
# The debt-growth relation in central-western Europe in a new economic and financial era

Jury members

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# Executive summary

The purpose of this thesis is to include the problems of implicit pension debt to the debate about high public debt levels and economic growth. It analyses the impact of explicit public debt and implicit pension debt on economic growth rates in the oldest six European countries over the recent period 1995-2015. The methodology used to investigate these relations is based on a neoclassical growth model inspired by the Solow model. Implicit debt levels are estimated with current pension expenditures and the expected average remaining years of life of the current retirees in each country. The conventional method of quadratic regressions is used to check for nonlinearities. The results show some evidence for a negative linear impact of explicit debt levels on economic growth for debt levels below the 90% of GDP. Even though the statistical significance is not entirely reached for the regression including implicit debt, standard errors and p-values improve drastically compared to the explicit debt analysis. Furthermore, the descriptive statistics show the importance of implicit pension debt. In order to improve these results, it is recommended to broaden the database in the future and to deepen the research on more accurate methods of implicit pension debt estimations.

*French version*

L'objet de cette thèse est d'inclure les problèmes liés à la dette implicite des pensions au débat sur la croissance économique et les taux d'endettement public élevés. L'impact de la dette publique explicite et implicite sur la croissance économique est étudié dans les six pays fondateurs de l'Union Européenne sur une période récente, de 1995 à 2015. La méthodologie employée est basée sur le modèle de croissance néo-classique de Solow. La dette implicite est évaluée sur base des dépenses publiques de pensions courantes et l'espérance de vie moyenne des pensionnés dans chaque pays. Afin d'apprécier des relations non-linéaires, la méthode des régressions quadratiques est employée. Les résultats de cette étude confirment la présence d'un effet linéaire négatif de la dette publique explicite sur la croissance économique pour les niveaux de dette inférieurs à 90% du PIB. L'analyse portant sur la dette implicite ne présente aucun résultat significatif. Malgré tout, ces régressions permettent d'améliorer les écarts-type par rapport aux régressions sur base de la dette explicite. En outre, les statistiques descriptives permettent d'appuyer l'importance et l'ampleur de la dette implicite des pensions. Afin d'améliorer les résultats, il est recommandé d'étendre les bases de données dans le futur et d'approfondir les recherches en matière de la dette implicite.

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# CHAPTER 1: Introduction

Public debt levels have increased continuously since the 70s-80s in advanced economies and today they attain historically maximal levels. However, attention has never been drawn to this intense increase, not until the first financial crisis of the 21st century. Following the Great Recession which burst out in the United States in 2007 and has spread to the world since then, Europe has been struck by yet another crisis: the sovereign debt crisis. As a consequence to the Great Recession, many banks in the advanced world needed to be saved by the governments. The burden borne by the governments of the Euro zone was particularly substantial. For instance, it was in October 2011 that the Belgian state raised €4 billion to save the bank "Dexia", a bank of French, Belgian, and Luxembourgish collaboration (OEIC, 2015). After having benefited from several help packages of Belgian, French, as well as Luxembourgish origins, the bank finally fell victim of the large liquidity squeezes triggered by the financial crash of 2008.

The Dexia case was not the only incident where a bank needed to be saved by European governments. In fact, during the last quarter of the year 2011, many of the most important European banks were deemed as "too big to fail" as governments relied especially on these banks to provide liquidities in the financial markets and to support the public debt creation process. Although the crisis and its rescue-packages have certainly played a role in the public debt build-up of industrialized countries, there are some signs that it is not the major cause: growing budget deficits are accountable for a large proportion of the rise in public debt since the crisis (Nautet & Van Meensel, 2011). The change in the employment and pension landscape in European countries is in fact mainly responsible for these increasing budget deficits. As a matter of fact, public pension expenditures are confronted to large expansions because of the ageing population in most of the advanced economies. As most countries are bound to unfunded pension programmes, the financing of these increasing expenditures will most likely have to rely on future debt issue. Consequently, pension expenditures represent an implicit future debt of the government, another burden on public finances.

The dangers of the long-lasting crises which reign in Europe and other advanced and developing economies ever since are plentiful. Spiking unemployment (Elsby, Hobijn & Sahin, 2010), distorted saving behaviour, indebted consumers, and the rise of political turmoil (Bellofiore & Halevi, 2014) represent only a few of the harmful consequences. Moreover, without policy adjustments, population dynamics and the stress created by health care and pension allocations

will push the public debt burden even further in advanced economies. Nautet & Van Meensel (2011) project that, without any change in policies, pension systems will push explicit public debt levels beyond 180% of GDP in the euro area within 15 years.

