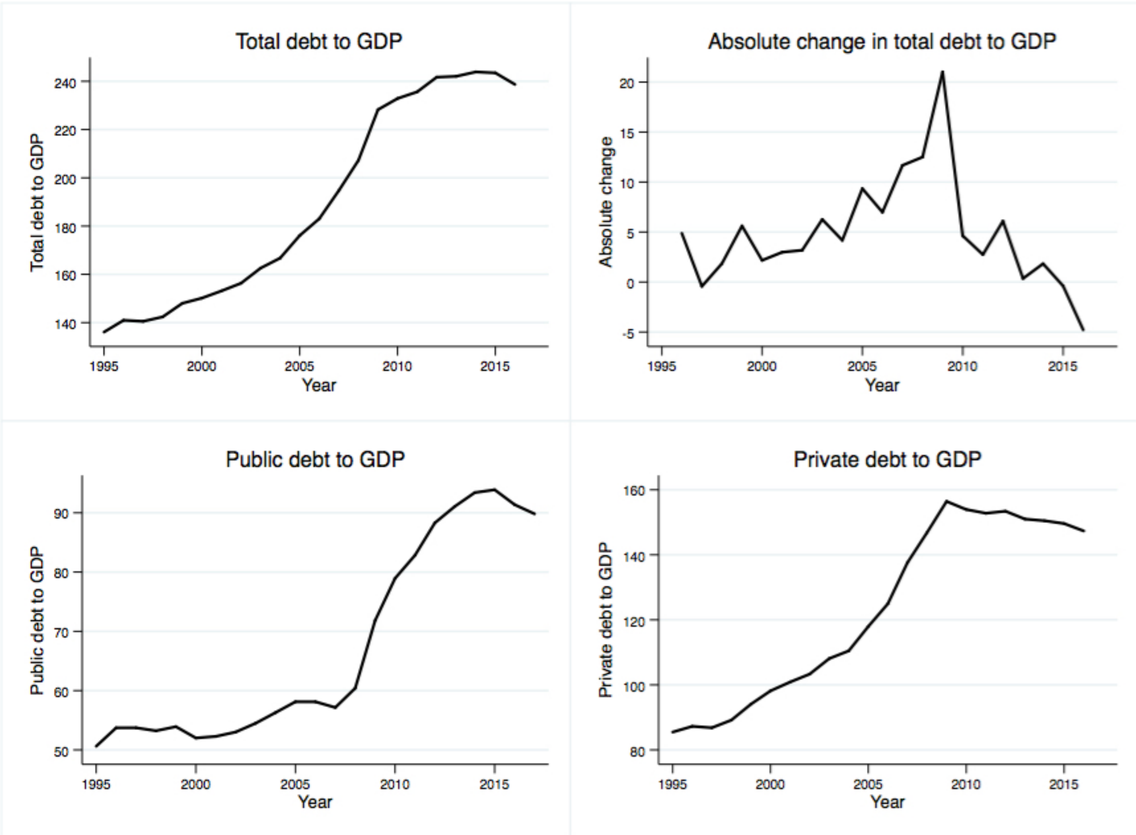
Figure 3: Public and private debt to GDP ratio from 1995 to 2017. Countries with low public debt to GDP ratio in 2017



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 3 presents the trend of movement for both public and private debt to GDP ratio from 1995 to 2017. The countries that are represented in this figure are chosen because their public debt to GDP ratios in 2017 belonged to the lower third in the EU. The graph on the left shows the movement of public debt to GDP ratios. Public debt to GDP ratios were in these countries relatively low even after 2008 and the stabilization of dynamics mainly followed after 2011. The ratios were rising very fast only during 2008 to 2011. Bulgaria seems like a special case since with respect to public debt to GDP, the crisis only stopped the decreasing trend and an increase followed only after 2013. Estonia is, in the whole period, the country with lowest public debt to GDP and the crisis did not change their dynamics significantly at all. They do ,however, experience the “normal” movement of private debt to GDP ratios. The graph on the right hand side shows the movements of private debt to GDP ratios. Countries in this group (with the exception of Luxembourg) have very similar movements, with the credit crunch again clearly visible after 2009. From Figure 1, Figure 2 and Figure 3 a clear trend appears. First, the public debt to GDP started to sharply rise after 2008 and private credit crunch followed after 2009. The movements of aggregated EU indebtedness is further shown in Figure 4 for combined total debt to GDP ratios, absolute change in total debt to GDP and also public and private debt to GDP ratios.

Figure 4: Public, private and total debt to GDP movement from 1995 to 2017 in the European Union



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 4 shows the debt to GDP movement analysis in aggregate form for the whole EU. Ratios were obtained from GDP data and indebtedness data, that were both in millions of EUR in constant 2010 prices. Graphs show the movement of combined total and private debt to GDP in aggregate terms for all 28 countries that at the moment form the EU. Total debt is here seen to rise during almost the whole period with the exception being 2015 forward. The most severe absolute change in percentages of total debt to GDP was present from 2007 till 2011, when absolute yearly changes ranged from 7 to 22 percentage points. Lower portion of Figure 4 shows the movements in public and private debt to GDP separated. A fast increase is clearly observed in public debt after 2007 and a decline started only after 2014. This was mainly a consequence of extra resources needed to mitigate the problems that financial sector caused, which then led to the Great Recession. A credit crunch is also nicely seen in private debt to GDP movement since it started to fall after 2008 and before 2008 it was increasing from 1995 onwards. The pre-crisis increase in private indebtedness is mainly a consequence of resources being abundant, followed by loose overall lending conditions. Private debt to GDP ratio is still falling currently.

4 EMPIRICAL ANALYSIS

In this chapter, I present the empirical analysis of the relationships between both public and private indebtedness and growth along with the effect that indebtedness has on convergence. First, I investigate the effect that public debt potentially has on growth in both linear and non-linear form and then repeat this for private debt. My analysis confirms mainly linear relationships, with a very weak possibility of non-linear relations also existing. I proceed with graphical analysis of absolute convergence, where I find out that the Great Recession had a major effect on convergence, but that convergence nevertheless exists on the level of the EU. Absolute and conditional beta convergence are also tested and I come to the same conclusion – convergence process exists in both forms but is not affected by indebtedness. There is some small evidence of quadratic relationship between public and private debt and growth, but it is very similar in approximation to linear one and could be the consequence of the methodology used, therefore I still claim that the correct relationship estimates are linear. Lastly, I investigate sigma convergence where findings point to a more ambiguous process.

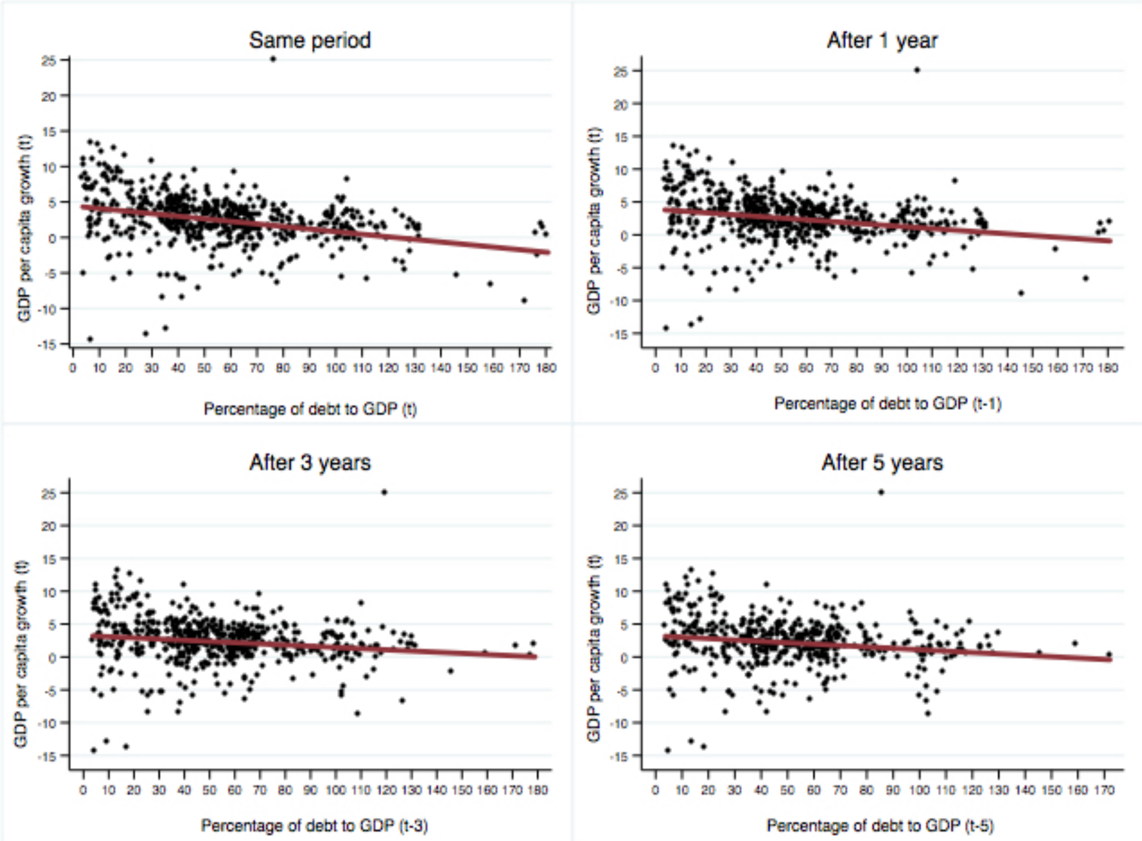
4.1 Indebtedness and growth

Relationship between debt and growth is an ambiguous one since there are a number of studies disagreeing on the direction of causality. Here, I try to offer a statistical approach of determining and quantifying the relationship between them.

4.1.1 Connection between public indebtedness and growth in the European Union

Similarly to Pescatori, Sandri and Simon (2014), I examine public debt in relation to GDP per capita growth in multiple periods, with lags added to study the possible delayed effects. In addition, the claim of 90 percent threshold is here tested graphically and econometrically. My findings differ greatly from Baum, Checherita and Rother (2010) and Checherita and Rother (2010), since I was not able to confirm any quadratic relationship with a negative leading coefficient between public debt to GDP and growth when modeling. Neither was I able to confirm any non-linearities of non-quadratic form when testing with interaction indicator variables for debt. My findings are instead in line with Eberhardt and Presbitero (2015), who have not been able to find any thresholds for specific countries, let alone a common threshold for all. Kumar and Woo (2010) also tried a similar approach for modeling non-linearities in the relationship and they also did not find existence of any, apart from their advanced countries sample. My data, however, differs significantly from theirs since passing of almost a decade from their papers enabled me to include at least additional 7 years of data, when both, crisis and post-crisis period were added. What is also different in my analysis is the country selection. I must stress that I am in no way trying to disprove any of these studies and only claim, that their relationships do not seem to hold on different data in later periods and that post-crisis dynamics may differ greatly from pre-crisis ones. After the analysis of the relationship between public debt and growth, I also focus on the analysis of private and total debt to GDP and their effect on growth both graphically and parametrically.

Figure 5: Relationship between percentage of public debt to GDP and growth rates



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 5 shows the relationship between percentage of public debt to GDP and growth rate in 4 different time horizons. The upper left graph named "Same period" shows the observations for all EU countries (28 countries) for their respective debt to GDP ratios and growth rates in the same year. As can be expected, there is a negative relationship between debt to GDP and growth rate, which means that countries with more debt grow slower, as was already documented numerous times. Reinhart and Rogoff (2010) claim the 90 percent of debt to GDP should present a break in the linearity, but that is obviously not the case for the EU since no break can be observed and data appears to be linear even after crossing the 90 percent threshold. As Pescatori, Sandri and Simon (2014) noted when performing the analysis on IMF's Fiscal Affairs Department dataset, the volatility in output should increase with higher debt, but the same can hardly be said when the EU dataset is used. It almost appears that volatility in growth rate of GDP per capita decreases when nearing the 90 percent limit and starts to increase again only after exceeding this threshold. However, no major conclusions can be drawn from this, since my data sample does not include a lot of observations around 90 percent of debt to GDP and beyond. Another method already used in Pescatori, Sandri and Simon (2014) was to look at the lagged relationship between debt to GDP percentage and growth, since debt may have a lagged effect on growth. This relationship of debt to GDP percentage in period t-1 and growth rate of GDP per capita in period t is shown in the graph "After 1 year". No break can be observed and neither can the increase in volatility be spotted. One could almost claim, that even if the relationship is linear and negative in nature, a decrease in volatility of growth rate follows after increasing the debt level. The relationship when debt to GDP percentage is observed in year t-3 and growth rate of GDP per capita is observed in year t is shown in the graph "After 3 years". The relationship when debt to GDP percentage is observed in year t-5 and growth rate of GDP per capita is observed in year t is shown in the graph "After 5 years". An important insight from comparing the lagged relationship between the public debt ratio and GDP growth is the fact, that the slope of the linear approximation of the relationship is getting more level as growth and debt are observed further apart in time and that is, that the negative effect of debt on growth diminishes as the time progresses. A conclusion can also be drawn regarding volatility of growth rates since volatility seems to decrease with increasing debt to GDP percentage and the relationship still seems to be negative and linear and not at all conditional on the lag between the observations.

Table 4: Summary statistics for the European Union per capita GDP growth

Percentage of public debt to GDP	N	Mean GDP pc growth	Median GDP pc growth	Std. dev.	Min	Max
less that 30 percent	125	4.23	4.41	4.50	-14.60	13.30
30 to 60 percent	226	2.50	2.83	3.12	-13.00	10.70
60 to 90 percent	148	1.68	1.61	3.14	-6.50	24.80
90 to 120 percent	71	1.37	1.44	2.21	-6.00	8.00
over 120 percent	31	0.22	1.40	3.95	-9.00	9.50

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 4 presents the summary statistics for EU member states. It includes the mean of GDP per capita growth and standard deviation. From the data presented the negative relationship between percentage of debt to GDP and average growth rate of per capita GDP is clear, but it does not clearly break the linearity at neither 90 percent nor the 120 percent threshold. What is very interesting is the reduction in volatility up to 120 percent threshold and then an increase again only after 120 percent of debt to GDP.

To further confirm that there is indeed no thresholds present in the case of EU, I constructed a simple model with which non-linearities are tested in a form of interaction indicator variables. Equations (12), (13) and (14) represent the pooled OLS model, static panel data model and dynamic panel data model respectively. Besides lnGDPpc (logarithm of GDP per capita) and PDEBT (public debt to GDP ratios), also additional interaction indicator variables (D_1PDEBT – D_4PDEBT) are present. These variables hold the value of public debt to GDP ratios if the value is within certain brackets and 0 otherwise. For instance, D_1PDEBT holds only values for public debt to GDP ratios when these ratios are between 30 and 60 percent of public debt to GDP and the value 0 when they are outside of that range. The same goes for D_2PDEBT, D_3PDEBT and D_4PDEBT where the corresponding public indebtedness brackets are 60 to 90 percent, 90 to 120 percent and over 120 percent respectively.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 D_1 PDEBT_{it} + \beta_5 D_2 PDEBT_{it} + \beta_6 D_3 PDEBT_{it} + \beta_7 D_4 PDEBT_{it} + \varepsilon_{it} \quad (12)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 D_1 PDEBT_{it} + \beta_5 D_2 PDEBT_{it} + \beta_6 D_3 PDEBT_{it} + \beta_7 D_4 PDEBT_{it} + \varepsilon_{it} \quad (13)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 D_1 PDEBT_{it} + \beta_5 D_2 PDEBT_{it} + \beta_6 D_3 PDEBT_{it} + \beta_7 D_4 PDEBT_{it} + \beta_8 GROWTH_{it-1} + \beta_9 GROWTH_{it-2} + \varepsilon_{it} \quad (14)$$

where it holds that:

Indicator variable $D_1 = 1$ if public debt to GDP is between 30 and 60 percent and 0 otherwise
Indicator variable $D_2 = 1$ if public debt to GDP is between 60 and 90 percent and 0 otherwise
Indicator variable $D_3 = 1$ if public debt to GDP is between 90 and 120 percent and 0 otherwise
Indicator variable $D_4 = 1$ if public debt to GDP is over 120 percent and 0 otherwise

These model forms enable me to test any non-linearities in coefficients since the correct coefficient estimate for PDEBT is actually not always β_3 but instead ($\beta_3+\beta_4$) when public debt to GDP ratio falls into 30 to 60 percent bracket, ($\beta_3+\beta_5$) when it falls into 60 to 90 percent bracket, ($\beta_3+\beta_6$) when it falls into 90 to 120 percent bracket and ($\beta_3+\beta_7$) when it falls into over 120 percent bracket. For any non-linearities to exist between public indebtedness and growth, at least one of the coefficients from β_4 to β_7 must be statistically significant and different from zero in value. To claim with certainty that downward non-linearities exist, I believe that those coefficients should be statistically significant and negative in value in all three model forms and additionally it should also hold that $|\beta_4| < |\beta_5| < |\beta_6| < |\beta_7|$. This increase in absolute value of coefficient estimates would imply the increasing negative sensitivity of growth with respect to public debt to GDP. If β_4 to β_7 coefficients would be positive and statistically significant, the upward non-linearity would be implied, meaning, that the increase in public debt to GDP ratio associates with lesser reduction of growth when ratios are getting higher. In this case it should also hold that $\beta_4 < \beta_5 < \beta_6 < \beta_7$. For the threshold theory of Reinhart and Rogoff (2010) to hold, at least the coefficient estimate for β_6 (which represents the 90 to 120 percent of public debt to GDP) should have a negative and statistically significant result.

It is important to understand that these indicator variables and their corresponding coefficient estimates do not interpret together with an intercept as it is usually the case. I am therefore not testing if growth is lower in countries with higher public debt to GDP with these indicator variables – this effect will be captured in coefficient estimate β_3.which corresponds to a linear relationship between public debt to GDP ratio. The value of the coefficient estimate has to be negative and statistically significant in order to claim a negative relationship between public debt to GDP and growth rates in the same period.

Table 5: Testing of non-linearity between growth and public debt to GDP

	Pooled OLS			RE estimator			AB estimator		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
GROWTH (t-1)							0.32	0.015 (0.106)	0.000 (0.003)
GROWTH (t-2)							-0.32	0.011 (0.093)	0.000 (0.001)
lnGDPpc	-1.17	0.200 (0.209)	0.000 (0.000)	-1.19	0.250 (0.231)	0.000 (0.000)	0.27	0.877 (2.286)	0.761 (0.907)
PDEBT	-0.08	0.027 (0.031)	0.005 (0.013)	-0.08	0.029 (0.035)	0.005 (0.020)	-0.21	0.018 (0.076)	0.000 (0.005)
D_1PDEBT (30-60)	0.02	0.019 (0.021)	0.291 (0.324)	0.02	0.020 (0.023)	0.278 (0.335)	0.02	0.014 (0.052)	0.194 (0.730)
D_2PDEBT (60-90)	0.03	0.022 (0.024)	0.144 (0.176)	0.03	0.023 (0.026)	0.129 (0.183)	0.04	0.017 (0.058)	0.013 (0.458)
D_3PDEBT (90-120)	0.05	0.023 (0.026)	0.057 (0.082)	0.05	0.025 (0.029)	0.051 (0.096)	0.07	0.016 (0.065)	0.000 (0.268)
D_4PDEBT (>120)	0.04	0.025 (0.028)	0.135 (0.176)	0.04	0.026 (0.031)	0.115 (0.183)	0.08	0.019 (0.066)	0.000 (0.244)
Intercept	16.61	1.967 (2.152)	0.000 (0.000)	16.91	2.439 (2.512)	0.000 (0.000)	9.53	8.78 (22.29)	0.277 (0.669)
Note: robust standard errors and significance values in parenthesis									
N		595			595			515	
R^2 overall		0.1727			0.1727				
R^2 within					0.0645				
R^2between					0.7109				
F		20.46							
χ^2					90.03			87.53	

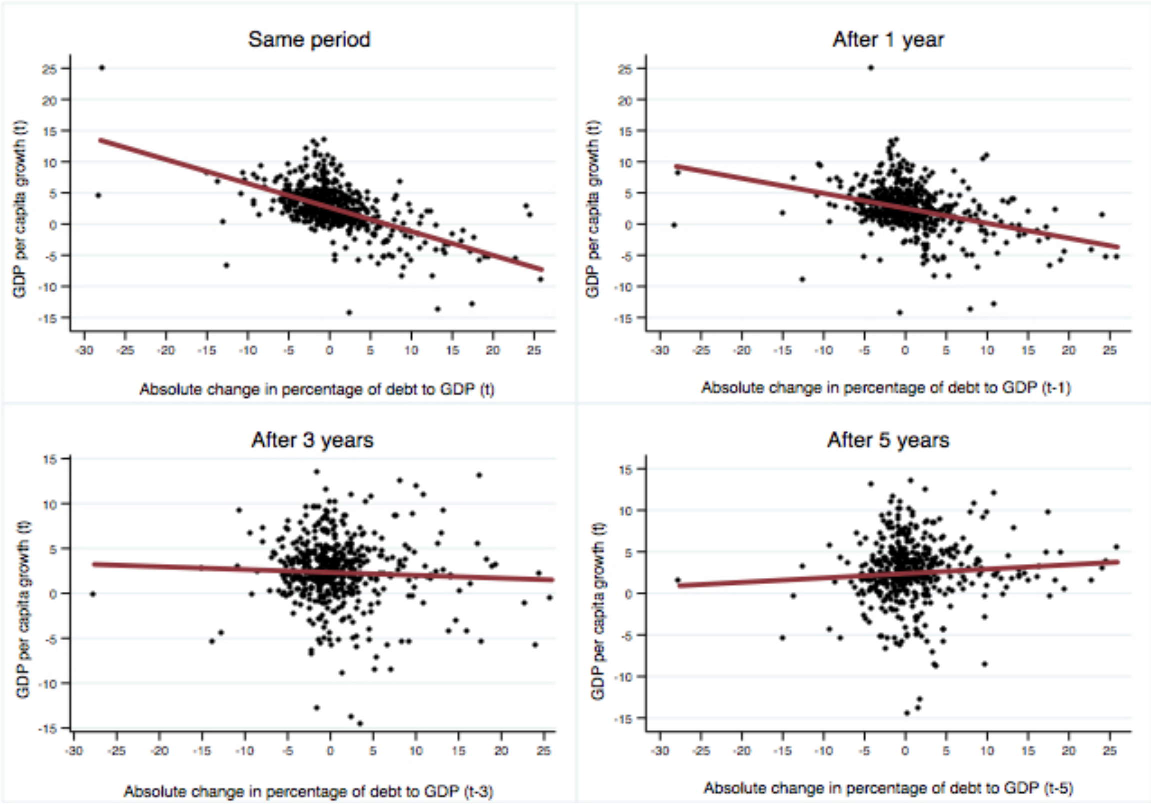
Breusch - Pagan random effects test	χ^2	1.69	*p*	0.097
Hausman test (FE, RE)	χ^2	2.85	*p*	0.828
Sargan test	χ^2	26.32	*p*	0.991
AB test for autocorrelation order 1	z	-2.99	*p*	0.003
AB test for autocorrelation order 2	z	-0.97	*p*	0.923

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 5 shows the assumption of nonlinearity tested econometrically, where estimates shown in pooled OLS, random effects (RE) and Arellano-Bond (AB) estimators correspond to model forms (12), (13) and (14) respectively. The first two variables, GROWTH (t-1) and GROWTH (t-2) denote growth of GDP per capita in lagged periods and are only used in dynamic model in equation (14). The logarithm of GDP per capita denoted as lnGDPpc exists in this regression just for controlling the initial wealth level which would, if excluded, bring a possibly vast bias to estimates. The coefficient estimate for β_2 can actually be interpreted as conditional convergence, which is negative and statistically significant in pooled OLS and random effects models and statistically insignificant in a model estimated with Arellano-Bond estimator. This would imply, that when public debt ratio is added as a control variable, the convergence still exists, but since a comprehensive conditional convergence testing will follow in chapter four, I shall not put too much importance on this result. It can nevertheless serve as a robustness check. As a note to all further models in this thesis, I should add that growth seems to be a highly autoregressive process when dynamic model is considered and therefore estimates for convergence are very hard to prove in these models and are not as informative as static model estimates. This however does not mean that the convergence does not exist if dynamic model shows no sign of it. I also tested the linear effect of higher public debt to GDP on growth of GDP per capita and a familiar result emerged. Raising public debt to GDP (PDEBT) by 1 percentage point is on average and all else held constant associated with a decrease of growth by 0.08 percentage points in pooled OLS regression, by 0.08 percentage points in random effects regression and by 0.21 percentage points in a regression estimated with Arellano Bond estimator. Coefficients are negative and statistically significant in all three model forms, which confirms negative but linear relationship that was also proved graphically in Figure 5. The non-linear effects of high debt to GDP ratios are also tested and coefficients for all interaction variables (D_1PDEBT – D_4PDEBT) remain statistically insignificant, which is the exact opposite of findings in Reinhart and Rogoff (2010). The estimates on PDEBT are actually quite high if I compare them to those of Kumar and Woo (2010) which range from 0.02 to 0.03, but a sample is different, both in country selection and in period. Specifically the Great Recession brought very low and even negative growth rates accompanied with very high debt accumulation, so naturally the coefficients are expected to be much higher.

Additionally, Table 5 also shows all model specification tests which reveal that the most consistent, unbiased and efficient estimator for static model actually remains the simplest model form found in pooled OLS and equation (12). The p value from Breusch-Pagan test for presence of random effects, although above 0.05 threshold, is still not high enough to completely remove any sensible doubt of such country specific effects present. Therefore, I still reported the estimates for panel data model in Table 5, just to be on the safe side. Hausman test leaned in favor of random over fixed effects estimation procedure, since the p value of 0.828 exceeds the threshold of 0.05. Additionally, because of the possibility of GDP per capita growth being an autoregressive process, dynamic panel data was also considered. Sargan test of overidentifying restrictions is within the desired range, since the p value of 0.991 very comfortably exceeds the 0.05 threshold. Same goes for Arellano-Bond tests for residual autocorrelation of order 1 and 2, since the p value of 0.923 cannot reject the null of second order autocorrelation not being present. The main point to take out from this model is that growth is diminished linearly when public debt rises and that no distinct downward non-linear relation could be found that would be consistent over all model specifications. Reinhart and Rogoff (2010) theory of 90 percent of public debt to GDP being the threshold from which linearity of the relationship between public debt to GDP and economic growth breaks, seems not to hold on the later period in the EU.

Figure 6: Relationship between absolute change in percentage of public debt to GDP and growth rates



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Additionally, it could be argued that there is some relationship between absolute change in percentage of public debt to GDP and growth rates. In other words, if debt to GDP ratio is changing fast, then growth might be compromised more, since higher volatility of debt to GDP may indicate an unstable economic environment. If there exists an obvious threshold from which linearity is broken, it could well be in the dynamics of indebtedness itself and not in levels. Figure 6 shows the relationship between dynamics of the public debt ratio represented as absolute change in percentage of debt to GDP on the horizontal axis and the annual growth rate of GDP per capita on the vertical axis. Similar to Figure 5, the relationship is presented for lagged periods with growth rate time horizons differing from those of debt dynamics. The relationship between growth rate of GDP per capita in time t and absolute change in percentage of debt to GDP in the same period is presented in graph “Same year”. An obvious and expected negative relationship can be observed with no apparent thresholds. The relationship between growth rate of GDP per capita in time period t and absolute change in percentage of debt to GDP in time periods t-1, t-3 and t-5 can be observed in graphs “After 1 year”, “After 3 years” and “After 5 years” respectively. There really is no other explanation of forcing the linear approximation through the data points other than the need for establishing the direction of the relationship (positive or negative). There also exist no real arguments for non-linear relationship making the linearity breaking threshold existence hard to prove from graphical methodology alone. Very interesting is the change in slope from the negative towards positive, when GDP per capita growth is observed further forwards in time. All, but the 3 year lag slopes are statistically significant at 0.05 level. This change in slope can be partially explained with the analogy similar to that of deflation forcing companies to become more efficient. The change towards a positive relationship after 5 years may also be there because of sudden high debt to GDP increase results in a need to boost efficiency on the level of whole economy and therefore resulting in higher growth rates in subsequent periods. What should be noted is that the same excluded variable bias already mentioned in Pescatori, Sandri and Simon (2014) possibly plays a major role, since the efficiency explanation is just one of many explanations that exist.