Economic growth has been substantially hit since the European sovereign debt crisis, and perishes even more since austerity measures remain enforced and, if they exist, solutions remain rather blurry. It appears that the low growth episodes occurred simultaneously to the sovereign debt crisis. As a consequence, researchers have been tempted to investigate on the relation between public debt levels and economic growth. The dominant hypothesis in the debate is that high levels of public debt exercise a negative pressure on economic growth through channels such as inefficient investment, low productivity rates and unsustainable economic models.

The literature on the relation between public debt and economic growth is large. Many studies attempt at identifying the differences between developing and advanced economies. Others focus on advanced economies or European countries. More recently, researchers have drawn their attention towards the application of endogenous threshold models in order to find a significant debt threshold. Even though some studies are able to find the evidence of threshold levels, allowing them to conclude that increasing debt burdens negatively affect economic growth, this evidence is not largely spread: analyses that particularly focus on more recent time spans fail to confirm any evidence for the relation.

The aim of this thesis is to review the existing literature and to contribute to it in the following way: first, the analysis focuses on a shorter time-span in order to look for the relation between debt and growth that is present today. Second, it includes a measure of implicit (public) pension debt in order to take account of the future massive expenses governments will face. It attempts to find answers to the following questions: Is there an ascertainable relation between debt and growth? If so, does debt negatively affect economic growth? Are nonlinear relations justifiable? How does the 90% threshold fit to the data? Lastly, what is the role of implicit pension debt and how does it affect the relation between public debt and growth?

The choice of a shorter time span is easy to understand. After the Second World War, Europe has known a rather long period of reconstruction and high growth (1950-1970). This period is usually known as the Golden Age. Subsequent to this, arrived a period of unrest due to the collapse of the Bretton Woods system. The 1990s were marked by the diffusion of financial innovation throughout the world. These lead to the economic and financial systems as one knows

them today. As a consequence, the new economic and financial era describes the period of financial and economic innovation and change that started in the 90s and lead to the crises and problems of today. It is also characterised by stagnating economic developments, low unemployment levels and problems caused by the ageing of the population.

As public pension expenditures represent a large share of total government expenditures, and will be increasing dramatically over the next decades, it is important to include them in the public debt debate. However, research in the field of implicit pension debt is a young branch of economic analysis and data is not collected in a systematic way. Nevertheless, regarding the future expansion of public pension expenditures, it is a priority to include these public costs in the public debt debate.

This thesis is structured as follows: chapter 2 review the existing literature that studied the relation between government debt and economic growth. It especially focuses on the initiators of the current debate, Reinhart and Rogoff, and the subsequent development in the research. Chapter 3 introduces the data as well as the selected methodology and illustrates some descriptive statistics. It shows the evolution of public debt levels and economic growth, the evolution of government expenditures and introduces the concept of implicit pension debt. Chapter 4 presents the results. Chapter 5 discusses the limitations of this study and developments for research in the future. Finally, chapter 6 concludes.

# CHAPTER 2: Literature review

## 2.1 The « remote » theoretical literature on public debt

Followers of the Keynesian institution about state intervention might have claimed, in the beginning of the crisis, that state intervention is necessary to resolve the problems. Today however, positive consequences of the liquidity injections aiming to revive economic activity remain rather weak. Instead, austerity measures have taken the lead in European governments. The debate about debt stabilisation and debt reduction reaches more importance than ever. Therefore, the question of how to manage public debt levels and what their impact on growth is become of high priority. Since the turn of the last decennia, researchers have attempted to tackle these issues and the empirical as well as the theoretical literature on economic growth and its relation to debt levels has increased.

Although the recent crisis motivates the hypothesis a lot, the topic has been touched upon in the past as well, although not thoroughly. Diamond (1965) established a neoclassical growth theory in order to investigate the long-run competitive equilibrium of growth and how it is affected by government debt. Taxes are supposed to be raised in order to finance government debt and affect individual utility. The intergenerational model particularly focuses on the steady state, or the 'Golden Age Path' of the distribution of individual consumption and utility over a lifetime, allowing for different quantities of outstanding government debt. Furthermore, the model makes a distinction between external and internal debt. In a somehow different intergenerational model, Aiyagari and McGrattan (1997) investigate the costs and benefits of public debt in a framework based on US-economy characteristics and attempt to determine the optimum quantity of debt and how deviations affect the economy in the USA.

Barro (1979) on the other hand, builds a theory of optimal public finance and studies what factors come into play in the decision process for debt issue or taxation. Variables that are found to be important in the determination of a public debt level are the expected inflation, temporary government expenditure and national income, whilst the existing level of debt appears to be insignificant with respect to future debt issue (Barro 1979). The hypothesis that the interest rate influences the growth rate of public debt is not confirmed by the empirical analysis either. However, with the modernization of financial markets, times have certainly changed as in 2016

astonishing negative interest rates appear[1]. Furthermore, Barro (1979) points to an improper measurement and therefore it cannot be excluded that interest rates can affect the public debt path. As it covers data from the 20th century, Barro's (1979) study reflects very clearly the influence of wars that increase public debt tremendously through war expenditures.