4.1.2 Connection between private indebtedness and growth in the European Union

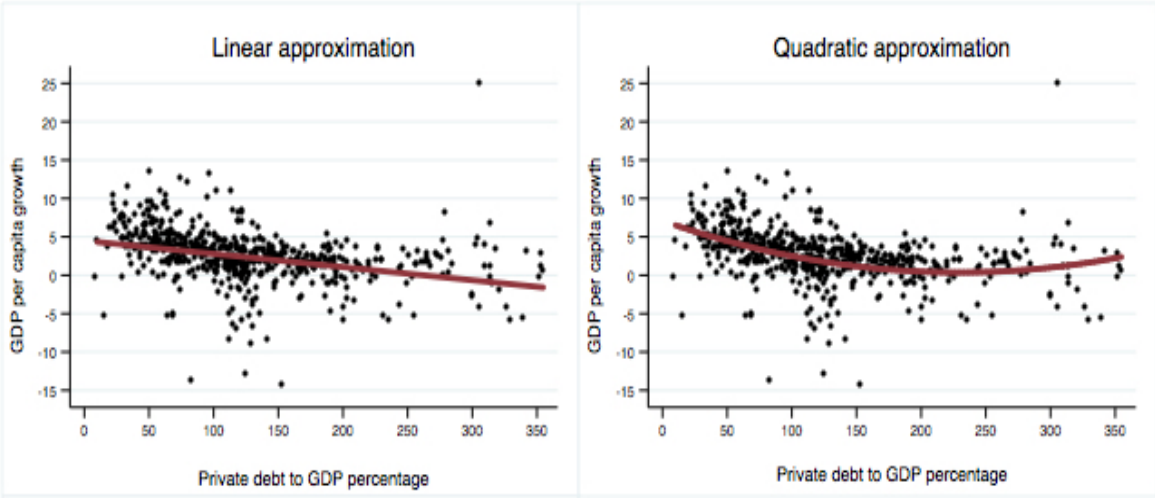
Table 6: Summary statistics for the European Union per capita GDP growth and private debt to GDP

Ratio of private debt to GDP	N	Mean GDP pc growth	Median GDP pc growth	Std. dev.	Min	Max
less than 30 percent	15	4.99	6.00	4.21	-5.50	10.10
30 to 60 percent	77	5.13	4.70	2.47	-0.30	13.30
60 to 90 percent	96	3.38	3.75	3.57	-13.90	12.40
90 to 120 percent	113	2.24	2.00	3.15	-8.70	12.90
120 to 150 percent	109	1.20	1.60	3.36	-13.00	8.40
150 to 180 percent	51	1.07	1.60	2.69	-14.60	4.10
180 to 210 percent	42	0.75	1.50	2.53	-6.00	5.10
210 to 240 percent	21	0.31	0.90	2.56	-6.00	3.50
over 240 percent	76	2.34	2.25	4.38	-6.10	24.80

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 6 shows the summary statistics for per capita GDP growth rate, with respect to percentage of private debt to GDP brackets in 28 member states of the EU from 1995 to 2017. It can be observed that there actually is a level over 240 percent that breaks the linearity in relationship, but rather an opposite of expected. For about 90 percent of all observations, the relationship between growth and percentage of private debt to GDP seems linear and negative, meaning that countries with higher ratios of private debt exhibit lower growth rates. For the most part, the reduction of the mean growth rates is accompanied with decreasing the volatility shown in the column named “Std. dev.”. Volatility of growth rates itself is the lowest on the interval from 180 to 240 percent where growth is also the lowest. Over the 240 percent of private debt to GDP threshold, the volatility of growth rates increases quite significantly and so does the average of growth rates, which is an interesting part of the data structure. Median GDP per capita growth is also linearly diminished when private debt to GDP ratio is increased, but it starts to rise after 240 percent private debt to GDP is reached. The minimum median growth of GDP per capita is found in the 210 to 240 percent of private debt to GDP bracket while the mean also has a minimum in the same private debt bracket. It is, however, difficult to make any conclusions since this bracket only offers 21 observations while the majority of all observations lie between the 60 and 150 percent of private debt to GDP.

Figure 7: Relationship between private debt to GDP percentage and GDP per capita growth rate



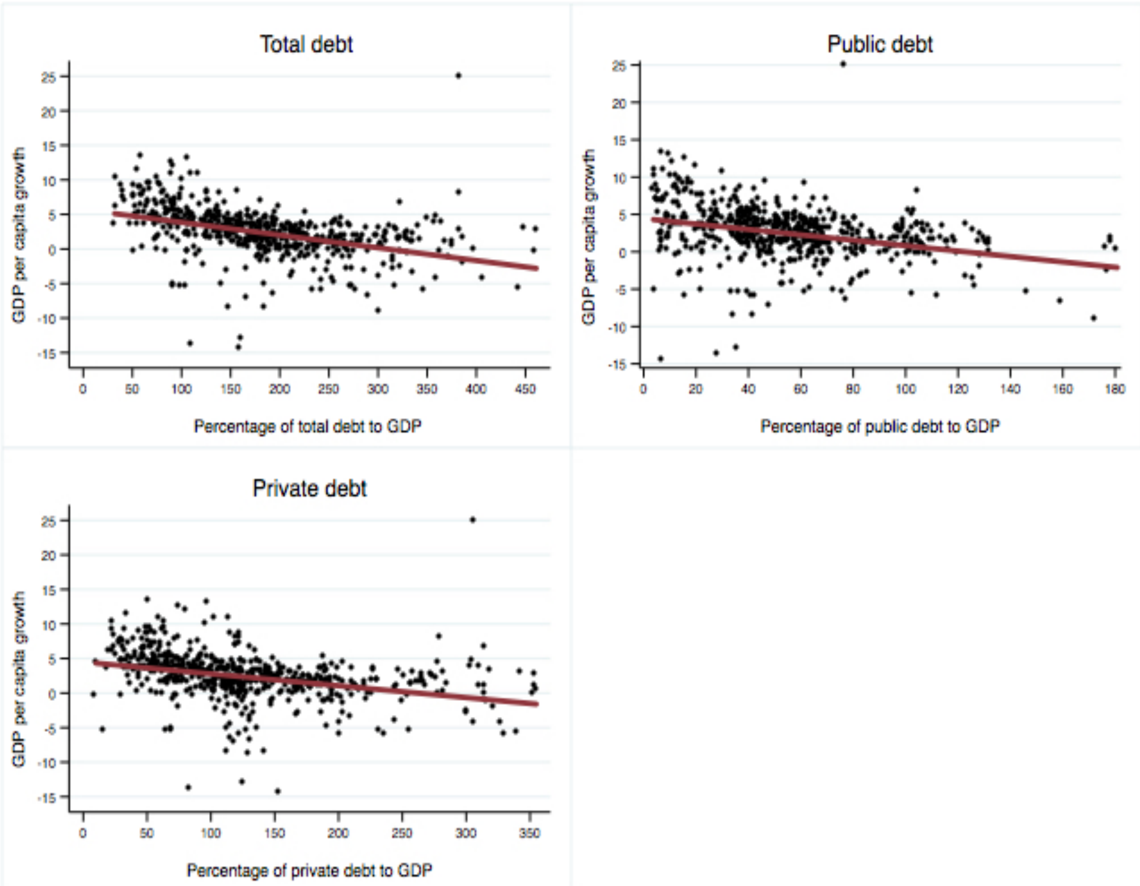
Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 7 represents the private sector debt to GDP percentage in relation to GDP per capita growth rate graphically. The relationship with growth rate of GDP per capita is not as clear as one might think or expect from previous graphical analysis when public debt was examined. The two graphs in Figure 7 show a linear and quadratic approximation of the relationship between private debt to GDP ratio and annual GDP per capita growth rate, with quadratic surprisingly being a better fit to the data at first glance. In linear approximation, which presents a better fit for the majority of observations (up to approximately 240 percent of private debt to GDP), the familiar negative relationship is evident, implying that higher private debt to GDP percentage goes along with lower GDP per capita growth rates. It is, nevertheless worth mentioning, that many economists besides Krugman (2010) noted, that the causal relationship could run both ways – higher public or private debt can be either a consequence or a cause for low GDP per capita growth. One argument linking private indebtedness to having an effect directly on growth for instance is the fact that credit crunch in the private sector reduced financing options for firms and as already noted in Campello, Graham and Harvey (2010), constrained firms behave differently and many times also make some sub-optimal decisions, which do in fact lead to a decrease in economic growth. What is also worth noting, is that the slope of private debt to GDP percentage relationship is slightly less steep than that of public debt to GDP percentage relationship, implying that public debt has a greater negative effect on growth. However, if the quadratic relationship is examined, it can be seen that it is a function with a positive leading coefficient, signaling the minimum growth at around 230 percent of private debt to GDP. From roughly 230 percent on, the relationship becomes positive which can have many explanations. One of them, previously mentioned, is a possible efficiency boost from high indebtedness of corporations, forcing them to more efficiently reallocate resources and manage their risk differently.

Another explanation for the positive shift can be the excluded variable bias that prevents the correct or unbiased relationship to emerge. I should add again that the causality is not a thing to be determined with graphical analysis.

Figure 8 shows combined, both public and private debt relationship to annual GDP per capita growth rates. As can be seen, there is no obvious linearity break in the relationship when combined total debt is investigated. Up until 300 percent of combined total public and private debt to GDP is reached, the relationship is negative and approximately linear. The volatility of growth rates is also quite stable and no obvious trend can be spotted, since it only starts to rise after 240 percent of combined total indebtedness. In addition, the summary statistics for per capita GDP growth rate are shown in Table 7, which again includes brackets for percentages of combined total of public and private debt to GDP . Average growth rate of GDP per capita briefly becomes negative in the 270 to 300 percent bracket but starts to rise again after. Median growth rate of GDP per capita also seems to decrease in a linear fashion when total debt to GDP ratio is increased, but it does never turn negative as is the case with average growth.

Figure 8: Relationship between private and public debt to GDP percentage and GDP per capita growth rate



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 7: Summary statistics for the European Union per capita GDP growth

Percentage of total debt to GDP	N	Mean GDP pc growth	Median GDP pc growth	Std. dev.	Min	Max
30 to 60 percent	23	6.92	7.40	2.97	-0.40	13.30
60 to 90 percent	48	5.22	5.15	2.64	-0.50	10.10
90 to 120 percent	73	3.94	4.20	4.36	-13.90	12.90
120 to 150 percent	68	3.25	3.40	2.69	-8.70	8.40
150 to 180 percent	71	1.87	2.20	3.36	-14.60	8.40
180 to 210 percent	92	1.52	1.65	2.34	-8.70	7.00
210 to 240 percent	67	1.06	1.40	1.95	-6.00	5.10
240 to 270 percent	45	0.50	1.00	2.39	-6.00	4.30
270 to 300 percent	22	-0.48	0.85	3.14	-6.80	3.50
over 300 percent	91	1.95	1.90	4.28	-9.00	24.80

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

4.1.3 Direction of causality in debt to GDP and growth relationship

The debate on the direction of causality in relationship between debt to GDP and economic growth is an interesting one, since there exist so many different arguments. The well-known Reinhart and Rogoff (2010) argument of debt having a negative effect on growth was opposed shortly after their publication by Krugman (2010), who argues, that it is the other way around. Panizza and Presbitero (2014) employed instrumental variable and a two stage OLS regression approach to determine the direction of causality and as noted in that study, the answer to the question in which direction causal effect runs is simply: we do not know. The coefficient in that study changed across different specifications of models and different instruments being used. In all fairness, most of the studies come to a conclusion based on authors opinions, which were many times predetermined before the study even started. Checherita and Rother (2010) also find the 90-100 percent public debt to GDP bracket to be negatively associated with economic growth, but they seem reluctant to point to the direction of causality. Interestingly enough, the effect of indebtedness is in their study statistically significant and quadratic with a negative leading coefficient. I was not able to confirm any sort of non-linearity on the EU data with neither modeling nor graphical analysis presented in this chapter.

The only thing that I can add to the debate, is that the correlation exists but that direction of causality could indeed run both ways and maybe even both ways at once in a form of a circular effect. I can claim that there is no distinct non-linearities between public debt to GDP and growth, but I did find some results implying the upward non-linearity between private debt to GDP ratios and GDP per capita growth rate. In this chapter, I will also test the effect of indebtedness as a form of conditional convergence which is, again, not implying causality, but rather the relationship between them. Any sort of causality between different forms of indebtedness should be tested with appropriate causality tests, but I will not perform those tests in this thesis.

4.2 Convergence analysis in the European Union

Now I focus on convergence between member states of the EU. I employ three methods. First is a deductive method where I base my arguments on correlation coefficients, second is the graphical analysis of logarithm of GDP per capita and third is a parametric method where I also quantify the convergence with regression analysis.

4.2.1 Correlation and graphical analysis

The data analysis so far has shown that there exists an obvious connection, or better said, a correlation between higher debt to GDP and lower annual GDP per capita growth rates, be it public, private or combined total debt. The main question and goal of this thesis, however, is to understand how debt effects the convergence inside the EU. Are the 28 selected countries converging conditional on debt to GDP ratios and other indebtedness indicators? One simple, but quite restrictive way to test whether or not debt helps with convergence, is the logical conclusion that follows from taking a deeper look at summary statistics for debt to GDP ratios, annual GDP per capita growth rate and GDP per capita levels. Since there clearly exists a negative relation between growth and public or private debt to GDP, the convergence itself should take place if richer countries on average experience higher public or private debt to GDP percentages. As can be seen in Figure 9, the relationship between debt to GDP percentage and GDP per capita is positive for public, private and combined debt, which should in theory suggest that since richer countries on average exhibit higher debt to GDP levels and since the relationship between debt to GDP percentage and annual GDP per capita growth rate is negative, the conditional convergence really is happening. The data presented in Figure 9 is still based on the EU countries from 1995 to 2017. Table 8 further shows the correlation matrix for all five economic indicators needed to support the statements about convergence that I made.

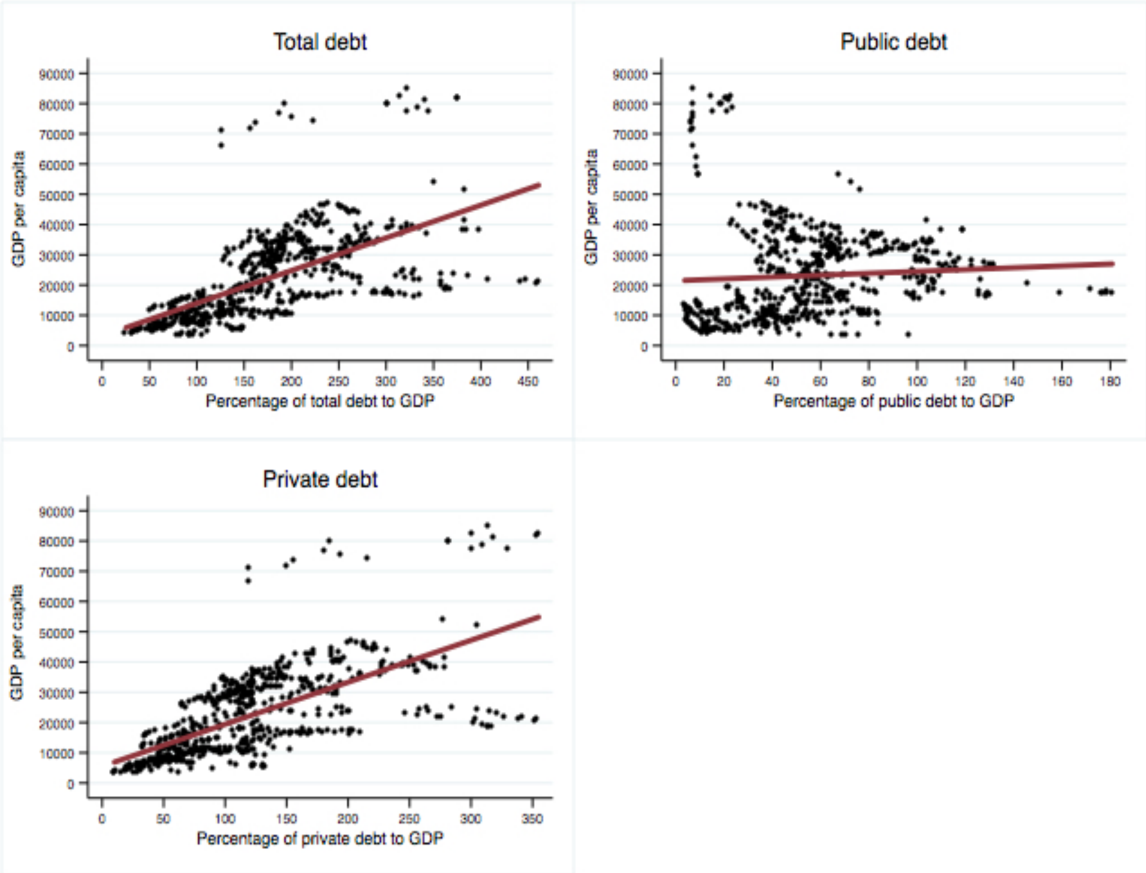
Table 8: Correlation matrix for convergence