Consequently, previous theoretical literature rather centres on the different means of financing a government, i.e. taxation or debt issuance as well as on welfare analysis of the optimal level of debt. Even though these studies have brought highly valuable insights, today they are somehow outdated. In fact, over the last four decades, one has observed surprising changes in public debt behaviour and movements in financial markets. Furthermore, the effects of the century of wars are not present anymore.

This remote literature on public debt does not present a model that explicitly theorises the effect that public debt (external or internal) has on the growth rate of an economy. More recently, Greiner and Fincke (2009) have developed a theoretical model of the relation between public debt and growth that is built on three pillars: the household sector, the productive sector and the government sector. This basic theoretical model assumes that public spending, described as simple waste of resources, follows in no ways a productive or utility maximizing objective. As governments can, nowadays, use fiscal policies to affect growth levels, this variable should be regarded as endogenous in economic growth models (Greiner and Fincke, 2009).

As the reminder of this section will show, the relation between economic growth and public debt is quite difficult to determine and varies substantially with respect to the assumptions made. It is therefore very delicate to establish a theory that would correctly apply to a multitude of cases.

## 2.2 Reinhart and Rogoff in 2010: Growth in a time of debt

More recent literature has focused on the empirical relation between debt levels and growth rates. The initiators, if one may call them so, of this empirical literature are Reinhart and Rogoff (2010), who are well known authors for their contributions in the field of the economic impacts of various crises. The authors support that financial crises harm asset prices, employment, and economic development and trigger public debt build-up (Reinhart & Rogoff, 2009). In a paper published in 2010, the authors seek for a systematic relationship between debt levels, growth and

[1] Negative interest rates will be discussed in a later chapter of this work.

inflation (Reinhart & Rogoff, 2010). On the basis of a database covering over 200 years and a range of advanced as well as developing countries, results show that the link between the two variables of interest is rather weak at "normal" levels of debt (Reinhart & Rogoff, 2010a). Only very high levels of debt, defined as beyond 90% of GDP, are found to negatively affect economic growth. In fact, their post-war observations for advanced economies show that median growth rates are around 1% lower in the high debt category (characterized by a debt/GDP level beyond 90%) and reveal that growth rates even decline by 4% compared to lower public debt categories (Reinhart & Rogoff, 2010).

Moreover, according to the authors, the relation is remarkably similar across emerging and advanced economies. However, external debt is more binding in developing countries, as these must rely on some sort of foreign borrowing more frequently. On the other hand, advanced countries usually do not rely on external debt as their primary source of financing. The conclusion that the relation is similar across both types of countries is quite questionable, as transmission mechanisms are very different across developing and advanced economies. Public debt levels in Europe have been affected by the financial crisis of 2008 which lead to the multi-year sovereign debt crisis that erupted in 2009.

Furthermore, the paper does not confirm any specific mechanisms between inflation and public debt levels (Reinhart & Rogoff, 2010). This result certainly does not apply to the present. The quantitative easing programme of the European Central Bank was established in order to increase inflation in the euro area and attain levels of inflation below, but close to 2%. The effect of such a policy on government bond yields is to reduce these drastically (Claeys, Leandro & Mandra, 2015). With low government bond yields, debt becomes less expensive for governments. As a matter of fact, the risk exists that governments of the euro area will take advantage of the situation and issue larger amounts of debt than expected. Therefore, it is supposed that inflation influences debt levels at present.

Although the method used in Reinhart and Rogoff's initial paper is purely based on the analysis of correlations between variables, it has enabled to guess some kind of relation between debt and growth and has triggered the current debate. Reinhart and Rogoff (2010) define a 90% level in the debt-to-GDP ratio as the important threshold and conclude that when a country's gross government debt is above this threshold, average growth levels are about 4% lower than when debt levels are below this threshold in advanced economies. For developing economies that decline is about 3%. No significant effects are observed for debt levels below 90% of debt/GDP.

These results have contributed to the building of the current debate around government debt structures and their management. They also seem revealing and helpful for the future political decisions. They seem to clearly translate a negative relation between growth and debt at debt levels beyond 90% of debt/GDP, whereas no significant relation is observed below it, pointing to the importance of debt reduction and debt sustainability measures in countries whose debt levels have passed the 90% threshold. Most of the time, advanced countries are the ones that have higher levels of public – as well as private – debt. Accordingly, these economies should focus on debt reducing activities especially, since the economic and financial crisis of 2008 has contributed to a substantial debt build-up.