	GDP per capita growth rate	Public debt to GDP	Private debt to GDP	Public and private debt to GDP	GDP per capita
GDP per capita growth rate	1.0000				
Public debt to GDP	-0.3324 (0.000)	1.0000			
Private debt to GDP	-0.3371 (0.000)	0.1821 (0.000)	1.0000		
Public and private debt to GDP	-0.4228 (0.000)	0.5461 (0.000)	0.9231 (0.000)	1.0000	
GDP per capita	-0.2200 (0.000)	0.0656 (0.103)	0.6504 (0.000)	0.5939 (0.000)	1.0000

Note: significance values in parenthesis

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

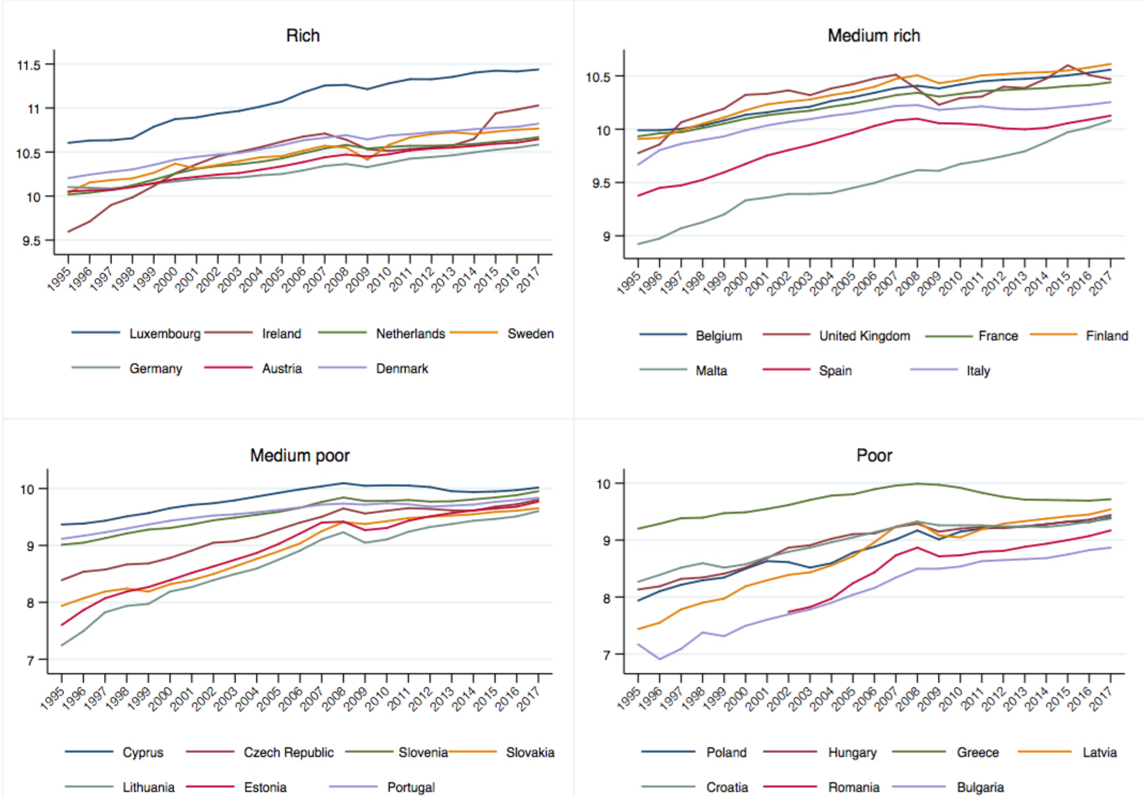
Figure 9: Relationship between public and private debt to GDP and GDP per capita



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

By analyzing the data graphically, the conditional convergence can indeed be confirmed for public, private and combined debt, but when taking a closer look at the correlation matrix presented in Table 8, the relationships are not so distinctive anymore when public debt is examined. Although there is a statistically significant and negative correlation coefficient between public debt to GDP percentage and annual GDP per capita growth rate, there exists positive but not statistically significant correlation coefficient between GDP per capita and public debt to GDP ratios. This makes the claim of existence of conditional convergence with respect to public debt a little less credible. This ambiguity is the main reason for econometric modeling approach taken later in this chapter. As expected, the correlation coefficient between ratio of private debt to GDP and GDP per capita growth rate is negative and significant, but this time also the positive and statistically significant correlation coefficient between GDP per capita and private debt to GDP is present, indicating that the conditional convergence with respect to private debt exists. The same finding as in the case of private debt also applies for combined total debt with respect to statistical significance and correlation coefficient signs. Correlation coefficients and graphical methods say little about convergence if other economic and demographic variables are not controlled and included in a model. These findings can therefore serve for getting to know the bigger picture of the indebtedness and growth relationship and it should not be taken to draw strong definitive conclusions or even causal relationships between them.

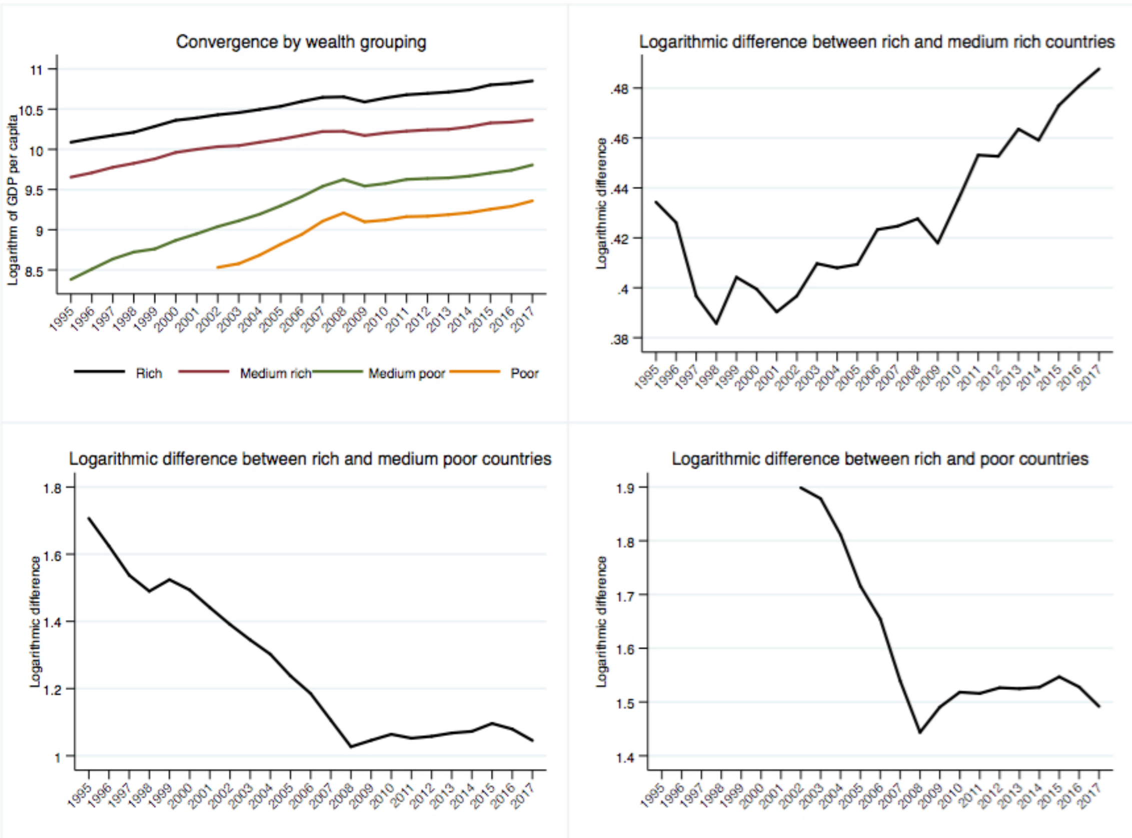
Figure 10: Convergence of logarithm of GDP per capita within wealth income groupings



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Another way of looking at convergence graphically is to compare GDP per capita trends between different countries over a certain time period. This method is good at uncovering indications of absolute convergence (i.e. convergence of less developed countries towards more developed countries without considering any other economic or non-economic factors). For the purpose of graphically analyzing absolute or non-conditional convergence of GDP per capita inside the EU, I grouped the GDP per capita data for 28 EU countries into 4 groups. The countries are selected into a group with respect to their level of GDP per capita, with resulting groups separating rich, medium rich, medium poor and poor countries. On the y axis a logarithm of GDP per capita is represented enabling the analysis of non-conditional convergence in relative terms instead of absolute (i.e. convergence would be represented by a decreasing logarithmic difference between less developed and more developed countries). Figure 10 shows the graphical representation of GDP per capita trends in the aforementioned four groups of countries. The first group contains the rich countries that do not show any major sign of relative non-conditional convergence, since the logarithmic difference hardly changes. What is interesting is that until 2007, a trend of slight divergence took place in general in this group. From 2007 onward, it seems that Luxembourg is on its own path, but the rest of the countries in this group are exhibiting a weak level of convergence. The Great Recession period is clearly visible from the kink around 2008 and the country with the fastest and also most volatile convergence is Ireland. In the second, medium rich, group absolute convergence becomes more apparent. If Malta and Spain were excluded, however, the picture again becomes less certain since either a convergence or divergence can be observed on almost the whole time horizon. Next, the medium poor countries exhibit a textbook perfect non-conditional convergence in relative terms. The convergence was happening until 2008 and after 2010, but in a period between 2008 and 2010, a clear fact jumps out, that poorer countries in this group were more strongly affected by crisis. Last are countries in the poor group and convergence is again apparent, but with Greece playing a major role, since logarithm of GDP per capita is falling from roughly 2008 onwards, implying a downward convergence. The additional question now is, whether or not groups themselves are converging towards the level of the rich country group unconditionally.

Figure 11: Convergence analysis between groups based on wealth



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Figure 11 shows the absolute or non-conditional convergence of GDP per capita in relative terms between wealth groups in the EU from 1995 to 2017. The first graph in this figure – convergence by wealth grouping was obtained by transforming the data slightly. The lines now represent the average logarithm of GDP per capita for each group. The other three graphs show more in detail the logarithmic difference, which indicates non-conditional or absolute convergence in relative terms when falling and divergence when rising. Every logarithmic difference is taken with rich group as a base, since the intrinsic logic of convergence is for less developed countries to catch-up with their more developed peers. Second graph in Figure 11 therefore shows the logarithmic difference between rich and medium rich countries and the shape of the line suggests a convergence trend up until 1998 and then surprisingly a constant trend of divergence with very slight fluctuations in slope. Excluding Luxembourg from a sample would guarantee a higher degree of cohesion, but in the name of unbiasedness and using as much data as possible, I decided, that it would not be representative or even correct to exclude it from the sample. The next graph is the logarithmic difference between rich and medium poor countries which shows that from 1995 to 1998 a non-conditional relative convergence was present with a slight break into divergence process until 2000. After 2000 to 2008, a constant nonvolatile convergence took place until the Great Recession took place. After 2008, almost 8 years of slight non-conditional divergence is observable from the data and only after 2016 the process of convergence appears to be happening again. Lastly, the graph named logarithmic difference between rich and poor countries shows the convergence process until 2008 and after that, similarly to medium poor countries a process of divergence until 2015 took place. After 2015, an indication of convergence is again observed. It can be observed overall, that poorer countries were indeed more affected by The Great Recession in 2008 and onwards, than richer countries were.

4.2.2 Absolute beta convergence analysis

In modeling convergence, I first focus on absolute (unconditional) convergence, i.e. convergence that may be present regardless of economic and non-economic factors that may affect economic growth (and hence the path of convergence). To test the absolute convergence empirically, I constructed three model forms – pooled OLS, static panel data and dynamic panel data models where equations (15), (16) and (17) represent these forms respectively. If there is absolute convergence present, then the estimate for β_2 must be negative and statistically significant. The point here is that for absolute convergence to exist, there must be a negative relationship between relative country wealth (i.e. the logarithm of GDP per capita) and growth rates. This would mean that wealthier countries on average grow slower and that therefore the catch-up process unfolds between them. If absolute divergence is present, however, the estimate for β_2 must have a positive and statistically significant coefficient estimate. Positive and statistically significant coefficient estimate for β_2 would mean that countries with higher relative wealth (measured by the logarithm of GDP per capita) actually grow faster and therefore no catch-up process happens.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \varepsilon_{it} \qquad (15)$$
$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \varepsilon_{it} \qquad (16)$$
$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 GROWTH_{it-1} + \beta_4 GROWTH_{it-2} + \varepsilon_{it} \qquad (17)$$

For the purpose of being able to compare the results with the global economy data, absolute beta convergence will first be tested on the global level. Table 9 contains global convergence regression output for models estimated with the pooled OLS estimator, within (fixed effects) estimator and Arellano Bond estimator, where estimates correspond to model forms presented in equations (15), (16) and (17) respectively. GDP per capita growth rate was regressed on the logarithm of GDP per capita where data contains 230 countries for a period from 1995 to 2017. A pooled OLS regression estimate shows a negative, but statistically insignificant coefficient for lnGDPpc where a 1 percent increase of GDP per capita is on average and all else held constant associated with a decrease of GDP per capita growth by 0.002 percentage points. Breusch-Pagan test, however, shows the presence of random effects, while Hausman test discovers fixed effects, proving the need for the use of the within estimator.

Table 9: Global absolute convergence testing

	Pooled OLS			**Within estimator**			**AB estimator**		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
lnGDPpc	-0.20	0.11	0.067	2.14	0.36	0.000	3.51	0.59	0.000
Intercept	6.45	0.89	0.000	-12.79	2.99	0.000	-25.14	4.92	0.000
N		4993			4993			4533	
R^2 overall		0.0007			0.0007				
R^2 within					0.0073				
R^2between					0.0759				
F		3.36			34.85				
χ^2								170.19	

Source: own work based on data from World Bank (2018)

In regressions estimated with within estimator, the coefficient for lnGDPpc is statistically significant and positive, which means that a 1 percent increase in GDP per capita is on average and all else held constant associated with an increase of growth by 0.0214 percentage points. This result actually implies a divergence process on a global level. This is somewhat expected since the vast differences between countries on a global level cannot enable the same paths of development.

Additionally, because of the possibility that previous growth levels also in part determine current growth levels, a GMM model was also estimated with Arellano-Bond estimator which, again, has a positive and statistically significant coefficient estimate. In this case, a 1 percent increase in GDP per capita on average and all else held constant associates with 0.0351 percentage points increase in growth, which also implies a process of divergence on the global level.

These results confirm, that on the global economy level, there was no absolute beta convergence process going on in the selected time horizon. Since the primary focus of this thesis is the data on the EU, the same estimation process was repeated on the EU data and the results are shown in Table 10. Model forms (15), (16) and (17) still apply for the EU absolute convergence regressions. As expected, results change, since there are significantly more similarities regarding the economic characteristics between countries of the EU. The coefficient for lnGDPpc is negative and statistically significant in pooled OLS and random effects models but negative and insignificant in a model estimated with Arellano-Bond estimator. A 1 percent increase in GDP per capita in the EU context is on average and all else held constant associated with a decrease in GDP per capita growth by 0.015 percentage points in the regression estimated with pooled OLS, by 0.0263 percentage points in the regression estimated with random effects estimator and by 0.0234 percentage points in the regression estimated with Arellano Bond estimator. These results imply absolute beta convergence in the EU from 1995 to 2017. Breusch – Pagan test revealed the presence of random effects with a p value of 0.000 and Hausman test, with a p value of 0.174, leaned towards random effects instead of fixed effects. Sargan test could not reject the null that overidentifying restrictions are in the model valid with a p value of 0.999. Arellano-Bond test for second order autocorrelation could also not reject the null of not having it present in the model.

Table 10: Absolute convergence testing in the European Union

	Pooled OLS			**RE estimator**			**AB estimator**		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
GROWTH (t-1)							0.46	0.008 (0.135)	0.000 (0.001)
GROWTH (t-2)							-0.20	0.013 (0.133)	0.000 (0.137)
lnGDPpc	-1.50	0.199 (0.224)	0.000 (0.000)	-1.59	0.291 (0.331)	0.000 (0.000)	-2.09	1.179 (6.321)	0.076 (0.741)
Intercept	17.19	1.963 (2.241)	0.000 (0.000)	18.08	2.870 (3.244)	0.000 (0.000)	22.25	11.61 (61.89)	0.055 (0.719)
Note: robust standard errors and significance values in parenthesis									
N		603			603			519	
R^2 overall		0.0867			0.0867				
R^2 within					0.0177				
R^2between					0.4557				
F		57.02							
χ^2					29.92			3387.64	
Breusch - Pagan random effects test					χ^2	22.98		*p*	0.000
Hausman test (FE, RE)					χ^2	1.85		*p*	0.174
Sargan test					χ^2	27.01		*p*	0.999
AB test for autocorrelation order 1					z	-3.74		*p*	0.000
AB test for autocorrelation order 2					z	-1.87		*p*	0.062

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Sala-i-Martin (1995) also showed similar results both in value and sign of the coefficient when taking a look into absolute beta convergence testing. His dataset consisted of data points for 110 countries from 1960 to 1990, including separate regressions for more similar economic environments such as OECD, The United States and Europe, in which he got estimates that all confirm the presence of absolute beta convergence within the corresponding country groupings. Additionally, he performed a few regional regressions on a subsample of Germany, United Kingdom, France, Italy and Spain, with coefficients all similar in both value and sign, proving the existence of absolute beta convergence even when regional approach for each country is considered. When taking a look at the global economy however – regression including data from all 110 countries, there is a statistically significant estimate for beta divergence, which is all consistent with my estimates based on later time period and wider selection of countries. This means that the convergence dynamics do not change much through time.

Barro and Sala-i-Martin (1990) performed a similar convergence estimation exercise and they find a divergence process when a sample of 98 countries is investigated and convergence within OECD and United States. I conclude from all this, that absolute convergence is present only when relatively similar country set is compared within and that it is therefore not a process that happens everywhere by construct, but only in regions of the world that may also benefit from cooperating with each other in both trading and socio-economic perspective, which is certainly the case in the EU.

4.2.3 Conditional beta convergence analysis

I now move on to the analysis of conditional beta convergence. This analysis is the core of my thesis and I find that conditional convergence still exists even when all chosen steady state controlling variables, which are linked to affect economic growth, are included in the model. I try three model specifications presented in Table 11, Table 12 and Table 13 and I find statistically significant conditional convergence and a consistently negative and statistically significant effect of public indebtedness on growth. What surprised me the most, was the finding that the rate of convergence does not seem to be affected much by public debt. In other words, I could not find any meaningful proof that more indebted countries converge slower or faster.

I constructed three model forms in equations (18), (19) and (20) which correspond to pooled OLS, static panel data and dynamic panel data models respectively. GROWTH denotes the GDP per capita growth rate and it is measured in percent. The lnGDPpc is the logarithm of GDP per capita which is measured in thousands of Eur in 2010 constant prices. PDEBT denotes the public debt to GDP ratio multiplied by 100, so that value 20 means that public debt to GDP is at 20 percent. RATIO denotes the share of public debt in total indebtedness. SAVING denotes the gross savings to GDP rate again multiplied by 100. POPUL denotes the population growth in percent. The variable lnGFCpc denotes the logarithm of gross fixed capital formation per capita measured in millions of Eur in 2010 prices. The lnFDIpc denotes the logarithm of FDI per capita measured in millions of USD. The lnRDpc denotes the logarithm of research and development expenditures per capita in thousands of EUR in 2010 constant prices and finally WGI denotes a combined governance indicator value.

I also want to answer one of my main research questions - whether or not public debt influences the rate of convergence. I tested this in Table 11 with interaction variables (D_1lnGDPpc – D_4lnGDPpc) where D_1lnGDPpc holds values for lnGDPpc if public debt to GDP falls into 30 to 60 percent brackets and value 0 otherwise. D_2lnGDPpc, D_3lnGDPpc and D_4lnGDPpc hold the values of lnGDPpc if the public debt ratios fall into 60 to 90 percent, 90 to 120 percent and over 120 percent category respectively and value 0 if public debt ratio falls outside of that brackets. This method does not limit the non-linearities to a specific from but rather tests any existence of such non-linearities.

If the path of convergence is only altered because of the effect of high public debt to GDP ratio has on it, then at least one of coefficient estimates β_3 to β_6 must be statistically significantly different from zero. However, I propose a different rule for testing whether or not the definitive form of the effect to exist. For the unambiguous effect of public debt on the convergence however, the statistical significance is not the only criteria. To claim with certainty that the convergence rate is getting higher when public debt to GDP increases, then the coefficient estimates for β_3 to β_6 should not only be negative and statistically significant, but also increasing in absolute value so that it holds $|\beta_3| < |\beta_4| < |\beta_5| < |\beta_6|$. If a claim was to be made that the convergence rate gets lower when public debt to GDP increases, the coefficient estimates for β_3 to β_6 should then all be positive and it should also hold that $\beta_3 < \beta_4 < \beta_5 < \beta_6$. I am therefore interested in two things. First is whether or not public indebtedness affects convergence at all and the second is if this effect has a definitive form.

This way of testing again offers another robustness check for the relationship between public debt to GDP and growth. Later in Table 13, the quadratic effect of public and private debt to GDP ratios on growth will be considered, and this will also be the only definitive form of non-linearity that I will test besides non-definitive ones. Non-linearities between growth of GDP per capita and public debt to GDP ratios is this time not tested since I already performed that in Table 5. Rather, the non-linear effect of convergence coefficient β_2 and the assumption of debt led convergence will be tested in Table 11.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 D_1 lnGDPpc_{it} + \beta_4 D_2 lnGDPpc_{it} + \beta_5 D_3 lnGDPpc_{it} + \beta_6 D_4 lnGDPpc_{it} + \beta_7 PDEBT_{it} + \beta_8 RATIO_{it} + \beta_9 SAVING_{it} + \beta_{10} POPUL_{it} + \beta_{11} lnGFCpc_{it} + \beta_{12} lnFDIpc_{it} + \beta_{13} lnRDpc_{it} + \beta_{14} WGI_{it} + \varepsilon_{it} \quad (18)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 D_1 lnGDPpc_{it} + \beta_4 D_2 lnGDPpc_{it} + \beta_5 D_3 lnGDPpc_{it} + \beta_6 D_4 lnGDPpc_{it} + \beta_7 PDEBT_{it} + \beta_8 RATIO_{it} + \beta_9 SAVING_{it} + \beta_{10} POPUL_{it} + \beta_{11} lnGFCpc_{it} + \beta_{12} lnFDIpc_{it} + \beta_{13} lnRDpc_{it} + \beta_{14} WGI_{it} + \varepsilon_{it} \quad (19)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 D_1 lnGDPpc_{it} + \beta_4 D_2 lnGDPpc_{it} + \beta_5 D_3 lnGDPpc_{it} + \beta_6 D_4 lnGDPpc_{it} + \beta_7 PDEBT_{it} + \beta_8 RATIO_{it} + \beta_9 SAVING_{it} + \beta_{10} POPUL_{it} + \beta_{11} lnGFCpc_{it} + \beta_{12} lnFDIpc_{it} + \beta_{13} lnRDpc_{it} + \beta_{14} WGI_{it} + \beta_{15} GROWTH_{it-1} + \beta_{16} GROWTH_{it-2} + \varepsilon_{it} \quad (20)$$

where it holds that:

Indicator variable $D_1 = 1$ if public debt to GDP is between 30 and 60 percent and 0 otherwise
Indicator variable $D_2 = 1$ if public debt to GDP is between 60 and 90 percent and 0 otherwise
Indicator variable $D_3 = 1$ if public debt to GDP is between 90 and 120 percent and 0 otherwise
Indicator variable $D_4 = 1$ if public debt to GDP is over 120 percent and 0 otherwise

Table 11: Testing the effect of public debt on beta convergence in the European Union

	Pooled OLS			Within estimator			AB estimator		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
GROWTH							-0.02	0.090	0.835
(t-1)								(0.164)	(0.909)
GROWTH							-0.30	0.029	0.000
(t-2)								(0.083)	(0.000)
lnGDPpc	-1.89	1.280	0.140	-10.18	3.050	0.001	-11.03	18.78	0.557
		(1.319)	(0.153)		(3.596)	(0.009)		(34.74)	(0.751)
D_1lnGDPpc	0.01	0.064	0.955	-0.08	0.081	0.319	0.00	0.191	0.982
(30-60)		(0.066)	(0.957)		(0.084)	(0.389)		(0.373)	(0.991)
D_2lnGDPpc	0.04	0.099	0.689	-0.03	0.113	0.805	0.20	0.373	0.590
(60-90)		(0.096)	(0.679)		(0.119)	(0.864)		(0.703)	(0.774)
D_3lnGDPpc	0.18	0.147	0.221	0.17	0.160	0.286	0.41	0.621	0.509
(90-120)		(0.141)	(0.201)		(0.267)	(0.294)		(1.074)	(0.703)
D_4lnGDPpc	0.24	0.221	0.285	0.33	0.232	0.143	0.72	1.124	0.521
(>120)		(0.207)	(0.255)		(0.233)	(0.210)		(1.973)	(0.715)
PDEBT	-0.05	0.018	0.007	-0.06	0.020	0.008	-0.18	0.065	0.007
		(0.018)	(0.005)		(0.023)	(0.017)		(0.119)	(0.136)
RATIO	0.08	0.019	0.000	0.07	0.031	0.043	0.22	0.072	0.002
		(0.021)	(0.000)		(0.041)	(0.106)		(0.208)	(0.294)
SAVING	0.08	0.029	0.004	0.55	0.062	0.000	0.82	0.116	0.000
		(0.050)	(0.091)		(0.110)	(0.000)		(0.362)	(0.024)
POPUL	-1.49	0.267	0.000	-1.49	0.333	0.000	-1.66	0.533	0.002
		(0.319)	(0.000)		(0.303)	(0.000)		(1.256)	(0.186)
lnGFCpc	3.10	1.004	0.002	5.98	1.611	0.000	9.97	9.097	0.273
		(1.019)	(0.003)		(2.473)	(0.022)		(14.97)	(0.505)
lnFDIpc	0.28	0.131	0.036	0.45	0.150	0.002	0.40	0.161	0.014
		(0.142)	(0.052)		(0.219)	(0.050)		(0.354)	(0.263)
lnRDpc	-1.97	0.415	0.000	-1.41	0.883	0.111	-2.82	3.029	0.352
		(0.453)	(0.000)		(0.904)	(0.127)		(5.416)	(0.603)
WGI	2.50	0.752	0.001	-0.46	1.692	0.786	9.79	4.406	0.026
		(0.640)	(0.000)		(1.632)	(0.782)		(9.487)	(0.302)
Intercept	42.34	16.10	0.009	128.8	33.76	0.000	151.17	216.1	0.484
		(16.10)	(0.008)		(44.19)	(0.000)		(380.2)	(0.698)

Note: robust standard errors and significance values in parenthesis

	Pooled OLS	Within estimator	AB estimator
N	441	441	333
R^2 overall	0.3357	0.2450	
R^2 within		0.3369	
R^2between		0.5608	
F	16.6	15.64	
χ^2			195.53

Breusch - Pagan random effects test	χ^2	1.40	*p*	0.119
Hausman test (FE, RE)	χ^2	51.17	*p*	0.000
Sargan test	χ^2	21.70	*p*	0.705
AB test for autocorrelation order 1	z	-2.57	*p*	0.010
AB test for autocorrelation order 2	z	-1.00	*p*	0.317

Source: own work based on data from World Bank (2017, 2018), Eurostat (2018) and IMF (2018)

With respect to the effects of public debt on GDP growth, I attempted to estimate two effects. The first effect is the direct effect of public debt on growth, measured by the β_7 coefficient (PDEBT). The second is the indirect effect of public debt on growth through its effect on the rate of convergence, measured by coefficients β_3 - β_6 (interaction variables D1lnGDPpc – D4lnGDPpc). Regarding the first effect, a 1 percentage point increase in public debt to GDP

(PDEBT) is on average and all else held constant associated with a decrease of growth rate of GDP per capita by 0.05 percentage points in the pooled OLS regression, by 0.06 percentage points in the fixed effects (within) regression and by 0.18 percentage points in the regression estimated with Arellano Bond estimator. All three coefficients estimates are negative and statistically significant, regardless of the model form, which implies that countries with higher public debt to GDP grow slower. This further proves a negative correlation between these two variables. Since a negative relationship between the public debt ratio and GDP growth was established by the graphical method, correlation method and empirical testing with other explanatory variables controlled for, I can claim that it remains robust. Regarding the second effect, I tested for nonlinearity of the effect of public debt to GDP on conditional beta convergence (this is not to be confused with non-linearity testing of the effect of public debt on growth which was already done in Table 5). This effect is captured in coefficients for the interaction variables D_1lnGDPpc to D_4lnGDPpc that test for significant differences in the rate of conditional beta convergence when public debt to GDP belongs to the corresponding debt ratio brackets (30-60, 60-90, 90-120 and over 120). For example, the β_3 coefficient for the D_1lnGDPpc interaction term of the OLS model, which is equal to 0.01, implies, that the correct beta convergence coefficient for countries with public debt to GDP between 30 and 60 percent for Ln GDP p.c. is actually $\beta_2 + \beta_3 = -1.89 + 0.01 = 1.88$ and not -1.89. This would, if statistically significant, prove a nonlinear effect of public debt on conditional convergence which could be interpreted as slower convergence due to higher indebtedness. Since not even one of β_3 - β_6 coefficients, which test this nonlinear effect, are statistically significant, regardless of the model form and since the coefficients also change through model specifications, I can claim that public debt does effect growth directly, but that it has no distinct indirect effect on growth through the rate convergence. This would imply that regardless of the public debt ratio, convergence remains equally paced.