### a) Sources of doubt arising from the covered periods of time

Nevertheless, some questions arise on the reliability and applicability of Reinhart and Rogoff's findings. Sources of doubt arise concerning the covered periods of time as well as the robustness of the results. The first time span covered (1946-2009) indeed includes the post-war years of reconstruction during which high public debt levels reflect a normal feature rather than an abnormality. Furthermore, post-war periods are usually characterised by rather explosive levels of growth that correspond to the reconstruction of a country. Results therefore seem biased because of the effects of post-war reconstruction financing and the resulting growth. Moreover, conclusions relying on post-war data are difficult to apply in times of peace and financial developments and innovation that characterise the end of the 20$^{th}$ and the 21$^{st}$ century.

The second time span used in Reinhart and Rogoff's 2010 paper is 1790-2009. This one reaches far back in time. Even though the data can reflect interesting historical facts and relations, the conclusions drawn from that dataset might not reveal anything of interest for the present times and the current policy debate around debt sustainability and debt reduction. Government debt levels have never been as high as they are today and the build-up of these high debt levels begun in the 1970s. It has consequently occurred over a rather short period of time. The data of the 20$^{th}$ century does not seem representative of the new financial era as it reflects the century of wars. The data before this period, covering the end of the 18$^{th}$ century and the entire 19$^{th}$ century, is certainly of high interest but government finances were functioning differently from today. Therefore, it could yield misleading conclusions when this data is used in empirical exercises on political issues of the present.

The only time-span in Reinhart and Rogoff's analysis that reveals some useful information for the future and the understanding of how it may be valuable in the current policy debate is the one covering 1970-2009, which are the years that correspond the best to the 'new financial era' that reigns over today's modern society. The analysis that covers this period is, however, based on a database of 20 developing economies and its results are consequently irrelevant for advanced countries[2].

### b) Sources of doubt arising from the robustness of the results

The robustness of Reinhart and Rogoff's results is quite questionable too. In fact, a "historical boundary" of 90% in debt-to-GDP is unlikely to hold for a range of heterogeneous countries and it certainly varies over time. Herdon, Ash, and Pollin (2014) study these questions deeply and come up with interesting results: Reinhart and Rogoff's analysis is deemed unrobust across countries, periods of times and methodologies. In their critique of Reinhart and Rogoff's work, these authors conclude that the resulting relation between debt and growth beyond the 90% threshold is overstated and inaccurate due to three main errors made by the initial authors. Herndon et. al. (2014) have diagnosed three substantial problems: selective data exclusions, coding errors and inappropriate weighting methodologies. Taking the measurement errors into account, the authors conclude on the following statement:

*"when properly calculated, the average real GDP growth rate over 1946-2009 for countries carrying a public debt/GDP ratio greater than 90% is actually positive 2.2%, not negative 0.1% as RR claim"* (Herndon, Ash and Pollin, 2014).

Herndon et. al. (2014) emphasize that a non-linear relation is well present between the two variables. However, it occurs at public debt/GDP levels that lie between 0% and 30%. As pointed out by the authors, these debt levels seem trivial in the current political debate in advanced economies since most of them face public debt levels higher than 30% of GDP.

Nevertheless, when discussing the relevance of results in the current political debate, there is room for improvement. Indeed, Herndon et. al. (2014) replicate the exercise for only two time spans: 1946-2009 and 1790-2009. In order to be more suited to the current political debates in advanced economies, it would be interesting to replicate the exercise for advanced economies on a more recent time span, focusing on the end of the 20$^{th}$ century and the 21$^{st}$ century. Here it must be noted that Herndon et. al.'s main focus is to point towards the errors leading to an

[2] These results are included in the working paper version of Reinhart and Rogoff, 2010.

overstatement of the nonlinear relation between growth and high levels of public debt. By replicating Reinhart and Rogoff's work, they do in no means claim that a nonlinear relation is impossible at high levels of debt in advanced economies. However, on the basis of their own calculations, Herndon et. al. (2014) are able to conclude that the relation between public debt and economic growth weakens over more recent episodes. As a consequence, austerity measures can no longer be maintained based on the argument that further public indebtedness would severely damage a country's economy. This critical paper has largely contributed to encourage the collection of new databases, the optimization of threshold-calculation techniques and further studies on the relation between debt and growth in advanced economies.

In an errata document Reinhart and Rogoff (2013) correct the errors they had been accused of. Nevertheless, results stayed quite similar, although the gaps between low-debt and high-debt categories were slightly reduced (Reinhart & Rogoff, 2013). Country-per-country averages of peacetime growth drop for every country in the sample. Overall, the average and median growth rates appear to be cut by – at least – half between the categories of very low debt/GDP (0%-30%) and very high debt/GDP (>90%) levels.

The "out of the blue" assumption of a 90% threshold made by Reinhart and Rogoff is actually inspired from some earlier study in which the discussion is centred on debt intolerance levels. Debt intolerance behaviours highly depend on a country's default history and various other factors such as sovereign credit rating, external debt levels and access to capital markets (Reinhart, Rogoff & Savastano, 2003). Consequently, the relation between debt and growth levels is certainly country-specific (Reinhart and Rogoff, 2009). It is therefore easy to understand that the 90% threshold assumed in Reinhart and Rogoff's paper would certainly not be applicable to every country, as opposed to what the authors suggest in their 2010 paper.

The publishing of Reinhart and Rogoff's paper has awakened a large interest. Its main drawbacks were the conclusion of no differences across developing and advanced countries and the assumption that the 90% level of debt/GDP is a universally dangerous debt threshold. Later studies have aimed at resolving these issues. The focus on differences between developing and advanced countries, attempts to resolve the problem of reverse causality and methods of calculating correct thresholds have emerged. The next section reviews the "post Reinhart and Rogoff" literature and its main findings.

## 2.3 Following developments in the literature

Following Reinhart and Rogoff's contribution as well as the critique by Herndon, et.al. (2014), a large literature on the topic has arisen. Researchers have attempted to make the relation between debt and economic growth more scientific with empirical studies or have even attempted to elaborate a theory on the relation. Studies have deepened the knowledge about potential differences between developing and advanced economies and have tackled a series of issues such as country-specificity of the results, reverse causality between the debt and growth variables, or multicollinearity.

Another question the literature has tried to tackle, as the 90% threshold promoted by Reinhart and Rogoff is not supported by a lot of data, is the question of nonlinearities. Most studies attempt at confirming an inverse U-shaped relationship between debt and growth: up to a point, higher debt improves economic development whereas beyond this specific threshold, higher debt levels yield economic downturn. Methods to empirically establish that threshold have been elaborated by various researchers. Not surprisingly, there exists no commonly accepted threshold level in the empirical literature that followed Reinhart and Rogoff's paper. In the years following its publication, several studies found similar threshold levels based on more scientific methods. Later on however, new evidence in favour of much lower threshold levels has casted some doubt on the significance of the 90% threshold level. Other studies find no evidence for a significant relationship between public debt and growth rates.

The following sub-sections look at the conclusions of various studies, the issues encountered in the existing literature and how these were resolved and deepens the debate around the 90% threshold level.

### a) The differences between developing and advanced economies

One of the most important issues that followers of Reinhart and Rogoff's "revealing" paper have tackled is the differentiation between developing and advanced economies. In order to look at the differences across these countries, it is important to investigate what type of debt triggers economic downturn. In the case of developing countries it is often argued that external debt represents an important factor in the determination of economic growth while private and public debt levels attract the attention in advanced economies because these are more likely to provoke market failures and recessions.

Studies that focus on the relation between external debt and economic growth show interesting results for developing countries (Kumar & Woo, 2010). Advanced countries are assumed to have a weaker relation with respect to their level of external debt as they must not rely on it in the same way as developing countries have to. External debt represents a significant source of funding for the developing countries. A number of studies have put forward the importance of private debt and its impact on economic growth in advanced economies (Cecchetti, Mohanty and Zampolli, 2012). In fact, economic theory predicts that when the households' level of indebtedness rises, final consumption crumbles and economic growth declines. Furthermore, higher public debt often crowds out private investment via higher taxation and lower disposable income (Nautet & Van Meensel, 2011). This in turn implies that increasing government debt can indirectly affect economic growth through this crowding out effect.

Kumar and Woo (2010) analyse the effect of initial public debt on subsequent economic growth levels for a range of advanced and emerging economies focusing on the long term effects of this relation. They confirm the 90% turning point and conclude that a 10 percentage-point increase in initial debt-to-GDP ratio correlates to approximately a yearly 0.2 percentage-point reduction in annual real per-capita GDP growth and is stronger in emerging markets than advanced economies (Kumar & Woo, 2010). Also, the larger the initial debt level, the stronger the negative effect on growth. Kumar and Woo (2010) explain the adverse effects of debt on growth by the means of several channels of growth such as reduced labour productivity, lower investment and slower growth of capital.

Canner, Grennes and Koehler-Geib (2010) use the Hansen technique for threshold estimation[3] to highlight the difference between advanced and developing countries. The endogenous debt threshold for developing countries (64% of GDP) is much lower than the general one covering all countries (77% of GDP). This translates the higher sensitivity of growth to debt levels in emerging economies. Note that both of these thresholds are much lower than the exogenous threshold of 90% assumed in Reinhart and Rogoff (2010). In the same spirit, Minea and Parent (2012) use panel smooth threshold regression techniques. Their results confirm the presence of a negative relationship between public debt and growth at public debt ratios between 90% and

[3] Hansen B. (1996, 1999, 2000) develops various approaches to estimate single- and multi- threshold levels endogenously. He has established techniques for cross-sectional as well as panel data approaches. The main idea is to find the threshold level(s) that minimize(s) the sum of squared residuals of the regression. Various tests to measure the significance of the thresholds are also provided.