Additionally, I also tested the effect of other control variables. A 1 percentage point increase of public debt to total debt (RATIO) is on average and all else held constant associated with an increase of 0.08 percentage points of GDP per capita growth in a pooled OLS regression, 0.07 percentage points in fixed effects regression and 0.22 percentage points in a regression estimated with Arellano Bond estimator. The coefficient is positive and statistically significant in all three model forms, which implies that countries with majority of debt belonging to public and not private sector tend to grow slightly faster than those countries with lower ratios. This relationship further implies a negative impact of higher private debt to GDP percentage on growth rate, since increasing the private debt to GDP would result in lowering the ratio which would on average and all else held constant be associated with lower growth.

A 1 percentage point increase in gross savings to GDP ratio (SAVING) is on average and all else held constant associated with 0.08 percentage points increase of GDP per capita growth in pooled OLS regression. Fixed effect regression estimate of 0.55 percentage points and

Arellano Bond estimator of 0.82 percentage points further proves that countries that are able to save a higher percentage of GDP grow faster. This expected result may occur because of savings fueling investments which has a boost effect on GDP per capita growth. This is a classical (i.e. Solow) explanation of the effect of savings on output. Coefficients remain constant in sign and are statistically significant in all three model forms. There is, of course, a completely opposite explanation possible and that is, that countries which tend to grow faster, can also afford to save more.

A 1 percentage point increase in population growth (POPUL) is on average and all else hold constant associated with a 1.49 percentage points decrease in GDP per capita growth in a pooled OLS model and the same coefficient value in fixed effects regression. Slightly higher is the coefficient with 1.66 percentage points decrease on average and all else held constant in regression estimated with Arellano Bond Estimator which quite intuitively means that higher population growth means lower per capita GDP growth.

A 1 percent increase of gross fixed capital formation per capita (lnGFCpc) is on average and all else held constant associated with an increase of GDP per capita growth by 0.0309 percentage points in pooled OLS regression, by 0.0598 percentage points in fixed effects regression and 0.0997 percentage points in a regression estimated with Arellano Bond estimator. This is, again, the expected result. The coefficient estimates are statistically significant in both static models and remain positive, which means, that faster growth of gross fixed capital formation goes along with higher growth rates. In economics, the movement in capital stocks are usually assumed to influence output or in this case growth and not the other way around, but it is entirely possible that causality here runs both ways and that in multiple period setting growth also influences higher accumulation of gross fixed capital.

A 1 percent increase in inward FDI (lnFDIpc) is on average and all else held constant associated with 0.0028 percentage points increase of GDP per capita growth in a pooled OLS regression, 0.0045 percentage points in fixed effects regression and with 0.004 percentage points in a regression estimated with Arellano Bond estimator. The coefficients estimated are statistically significant in all three model forms and also remain constant in sign, which confirms the positive effect that inward flows of FDI's have on growth. FDI's are, as one of major factors of not just growth but also convergence, mentioned in numerous papers such as Barro (1996), Evans (2000), and more intensively in Cocris, Stoica and Sârbu (2017), where it is noted, that they are one of most important causes of convergence between Romania and Bulgaria. Jawaid and Raza (2012) concluded that FDI's exhibit a positive coefficient in all samples, be it rich or poor countries, but that it influences poor countries GDP growth significantly more and therefore help with convergence. On the other hand, Adams (2009) suggested that there is some non-linear effect present, which was explained by relying too much on foreign investments, resulting in discouraging domestic industrial and investment possibilities because of lower competitiveness levels of investors at home, so the picture is grey rather than black or white and the effect of FDI's can also follow a sort of a circular effect. Non-linearity of the relationship between FDI's and growth is not the focus of this thesis, so I will stick with linear estimation regardless.

A 1 percentage point increase in research and development expenditures per capita (lnRDpc) is on average and all else held constant associated with a decrease in GDP per capita growth by 0.0197 percentage points in the pooled OLS regression, by 0.0141 percentage points in the fixed effects regression and by 0.0282 percentage points in the regression estimated with Arellano Bond estimator. The coefficient estimate is not statistically significant in the fixed effects regression and neither in the GMM regression. It should be noted that this relationship is in no way indicating causality since a negative relationship in the EU can easily be explained by the fact that richer countries tend to grow slower and that there exists a very strong correlation between rich countries and higher per capita research and development expenditures. Therefore, a negative relationship of research and development per capita levels with growth may exist more as a consequence of this, rather than because of a negative causal effect. Gumus and Celikay (2015) clearly show, that research and development relationship with growth is positive on the long run but it could not be robustly proven when short run is examined. The relationship also became blurry when low and medium countries were modeled.

Estimates for the combined World Governance Indicator (WGI) were not statistically significant, apart from the dynamic model and also varied from positive to negative along model specification. This is an interesting conclusion, since governance indicators usually serve as a proxy for one democratic dimension of the quality of life. Since no obvious relationship between them and the growth rate exists, my conclusion is that growth depends on other economic and demographic variables. Nevertheless, these indicators still serve as at least one dimension of the quality of life and are therefore more important in social aspect. Additionally, an indirect effect on growth exists through that channel, which, I unfortunately cannot prove in this model setting.

Since public debt to GDP only affects growth directly and not indirectly through convergence rate, I now simplify the model and shrink it to the form that represents the conditional convergence process best. This model does not suffer from the loss of degrees of freedom as does the model presented in Table 11. This is true because all interaction indicator variables that were used to test the effect of higher public debt to GDP ratios on convergence are now removed (all proved statistically insignificant in Table 11). Simplified model forms corresponding to pooled OLS, static panel data and dynamic panel data are presented in equations (21), (22) and (23) respectively.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 RATIO_{it} + \beta_5 SAVING_{it} + \beta_6 POPUL_{it} + \beta_7 lnGFCpc_{it} + \beta_8 lnFDIpc_{it} + \varepsilon_{it} \quad (21)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 RATIO_{it} + \beta_5 SAVING_{it} + \beta_6 POPUL_{it} + \beta_7 lnGFCpc_{it} + \beta_8 lnFDIpc_{it} + \varepsilon_{it} \quad (22)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 RATIO_{it} + \beta_5 SAVING_{it} + \beta_6 POPUL_{it} + \beta_7 lnGFCpc_{it} + \beta_8 lnFDIpc_{it} + \beta_9 GROWTH_{it-1} + \beta_{10} GROWTH_{it-2} + \varepsilon_{it} \quad (23)$$

Table 12: Conditional beta convergence testing in the European Union – short model

	Pooled OLS			**Within estimator**			**AB estimator**		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
GROWTH (t-1)							0.11	0.031 (0.094)	0.000 (0.237)
GROWTH (t-2)							-0.27	0.011 (0.070)	0.000 (0.000)
lnGDPpc	-3.11	0.896 (0.964)	0.001 (0.001)	-11.81	2.073 (2.490)	0.000 (0.000)	-4.64	5.151 (11.16)	0.367 (0.677)
PDEBT	-0.04	0.008 (0.009)	0.000 (0.000)	-0.04	0.012 (0.013)	0.001 (0.005)	-0.14	0.021 (0.061)	0.000 (0.019)
RATIO	0.06	0.016 (0.019)	0.000 (0.004)	0.04	0.023 (0.033)	0.064 (0.209)	0.14	0.033 (0.139)	0.000 (0.315)
SAVING	0.07	0.025 (0.037)	0.005 (0.061)	0.44	0.053 (0.114)	0.000 (0.001)	0.73	0.054 (0.246)	0.000 (0.003)
POPUL	-1.15	0.217 (0.223)	0.000 (0.000)	-1.72	0.273 (0.276)	0.000 (0.000)	-0.83	0.158 (0.601)	0.000 (0.166)
lnGFCpc	2.46	0.836 (0.937)	0.003 (0.009)	5.94	1.341 (1.647)	0.000 (0.001)	3.72	4.191 (8.310)	0.375 (0.654)
lnFDIpc	0.34	0.111 (0.127)	0.002 (0.007)	0.40	0.128 (0.173)	0.002 (0.037)	0.42	0.081 (0.220)	0.000 (0.054)
Intercept	43.91	13.021 (14.03)	0.001 (0.002)	139.26	26.241 (31.02)	0.000 (0.000)	53.13	71.753 (145.84)	0.459 (0.716)
Note: robust standard errors and significance values in parenthesis									
N		547			527			430	
R^2 overall		0.2402			0.2288				
R^2 within					0.2716				
R^2between					0.6071				
F		23.48			20.72				
χ^2								10110.30	

Breusch - Pagan random effects test	χ^2	4.82	*p*	0.014
Hausman test (FE, RE)	χ^2	51.17	*p*	0.000
Sargan test	χ^2	24.78	*p*	0.921
AB test for autocorrelation order 1	z	-3.17	*p*	0.002
AB test for autocorrelation order 2	z	-1.56	*p*	0.119

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 12 shows the output from a regression, where primarily the conditional convergence was tested. Limiting the model to its most minimalistic form was a priority. The regression output is an empirical estimation of equations (21), (22) and (23). I consider estimates of convergence to be the most representative in this model forms since testing in Table 11 proved no indirect effects of indebtedness on convergence rate and therefore estimates here do not suffer from unnecessary pollution and the loss of degrees of freedom. The coefficients for logarithm of GDP per capita in Table 12 remain negative and increase in absolute sense in every model, while being now statistically significant in all but the dynamic model form. A 1 percent increase of GDP per capita is on average and all else held constant associated with anywhere between 0.031 to 0.118 of decrease in growth rate of GDP per capita depending on the model form. Coefficient estimates are implying a conditional convergence process in the European model. As far as public debt coefficient goes, the effect on growth is estimated to be negative still, since a 1 percent increase in public debt to GDP on average and all else held constant associates with a decrease in growth by anywhere from 0.04 to 0.14 percentage points depending on the model form. All coefficients for public debt are statistically significant in all model forms. This result is now much more similar to Kumar and Woo (2010), with the difference that nowhere in my modeling process was I able to confirm a negative and non-linear effect of indebtedness on growth, but the data is based on another area inside another time horizon. Other control variables that are present in this simplified model are within expectations, for both sign and value, and are mostly statistically significant while still being comparable to the results in expanded model, which was not able to confirm any sort of non-linearity assumptions. The sign of the coefficients remains the same in all model forms.

Lastly as far as conditional convergence modeling goes, Table 13 shows the output from a regression where assumptions of quadratic relationship are tested for both, public debt and private debt, when growth is considered along with conditional convergence testing in yet another form, serving as an additional robustness check. Studies such as Baum, Checherita and Rother (2010) and Checherita and Rother (2010) claim the quadratic relationship with a negative leading coefficient, so if there are indeed any downward non-linearities in a form of quadratic function present also on a later period and different country selection, then the coefficient estimates for β_4 should be statistically significant and negative. I also added private debt to GDP in the model and if any downward non-linearity would exist in the relationship between private debt to GDP and growth, the coefficient estimate for β_6 should be negative and statistically significant. The regression output is an empirical estimation for models shown in the equations (24), (25) and (26) which show a pooled OLS, static panel data and dynamic panel data models respectively.

$$GROWTH_{it} = \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 PDEBT^2_{it} + \beta_5 PrDEBT_{it} + \beta_6 PrDEBT^2_{it} + \beta_7 SAVING_{it} + \beta_8 POPUL_{it} + \beta_9 lnGFCpc_{it} + \beta_{10} lnFDIpc_{it} + \varepsilon_{it} \quad (24)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 PDEBT^2_{it} + \beta_5 PrDEBT_{it} + \beta_6 PrDEBT^2_{it} + \beta_7 SAVING_{it} + \beta_8 POPUL_{it} + \beta_9 lnGFCpc_{it} + \beta_{10} lnFDIpc_{it} + \varepsilon_{it} \quad (25)$$

$$GROWTH_{it} = \alpha_i + \beta_1 + \beta_2 lnGDPpc_{it} + \beta_3 PDEBT_{it} + \beta_4 PDEBT^2_{it} + \beta_5 PrDEBT_{it} + \beta_6 PrDEBT^2_{it} + \beta_7 SAVING_{it} + \beta_8 POPUL_{it} + \beta_9 lnGFCpc_{it} + \beta_{10} lnFDIpc_{it} + \beta_{11} GROWTH_{it-1} + \beta_{12} GROWTH_{it-2} + \varepsilon_{it} \quad (26)$$

Table 13: Conditional beta convergence testing in the European Union

	Pooled OLS			Within estimator			AB estimator		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
GROWTH (t-1)							-0.22	0.055 (0.111)	0.000 (0.047)
GROWTH (t-2)							-0.29	0.016 (0.534)	0.000 (0.000)
lnGDPpc	-2.64	0.909 (0.969)	0.004 (0.007)	-5.81	2.076 (2.503)	0.005 (0.028)	-0.24	7.957 (16.71)	0.976 (0.989)
PDEBT	-0.02	0.013 (0.018)	0.152 (0.293)	-0.09	0.020 (0.031)	0.000 (0.010)	-0.25	0.032 (0.096)	0.000 (0.008)
PDEBT^2	0.00002	0.001 (0.001)	0.830 (0.865)	0.001	0.001 (0.001)	0.000 (0.009)	0.002	0.001 (0.001)	0.000 (0.018)
PrDEBT	-0.06	0.009 (0.011)	0.000 (0.000)	-0.11	0.015 (0.018)	0.000 (0.000)	-0.36	0.038 (0.098)	0.000 (0.000)
PrDEBT^2	0.0001	0.001 (0.001)	0.000 (0.000)	0.0002	0.001 (0.001)	0.000 (0.001)	0.001	0.001 (0.001)	0.000 (0.025)
SAVING	0.01	0.026 (0.037)	0.643 (0.749)	0.33	0.051 (0.107)	0.000 (0.004)	0.55	0.059 (0.163)	0.000 (0.001)
POPUL	-1.08	0.223 (0.025)	0.000 (0.000)	-1.44	0.257 (0.319)	0.000 (0.000)	-0.91	0.273 (0.613)	0.001 (0.138)
lnGFCpc	2.80	0.863 (0.937)	0.001 (0.003)	7.22	1.266 (1.645)	0.000 (0.000)	14.69	5.025 (10.53)	0.003 (0.163)
lnFDIpc	0.46	0.111 (0.125)	0.000 (0.000)	0.33	0.122 (0.150)	0.007 (0.036)	0.27	0.082 (0.176)	0.001 (0.122)
Intercept	46.17	13.39 (14.08)	0.001 (0.001)	101.71	25.03 (31.06)	0.000 (0.003)	109.80	104.12 (218.27)	0.292 (0.615)
Note: robust standard errors and significance values in parenthesis									
N		527			527			430	
R^2 overall		0.3092			0.2069				
R^2 within					0.363				
R^2between					0.2438				
F		25.72			31.02				
χ^2								11070.62	

Breusch - Pagan random effects test	χ^2	9.48	*p*	0.001
Hausman test (FE, RE)	χ^2	67.98	*p*	0.000
Sargan test	χ^2	21.316	*p*	0.975
AB test for autocorrelation order 1	z	-2.73	*p*	0.006
AB test for autocorrelation order 2	z	-1.51	*p*	0.132

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

The coefficient for lnGDPpc is still negative in all three models while, as expected, not significant only in the dynamic model estimated with Arellano-Bond estimator. Much more interesting however is the quadratic relationship with a positive leading coefficient for both, public (PDEBT and PDEBT^2) and private (PrDEBT and PrDEBT^2) debt. Coefficients for PDEBT and PDEBT^2 are not statistically significant in the pooled OLS model, but remain significant in the fixed effects model and in the dynamic panel data model. What this implies is that both public and private debt start with a negative relationship when growth is considered and then slowly turn into a positive one. I interpret this with a bit of caution since this result is a bit controversial – increasing debt to GDP, be it in public or private form, brings lower growth, but the negative effect slowly vanishes. This is a very different result than any study proving exact opposite quadratic relationship such as Baum, Checherita and

Rother (2010) and Checherita and Rother (2010), but it is quite easy to explain. Their data consisted of mostly pre-crisis observations with 2 years of crisis period where, for instance, public debt jumped significantly and growth rates plummeted. This could bring the quadratic relationship with a negative leading coefficient, which might not still apply on more recent data, since the post crisis periods saw increasing growth rates but not so quick reduction of indebtedness. That way, the lead coefficient changes in sign and in value. Nevertheless, this is the only non-linear relationship that data reveals. Since coefficients estimates for quadratic terms are very small and through the whole area of indebtedness observations quadratic function follows very close to linear one, I cannot claim that there truly exist any really meaningful non-linear relationships between indebtedness and growth. In fact, since outliers effect the regression estimation process in quadratic form much more than in linear form, it is entirely possible that the relationship is just a product of estimation methodology and not even a true representation of the data. Excluded variable bias of course still play a role.

4.2.4 The convergence is not debt led

Artelaris, Kallioras, and Petrakos (2015) argue that the praised European model should, in theory, enable a high degree of convergence because of the 4 basic freedoms given by accessing the European single market (freedoms of movement of capital, goods, services and labor). It is argued that freedom of capital in itself should increase the convergence level. The problem that they see is that while absolute convergence does exist, it is mostly led by debt accumulation that will in the future cause more problems. They argued this by determining the debt in a two stage regression process where debt was split into targeted and non-targeted. The targeted debt was determined by regressing public debt to GDP levels on per capita GDP gap to the EU average and multidimensional proxy variables for the quality of life and governance that I also included in my models. The claim was, that the debt not determined by the gap or indicators for quality of life was non-targeted and due to corruption and inefficiency of government. Later they regressed the GDP per capita growth on the logarithm of GDP per capita and both, targeted debt, which were the predicted values from the first regression and non-targeted debt, which were the residuals from first regression. The coefficients were positive, positive and negative in sign respectively which means, that when debt is neutralized, the European model actually initiates a divergence process. The question of the study mainly goes to the sustainability problem of debt accumulation, since the possibility of convergence not existing when debt would be neutralized would mean, that the European model does not on its own initiate a convergence process. My findings are opposite and I could not replicate neither in sign nor in value the coefficient estimates from their regressions. My findings are that when debt along with other explanatory variables that were usually linked to growth accounting in studies such as Adams (2009), Barro (1991, 1996), Cocris, Stoica and Sârbu (2017), Erdal and Celikay (2015), Evans (2000), Karim (2005) and others are controlled for, there still exists a process of convergence even when private debt is also taken into account and that the model still exhibits quite high levels of conditional convergence. The problem of this study is that splitting the debt into targeted and non-targeted is quite an arbitrary procedure because the data for controlling the non-targeted debt exists on the EU level. For instance, corruption and government inefficiency could have easily been controlled for, since indicators of them exist in many databases freely accessible. Another issue is the fact that from their equations in the paper, it seems like they did not take logarithmic growth, which would be calculated as ln (GDP p.c. it/GDP p.c.it-1), but have rather seem to have applied a logarithmic transformation on GDP per capita growth itself, which in fact removes all the negative growths from their sample, so estimators might be biased heavily from possible accidental exclusion of the available data. I could not find that indebtedness statistically significantly alters the course of convergence in direct testing in Table 11. However, it is important to clearly understand that not being able to confirm the assumptions for non-zero coefficients is not at all the same as saying there is no relationship whatsoever. I am mainly stating that, statistically, those relationships seem to not exist between public debt and convergence.

4.2.5 Sources of possible bias in the models

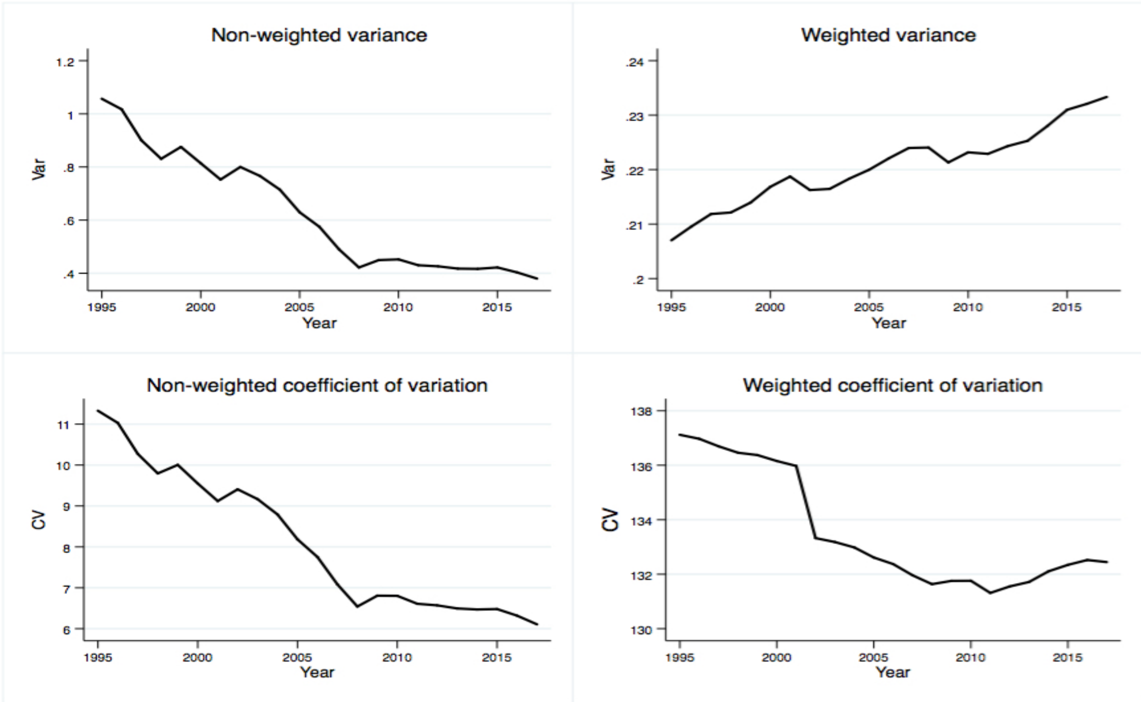
While it would be lovely to say that the models in this thesis explain everything while remaining unbiased, this is, objectively, just not the case. There are still other variables to be included in the model, along with those chosen in both simplified and expanded models, both with linear and with quadratic relationships, but because of the fact that both sign and value remain relatively close, I believe that the bias is not big enough to significantly change the results. The other possible bias which I believe to be a problem that has no remedy, are the unmeasurable effects. For instance, it would not be too unbelievable to claim that if a country has hawkish politicians running the country and if consumers listen to threats of 90 percent thresholds further from which growth will be effected on a daily basis, their consumer behavior may change ever so slightly when that threshold is crossed and it is so, as a terrible problem, portrayed in the media. This could have an impact on growth. Additionally, the same could be claimed for investors. The problem is that this nonlinearity would not actually be caused by debt, but by other variable that cannot be measured and debt would then get a biased coefficient estimate. Also worth mentioning is the remaining question of debt to GDP and growth causality direction. When all this is taken into account, a simple fact still remains that in general between 1995 and 2017 in the EU, both conditional and absolute beta convergence exist.

Another fact is that because of data limitations I did not control for whether debt is internal or external and neither was I able to include the analysis of allocation of resources from debt accumulation. I plan to study this in my future research.

4.3 Sigma convergence analysis

Barro and Sala-i-Martin (1991) showed sigma convergence between different regions of the United States during 1880 and 1988 where convergence process reversed into a divergence during 1920 and 1945, which also captures the whole period of The Great Depression as well as the Second World War. The finding that a major crisis reverses the convergence process in a sense of sigma is somewhat consistent with my findings during the period of The Great Recession, when non-weighted samples for the movement of both variance and coefficient of variation of logarithm of GDP per capita are examined and graphically presented in Figure 12.

Figure 12: Logarithm of GDP per capita - sigma convergence graphical analysis



Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Barro and Sala-i-Martin (1991) used the variance and standard deviation of logarithm of GDP per capita to determine whether or not countries converge also in a sigma form. The dispersion of income and the sigma convergence has also been studied as GINI coefficient movements in O'Neill and Kermn (2004) and coefficient of variation in Simionescu (2014) which should, when combined, give a more coherent answer to whether or not the convergence in a sense of sigma exists. Since data used in this thesis spans from 1995 to 2017 which includes only 23 points of observations and since the estimation procedure for sigma convergence removes the country specific dimension, I will not attempt to model the process and perform hypothesis testing and will rather resort to the graphical method, along with correlation matrix to support any claims. Figure 12 shows 4 graphs that present the movement of non-weighted and weighted variance and coefficient of variation for logarithm of GDP per capita through the years. Graph named non-weighted variance includes variance of logarithm of GDP per capita in each year and the movement itself is similar to that of beta convergence. It is worth noting that beta and sigma convergence need not go hand in hand. The variance is shown to be diminishing up until 2007 and after that the process slows significantly, while still mainly remaining downward sloping. The increase does not seem drastic and the effect of The Great Recession seems to be shown in the slowing down of convergence process but not really a divergence. Very similar is the movement shown in un-weighted coefficient of variation. Additionally, weighted variance and weighted coefficient of variation take into account the fact that sigma convergence is first and foremost a phenomenon with social consequences and therefore it should be studied with respect to demographic characteristics. Countries may converge in a sense of sigma, but the problem is that Germany gets equal importance in the process as Slovenia with much less people. To control for that, the population weights were used. Population weight used was the percentage of country's population in the whole EU 28 population. Weighting was applied to GDP per capita data for each country in each year and only after that the logarithmic transformation was used upon which normal variance and coefficient of variance obtaining procedure was performed. When weighted variance is examined, it is clear, that for people (and not countries) actually a process of divergence happens from 1995 to 2017, but a more logical conclusion can be made when taking a look at the movement of weighted coefficient of variation, which shows a process of convergence from 1995 till roughly 2011 and after 2011 the process of slow divergence starts. Weighted values themselves in this case do not represent any sensible data hence the only useful and correct way of interpreting them is in the dynamics of this weighted data and not in the levels.

Table 14: Correlation matrix for weighted and non-weighted samples

Weighted sample				Non-weighted sample			
	CV	Mean PDEBT	Mean PrDEBT		CV	Mean PDEBT	Mean PrDEBT
CV	1.0000			CV	1.0000		
Mean PDEBT	-0.5381 (0.008)	1.0000		Mean PDEBT	-0.6138 (0.002)	1.0000	
Mean PrDEBT	-0.9183 (0.000)	0.7124 (0.000)	1.0000	Mean PrDEBT	-0.9757 (0.000)	0.6284 (0.002)	1.0000

Note: significance values in parenthesis

Source: own work based on data from World Bank (2018), Eurostat (2018) and IMF (2018)

Table 14 shows the correlation matrix for weighted and non-weighted samples. The correlation coefficient between average of public debt to GDP in the EU and coefficient of variation is negative and statistically significant, with a medium value in both weighted and non-weighted samples, which means that, on average, higher public debt to GDP ratios go along with lower coefficient of variation for logarithm of GDP per capita. I claim no causality since there is a possibility that both are under influence of other economic indicators. Similarly, the private debt to GDP and coefficient of variation also exhibit negative and statistically significant correlation, with a very high value that is above 0.9 in absolute terms in both weighted and non-weighted samples.

The similar weighting of the data method was used already in Simionescu (2014), where it was discovered, that coefficient of variation for both weighted and non-weighted samples declined in the period from 2000 to 2012, but only values for those two years were given. It was also mentioned that the decrease in the coefficient of variation is not enough to be able to comfortably claim the existence of sigma convergence in EU 28. Young, Higgins and Levy, (2008) also could not conclude that statistically significant sigma convergence is present in the United States where they had the data on county level and over 3000 observations. They do, however, confirm the existence of beta convergence.

CONCLUSION

This thesis offers a thorough review of the effect of leverage on convergence and growth. Additionally, it also offers an empirical investigation in public and private indebtedness situation in the EU, along with the study of relationships between growth and indebtedness between 1995 and 2017. Apart from just summarizing the data as it is done in many studies, I decided to employ empirical modeling, which brought to life some interesting results. Subsequently, convergence was studied in multiple forms with non-linearity testing as a form of a robustness check. Convergence was studied in a form of absolute and conditional beta convergence, along with absolute sigma convergence. Conditional sigma convergence was not modeled due to limitation in the data. The effect of debt on sigma convergence was deducted from a logical conclusion from correlation matrices and data movements.

My empirical results suggest that in the EU, in general, a 10 percentage points increase in public debt to GDP goes along with a decrease in GDP per capita growth rate by anywhere from 0.4 up to 1.4 percentage points. The lower bound of my estimate is similar to that of 0.2 to 0.3 from Kumar and Woo (2010), but my data also includes more of the crisis period and therefore higher estimates are not so surprising. No non-linearities in the relationship between debt and growth could be statistically significantly proven to exist, which means that there are no thresholds to be observed and that the theory of the 90 public debt to GDP percent threshold from Reinhart and Rogoff (2010) does not hold in this case. I was also not able to prove any quadratic relationship with a negative leading coefficient as was the case in Baum, Checherita and Rother (2010) and also in Checherita and Rother (2010). I did find some results suggesting that the quadratic relationship has a positive leading coefficient for both public and private debt, but it was so close to zero that linear approximation fits almost the same as the quadratic one. Even after indebtedness along with steady state controlling economic characteristics and World Governance Indicators were controlled for in modeling, I still found reasonable conditional convergence on a similar set of data as Artelaris, Kallioras and Petrakos (2015), where they claimed, that convergence was in EU mainly debt led and therefore they got results of conditional divergence which is opposite to my findings. Panel data estimates in static form mainly proved the same direction of convergence process, but the estimates seemed higher than those of pooled OLS.