115% of GDP. Surprisingly, the relation turns positive at debt levels beyond 115% of GDP, which signals the existence of more complex nonlinearities between the two variables.

A factor explaining that interesting difference of debt thresholds across country groups is their openness to trade (Canner et. al., 2010). Many of the established barriers to entry are advantageous for advanced economies' development whereas emerging markets face more trouble of achieving a spot on international markets. Thereupon, emerging economies' growth and development capacities are distinctly more tied to the level of indebtedness of the country than it is the case for advanced economies.

Besides the literature that has focused on developing countries, other studies have steered their focus towards advanced economies. Having the same conception as this thesis, these studies point to the importance of catching the relation between the very high public debt levels of advanced countries and their growth rates as well as to the magnitude debt sustainability will achieve over the next years. In fact, the European sovereign debt crisis has proven that advanced countries are unable to sustain indefinite growth or to stay in control of their very high levels of debt. Although less spread than the analysis of developing countries and the links between external debt and growth rates, the literature that analyses advanced economies has gained some importance.

Advanced countries face an important demographic change due to ageing populations. Therefore, debt is likely to increase further over time and governments must act in order to take control of the debt situation. It has been advised that advanced countries' governments keep their debt levels below the thresholds in order to prevent dramatic effects in the case a new crisis hits the economy (Cecchetti et. al., 2012). For government debt, Cecchetti's et. al. (2012) calculated threshold lies between 84% and 96%, depending on whether a crisis variable is included.

Cecchetti, et. al. (2012) specifically study the impact of three different types of debt – private, non-financial corporate and government debt – for 18 OECD countries and found evidence that high debt retards growth and raises the risk and volatility of an economy. Empirical coefficients for private and corporate debt have no significant impact on growth whereas the coefficient of public debt is significant. Cecchetti, et. al (2012) locate the tipping point at 86% of GDP.

Checherita-Westphal and Rother (2012) have approached the problem of European countries' government debt earnestly. Using a balanced panel of 12 old European countries over the past 4 decades, they somehow confirm Reinhart and Rogoff's hazardous 90% threshold by finding a

robust 90-100% endogenous debt threshold with respect to economic growth (Checherita-Westphal & Rother, 2012). In the same spirit as Kumar and Woo (2010), the authors look for important channels through which this relation is affected. Non-surprisingly, these are private saving, public investment, total factor productivity and long-term nominal and real interest rates. In addition, some evidence that public debt might even have a prejudicial influence on growth rates below the calculated thresholds is put forward (Checherita-Westphal & Rother, 2012).

This concludes the part of this thesis that summarizes the main findings in the literature on public debt thresholds. Overall, estimated thresholds vary between 64% and 115% of debt/GDP for advanced economies. Although earlier studies mostly use exogenous threshold levels, more recent papers focus on methods which allow defining endogenous threshold levels as accurately as possible. Some studies argue for the lack of evidence for threshold levels once endogeneity is taken into account. The next section reviews the differences between exogenous and endogenous thresholds and analyses different methodologies used in the existing literature.

### b) Threshold levels: exogenous or endogenous?

In order to accept the existence of a threshold, causality requires some clarification. In fact, it must be assumed to depart from public debt towards growth. As Pescatori et. al. (2014) put it, if threshold effects exist between debt and growth, they must be driven by the causal effect of debt on growth. In the opposite case, where low growth induces higher debt, debt thresholds will not be particularly significant nor will they add much valuable information to the analysis. Nevertheless, when interpreting empirical result, the reverse causality bias must not be neglected.

Threshold levels imply two main issues. The first one relates to how to correctly define the threshold level while the second one is a matter of interpretation of the threshold level. Threshold levels can either be determined exogenously, as in Reinhart and Rogoff (2010), or endogenously, as later studies have attempted to define using data and empirical methods. An exogenous threshold level is often selected in advance to the actual empirical analysis. It has the advantage that it does not require complex threshold estimation techniques and is useful when the aim is to determine a relation around a specific, pre-selected level. Using a pre-determined exogenous threshold level is a good start to precede the estimation of an endogenous threshold.

In order to find more accurate results while using exogenous thresholds, it is best to use a multitude of potential thresholds. This method prevents misleading conclusions because the

initially selected single threshold might not be the best fitting one. Pescatori et. al. (2014) differentiate their study from Reinhart and Rogoff's initial paper through the use of such a method. Finding a 90% threshold as the turning point, the authors do not fail to draw the attention to the fact that this methodology is strongly influenced by the reverse causality and outliers. However, the 90% threshold level rapidly vanishes as the time horizons are extended to longer periods of time (Pescatori, et. al., 2014). Therefore, the authors completely reject the existence of debt thresholds relative to growth and suggest that debt trajectories are more relevant in predicting subsequent economic growth. Similarly, Panizza and Presbitero (2014) conclude that the evidence for threshold levels vanishes once endogeneity is taken into account.