There is proof of absolute and even conditional beta convergence in the EU, since countries with higher GDP per capita on average experience slower growth than countries with lower levels. The conditional convergence is faster than unconditional convergence. The conditional convergence, however, is not altered in different brackets of public debt to GDP and remains the same regardless of debt levels, which is the finding that I was most surprised by. This means that public debt only has a direct effect on growth, but that it does not affect convergence rates.

Absolute convergence analysis between rich and medium rich group of countries actually proves a divergence process, while convergence to the rich countries group level is present in medium poor and poor groups. The Great Recession proved to be a setback with respect to convergence, since it initiated a process of divergence lasting from 2008 to 2015, but over a whole period from 1995 to 2017, a parametrically based convergence applies in both absolute and conditional forms. When I tested absolute convergence, both on global level and in the EU in the same period from 1995 to 2017, I got results that fall roughly in line with Sala-i-Martin (1995), both in sign and also in value of coefficients. There are still differences between estimates, which is to be expected because of different data selection, but nevertheless, the results are comparable – no absolute beta convergence on the global level and significant convergence on the European scale.

Sigma convergence is present in variance and coefficient of variance of logarithm of GDP per capita in the EU with the Great Recession causing only a minor disturbance into divergence from 2008 to 2010. After 2010, the process of convergence has again begun, however, it is slower than before 2008. Weighted sample proves difficult to draw conclusions from, since the coefficient of variance shows a convergence process till 2010 and divergence since. From the correlation method one thing is obvious – higher public debt and private debt to GDP levels correlate highly with the reduction in the coefficient of variation of logarithm of GDP per capita, in both weighted and non-weighted samples. I used a similar weighting scheme as in Simionescu (2014), who also finds a similar result of sigma convergence existing between 2000 and 2012 in the EU.

Data limitations exist for every researcher, be it different methods of treating the data in different sources or incompleteness of data in specific databases such as Eurostat or World Bank etc. This data problem also opens the doors to incorrect or flawed studies, upon which policy makers make their choices. When I assembled the data base that was used in this thesis, I ran into a number of problems, such as missing data observations for certain countries in certain years that were reported in another data base or source, so I combined multiple sources together. Although I made sure that the methodologies used in collecting and treating the data when combining multiple sources were as closely matched as possible, there still exists a possibility for potential problems with the data itself, as is the case in almost all macroeconomic studies when multiple variable inputs are collected.

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APPENDICES

POVZETEK

Ekonomska konvergenca bruto domačega proizvoda na prebivalca med državami je že dobro raziskan proces, ki ni pomemben le strikno iz ekonomskega, ampak tudi iz političnega in socialnega vidika. V Evropski Uniji je proces konvergence pomemben med drugim tudi zaradi politične konvergence in lažjih odločitev, ki jih lahko tako izvoljeni poslanci sprejemajo. Velike ekonomske razlike med državami onemogočajo učinkovito načrtovanje in predstavljajo problem iz vidika razporejanja sredstev, popolnoma drugačnih političnih usmeritev, kar pa lahko potencialno ogrozi celo strukturo Evropske Unije. V zadnji finančni krizi je zaradi prekinitve ekonomske konvergence ta problem postal boleče očiten, povezava med ekonomsko, socialno in politično konvergenco, pa se je izkazala za enega izmed glavnih razlogov za nastanek populističnih gibanj v nekaterih državah članicah Evropske Unije. Zato je globje poznavanje procesa koristno iz vidika oblikovanja ekonomskih politik, poleg tega pa je potrebno razumeti, katere sile vplivajo na ta proces. V tej magistrski nalogi sem se odločil raziskati absolutno in pogojno beta ter sigma konvergenco, kot jih je definiral že Sala-i-Martin (1995). Poleg tega se v nalogi osredotočam na vpliv zadolženosti javnega in privatnega sektorja na gospodarsko rast in posledično na vpliv, ki jo zadolženost ima na konvergenčni proces.

Glavna raziskovalna vprašanja mojega magistrskega dela so torej:

- Kakšna je povezava med zadolženostjo in rastjo?
- Ali je v Evropski Uniji prisotna absolutna beta konvergenca?
- Kakšen vpliv ima zadolženost na konvergenco - ali bolj zadolžene države konvergirajo drugače?
- Ali se v relativnem smislu zmanjšujejo razlike v BDP na prebivalca v državah članicah Evropske Unije?

Prvo poglavje predstavlja pregled relevantne literature. Študije Reinhart in Rogoff (2010), Baum, Checherita in Rother (2010), Checherita in Rother (2010) ter pa Kumar in Woo (2010) vse prikazujejo določeno nelinearno zvezo med zadolženostjo javnega sektorja in gospodarsko rastjo. Nad določeno mejo namreč v teh študijah dodaten javni dolg v BDP močno upočasni gospodarsko rast, vsaka izmed njih pa prikazuje malenkost drugačno zvezo. Študijo linearnosti vplivov in pa vplivov na konvergenco sem se zato odločil izpeljati ekonometrično preko modeliranja procesov rasti, kjer sem kot kontrolne spremenljivke vključil različne indikatorje, ki so jih študije rasti že povezovale s konvergenco in rastjo. Zbral sem podatke iz baz Eurostat, World Bank in pa IMF za 28 držav ki trenutno tvorijo Evropsko Unijo v obdobju med 1995 in 2017. Za potrebe preverjanja in testiranja konvergence in nelinearnih vplivov sem v grobem definiral tri oblike modelov - navaden linearni regresijski model, linearni model statičnih panelnih podatkov in pa dinamični model panelnih podakov, vsakega izmed njih pa sem testiral v več specifikacijah izbranih pojasnjevalnih spremenljivk. Med drugim sem se v pregledu literature osredotočil na determinante javne zadolženosti iz študije Swamy (2015), in pa na problem finančne

poglobljenosti, ki so jo raziskovali Arcand, Berkez in Panizza (2015) in pa Levin (1993, 1997). Iz omenjenih študij je mogoče opaziti, da je razvitost finančnega sektorja (merjena z različnimi indikatorji) pozitivno korelirana z gospodarsko rastjo, kljub temu pa je prisoten nelinearen vpliv, kjer prevelika razvitost oziroma poglobljenost prične negativno vplivati na rast. Ker je poleg javne zadolženosti pomembna tudi zadolženost privatnega sektorja, sem se osredotočil tudi na študije obnašanja ekonomskih subjektov v pogojih visoke zadolženosti in finančnih omejitev. Campello, Graham in Harvey (2011) opozarjajo na dejstvo, da se podjetja obnašajo povsem drugače v časih visokih finančnih obremenitev in pomanjkanja financiranja, kar pomeni, da tudi njihove odločitve niso sprejete optimalno. Dolg privatnega sektorja je torej zanimiv iz vidika spremembe racionalnosti obnašanja posameznih ekonomskih subjektov (podjetja, organizacije, fizične osebe), kar pa lahko močno vpliva na gospodarsko rast in posledično tudi na konvergenco.

V drugem poglavju sem definiral metodologijo raziskave, ki sem jo nato opravil v četrtem poglavju. Med drugim sem definiral vse funkcijske oblike modelov testiranja hipotez o obstoju absolutne in pogojne konvergence in podal razlago za vse statistične teste za specifikacijo in ustreznost modela, ki sem jih potem opravil pri vsakem modeliranju. V opisu metodologije sem se naslanjal na raziskave o konvergenčnih procesih. Študije Barro in Sala-i-Martin (1990, 1991) in pa Sala-i-Martin (1995) kažejo na absolutno divergenco na svetovni ravni, medtem ko države, ki tvorijo bolj koherentne ekonomske zveze (EU, OECD, ZDA) med seboj konvergirajo. Sigma konvergenco na ravni Evropske unije je med letoma 2000 in 2012 preučeval Simionescu (2014), kjer je jasno razvidno, da le-ta obstaja.

V tretjem poglavju sem se najprej osredotočil na razlage in pregled zbranih podatkov, kjer sem ponudil opisne statistike in pa razloge za vključitev teh spremenljivk v podatkovno bazo, nato pa na temeljit grafičen pregled gibanja javnega dolga in dolga privatnega sektorja v BDP v izbranem obdobju za vsako izmed 28 držav. Gibanje javnega, privatnega in celotnega dolga sem dodatno analiziral na agregatni ravni za celotno Evropsko Unijo, kjer se iz gibanja že za vsako državo posebej, sploh pa za agregatno analizo opazi povečevanje javnega dolga v obdobju med 2008 in 2015 in pa padanje od leta 2015 naprej. Obratna zgodba se v istem obdobju odvija za dolg privatnega sektorja, kjer je iz grafičnih prikazov mogoče zaslediti jasno viden kreditni krč, saj je po letu 2009 privatni dolg v BDP začel padati.

Četrto poglavje predstavlja glaven del študije, ki sem jo opravil kot samostojen prispevek k celotni temi naloge. Najprej sem grafično in tabelarično raziskal vpliv javne zadolženosti na rast BDP na prebivalca v različnih zamikih obdobij. Glavna ugotovitev je, da je zadolženost javnega sektorja negativno ampak linearno povezana z rastjo tudi, ko omogočim zamik rasti po določenem številu let. Analiza pokaže, da je prečkanje mej med 90 in 100 odstotki javnega dolga v BDP linearno tudi, če je dolg opazovan v letu t, rast pa v obdobjih t+1, t+3 in t+5. Poleg tega se povprečna rast vseh držav in mediana rasti zmanjšujeta linearno, ko se zadolženost javnega in privatnega sektorja veča. Ker je bilo predvsem v različnih medijih v obdobju med 2008 in 2015 mogoče zaslediti argument, da za rast ni toliko škodljiv sam dolg kot pa hitrost akumulacije dolga, sem opravil tudi analizo med absolutno akumulacijo javnega dolga in rastjo, kjer je mogoče zaslediti zanimivo povezavo. Najprej je razmerje linearno in negativno, nato pa se skozi leta prevesi celo v pozitivno zvezo, kar lahko pomeni, da velika absolutna sprememba javnega dolga v BDP v letu t dejansko prisili državo v večjo učinkovitost, ki se prikaže z zamikom. V Evropski Uniji je rast v obdobju t+5 tako pozitivno povezana z veliko absolutno spremembo zadolženosti v obdobju t. Nelinearne vplive javnega dolga na rast sem testiral tudi ekonometrično, kjer sem uporabil neprave interakcijske pojasnjevalne spremenljivke za različne nivoje javnega dolga v BDP, glavna ugotovitev pa je, da v izbranih podatkih ni nikakršne nelinearne zveze, kar je v nasprotju s študijami, ki take vplive prikazujejo. Pri tem poudarjam, da moji rezultati ne zanikajo rezultatov teh študij, le, da na podatkih za Evropsko Unijo med leti 1995 in 2017 te zveze ne držijo. Podobne postopke sem ponovil tudi za zadolženost privatnega sektorja, kjer je povezava podobna, razlika je le v tem, da je v podatkih mogoče zaslediti nelinearno povezavo, ampak v obratni smeri – nad mejo 240 odstotkov privatnega dolga v BDP, se negativna občutljivost rasti dodatnega dolga namreč zmanjša.

Konvergenčni proces sem najprej raziskal grafično, kjer sem konvergenco razdelil glede na nivo bogastva v državah. Ugotovil sem, da je konvergenčni proces v skoraj vsaki državi prekinjen med obdobjem 2008 do 2010, kar pomeni, da sta recesija in svetovna kriza imeli velik vpliv. Zanimivo je dejstvo, da srednje bogata skupina držav ne konvergira proti bogati, medtem pa države z manj bogastva močno konvergirajo proti bogati skupini do leta 2008.

Sledi analiza beta konvergence po definiciji ponujeni v Sala-i-Martin (1995) - najprej v absolutni definiciji, kjer bogatejše države rastejo počasneje, nato pa še analiza pogojne beta konvergence, kjer bogatejše države rastejo počasneje tudi, ko so kontrolirani vplivi ekonomskih spremenljivk, ki vplivajo na rast. Pri analizi absolutne konvergence sem najprej primerjal globalno oceno koeficienta konvergence s koeficientom za Evropsko Unijo, kjer je mogoče sklepati, da med ekonomsko in socialno bolj podobnimi državami, ki so pogosto tudi geografsko blizu, prihaja do višje in hitrejše konvergence, kot pa v globalnem pomenu, ki dejansko prikazuje divergenčni proces. Nadaljeval sem z analizo pogojne beta konvergence, kjer sem najprej testiral razširjeni model vplivov na rast s poudarkom na testiranju vpliva javnega dolga ne samo na rast, ampak tudi na koeficient konvergence. Vprašanje, na katero sem skušal odgovoriti, je torej, če bolj zadolžene države konvergirajo počasneje. Presenetljivo, rezultati ocen regresijskih koeficientov kažejo, da med hitrostjo konvergence visoko zadolženih in nizko zadolženih držav dejansko ni statistično značilnih razlik. Nato sem testiral še poenostavljeni model, oba pa kažeta jasno zvezo – konvergenca v Evropski Uniji obstaja v absolutni in pogojni obliki, njen obstoj pa ni pogojen z velikostjo dolga, kot to razlagajo Artelaris, Kallioras in Petrakos (2015).

Sigma konvergenco sem v četrtem poglavju testiral grafično in preko korelacijske matrike, ne pa tudi parametrično, glavna ugotovitev pa je, da obstoj sigma konvergence ni tako jasen kot v beta obliki. Sigma konvergenca je v Sala-i-Martin (1995) definirana kot zmanjševanje razpršenosti oziroma variance BDP na prebivalca med državami. Podatke sem analiziral tudi v obteženi obliki, kjer sem uteži določil preko deleža populacije v določeni državi v določenem letu glede na skupno populacijo v istem letu v Evropski Uniji oziroma v vseh 28 državah, ki danes tvorijo Evropsko Unijo kot celoto. Varianca in pa koeficient variacije logaritma BDP na prebivalca se zmanjšujeta do leta 2008, nato pa se konvergenčni proces za skoraj tri leta prekine. Drugačno zgodbo prikazuje obtežen vzorec, kjer se varianca v grobem povečuje skozi celotno obdobje, koeficient variacije pa se do 2008 zmanjšuje, nato pa je moč opaziti trend naraščanja. Rezultati so v grobem primerljivi s študijo Simionescu (2014), kjer je med letoma 2000 in 2012 v Evropski Uniji prisotna sigma konvergenca. Za parametrično testiranje pogojne sigma konvergence nisem uspel zbrati dovolj podatkov, saj struktura podatkov za pogojno sigma konvergenco med leti 1995 in 2017 ponudi samo 23 opazovanj, kar pa je na žalost absolutno premalo za kakršnokoli ekonometrično modeliranje.