On the other hand, endogenous thresholds are by far more accurate since they are estimated on the available data. Diverse statistical methodologies exist in order to detect a threshold level. The most conventional method to calculate a threshold level of a nonlinear relationship is to use a quadratic term in the estimated equation that translates the inverse U-shaped relation between debt and growth. The threshold level would correspond to the maximum (or minimum) of the curve. The use of a quadratic term in the regression implies the assumption of a specific nonlinear nature in the effect of public debt on growth. The caveat here is that the regression completely ignores other possible, more complex nonlinearities.

Other more advanced methods have been developed and are still improving. Examples include the Hansen technique of minimizing the sum of squared residuals (Hansen, 1996, 1999, 2000), or the adaptation of the Monte Carlo design to test for thresholds (Chudik, Mohaddes, Pesaran and Raissi, 2015). However, in any methodology it is fundamental to take account of possibly unobserved common factors in the quest for threshold levels. Neglecting this step could yield to erroneous conclusions (Chudik, et. al., 2015).

Canner, et. al.'s (2010) study of the relationship between total public debt and growth greatly contributed to debt-threshold debate: making use of a threshold estimation method developed by Hansen (1996, 1999, 2000), they are among the first to provide endogenous threshold levels of public debt/GDP. As mentioned before, they find an overall threshold of 77% of public debt/GDP for the entire sample and a 64% threshold for developing countries. These results agree with the previously mentioned argument that developing countries are more sensitive to high levels of public debt (Canner, et. al., 2010).

**Box 1: Debt threshold levels in the European context**

Following the Treaty of Maastricht on European Union that came into effect in November 1993, the European Union as it is known today was created. The Treaty instituted the economic and monetary union (EMU) and established a Stability and Growth Pact that listed rules to be followed in order to avoid diverging fiscal policies – which cause disastrous effects in a monetary union – and to monitor deficits and debt levels of the member states. These rules are often referred to as the Maastricht convergence criteria.

Protocol No 12 on the excessive deficit procedure of the Treaty establishes the reference values of the ratio of government debt to GDP. It is excessive once it reaches a ratio of 60% of GDP without diminishing at an adequate pace. However, when the Treaty was signed, many countries had government debt ratios that outreached the 60%. Critics have argued that the debt criterion is too vague and that each country could eventually act how it wished to, depending on its interpretation of the flexibility of the criteria (Gros, 2010). Furthermore, the choice of limiting deficit and debt levels at 3% and 60% respectively seems quite arbitrary (Baimbridge, Burkitt & Whyman, 1999).

The papers reviewed in this section all argue for threshold levels beyond the 60% of GDP established in the Treaty of Maastricht. Reinhart and Rogoff (2010) promote a 90% threshold for advanced as well as developing countries. Subsequent studies confirm threshold around 80%-90% of GDP for advanced economies or find even higher threshold levels that border on the 100% of GDP. More sceptic researchers have found somewhat lower thresholds for advanced economies, varying between 60% and 80% of GDP. Others have rejected the existence of threshold levels.

These results raise the question why the Treaty limited public debt to GDP ratios at 60%. Even if higher thresholds apply, would it be a better option to respect the 60% level because governments would then have larger "safety areas" if the debt level came to rise unexpectedly? Or would the economy be relieved of drastic austerity measures if the excessive debt criteria of 60% were abolished and gave room for more data-related numerical rules?

Amongst the "threshold-sceptics", many argue that a universally applicable single threshold level is unlikely to exist for advanced as well as for developing countries. Chudik, et. al. (2015) confirm the previous statement by developing threshold tests based on a Monte Carlo type of

test. These authors provide a deeper study of the importance to keep in mind several issues (e.g. reverse causality, heterogeneity, unobserved common factors) and elaborate a methodology that should help to prevent problems related to these. Even though their view is rather pessimistic, Chudik, et. al. (2015) find little significance for the existence of debt thresholds in advanced as well as in developing economies. The threshold levels resulting from their analysis are around 60-80% for the former, and 30-60% for the latter type of countries. Once common factors are included in the data, universal threshold levels disappear, or become at least insignificant.

Chudik, et. al. (2015) point to the importance of heterogeneity across countries. Heterogeneity does in fact hint to the possibility that countries could all have their own debt threshold, or at least their own dynamic threshold effect (Chudik, et.al.). Eventually, Chudik et. al. (2015) come to a similar conclusion as Pescatori et. al. (2014), namely that the debt trajectory is of higher importance and relevance rather than the debt level itself in defining the relation between debt and growth. Overall, exogenous thresholds have the advantage to ease the statistical methodologies. The most appropriate threshold value can easily be guessed from a quick look at the data. Endogenous thresholds, on the other hand, have the potential to reflect the relation between two variables more accurately.

Another issue arising with threshold applications is their interpretation. Even though accepting a threshold as a proper limit might be the statistical intuition, common sense questions such drastic interpretation and use of threshold levels. Assume an estimated 90% public debt to GDP threshold level. It is indeed highly debatable whether debt would still have a positive impact at the 89% level or, in the opposite case, whether the relation between public debt and growth immediately turns out negative once a public debt level of 91% is achieved. Therefore, threshold levels are interesting instruments but they should be interpreted with care.

## 2.4 Methodological problems

### a) Reverse causality

A range of problems have appeared in the empirical analyses of the relation between debt and growth. One of the most common but yet most inconvenient problems in empirical studies is the issue of endogeneity. Endogeneity appears whenever at least one of the independent variables in a model is correlated with the error term. This can appear in the case of an omitted variable, a

measurement error or the presence of simultaneity (Wooldridge, 2009). Simultaneity causes the reverse causality bias.

In the analysis of the relation between public debt and growth, the likelihood of simultaneity is high. Thereupon, reverse causality cannot be neglected. In fact, it is likely that growth depends on public debt, but also that public debt depends on growth, the dependent variable of the model. Reverse causality reflects the fact that a relation between two variables, the dependent variable and one independent variable, can work in both ways. In the case at hand, high public debt can reduce growth, whereas slow or inconsistent growth can trigger high levels of debt. The direction of the reverse relation is not pre-determined either: improving growth could push the level of debt downwards, by raising larger tax revenues, or upwards, by higher public investment for instance. On the other hand, a drop in growth could have similar effects, increasing debt because of a higher necessity in social insurance or reducing it because of lower public investment for instance. This is related to the assumption that a nonlinear aspect predominates the relation. When discussing the reverse causality aspect, the literature most of the time focuses on the arguments that high debt pushes growth down whereas low growth can trigger an increase in the level of public debt. Omitting an important variable that affects economic growth as well as public debt increases the potential of reverse causality and increases the bias of the results. This endogeneity issue is explained in the following example (Panizza & Presbitero, 2014): suppose the growth takes the following simple form:

$$G = a + bD + u,$$

Whereas public debt depends on economic growth:

$$D = m + kG + v.$$

Consequently, the ordinary-least-square (OLS) estimator of *b* is biased because:

$$\hat{b} = \frac{b\sigma_v^2 + k\sigma_u^2}{\sigma_v^2 + k^2\sigma_u^2}$$

and

$$E(\hat{b}) - b = \frac{k(1-bk)}{\sigma_v^2/\sigma_u^2 + k^2}.$$

Panizza and Presbitero (2013) have proven that the reverse causality bias is inexistent as long as the debt variable is not endogenous[4]. Otherwise, the bias on OLS estimators is downward. There exist two types of solutions to tackle the reverse causality problem. The simplest solution is to lag the independent variable which is likely to be correlated with the dependent variable. In this way, the reverse causality bias is mitigated because one links the independent variable of an earlier period *t-x* to the dependent variable of period *t*: using a lagged debt variable consequently mitigates the endogeneity bias because the debt level of period *t-1* for instance, is less likely to have a strong correlation to economic growth of period *t* than the debt level of period *t.* This method however, reduces the precision of the threshold estimates Furthermore, it is highly debatable whether lagged public debt is exogenous to future growth rates.

Another, more rigorous method of limiting the reverse causality bias is the use of instrumental variable methods. The trick is to select an instrument that is strongly correlated to the endogenous independent variable exclusively. This means that the instrument cannot show any correlation to dependent variable. It only affects the dependent variable indirectly, through the endogenous regressor. The most difficult task in this method is the selection of an accurate instrumental variable. In the case of the debt-growth relation this task appears particularly intricate because governments can now use fiscal policy to influence the growth rate (Greiner and Fincke, 2009). Consequently, most of the variables in this sector will be subject to reverse causality with the economic growth rate. An easily computable instrument for public debt could be the average debt level of the other countries as used in Checherita-Westphal & Rother (2012).

Moreover, when the long-term relation between the variables is the main focus, the use of rather longer periods of time is preferred as it helps to undermine the reverse causality problem (Pescatori, Sandri & Simon, 2014). Furthermore, longer data sets have the characteristic to smooth down the alterations of the data due to short term shocks.

All the methods illustrated above have advantages and disadvantages. The advantages of lagging the data are the following: i) the implementation is very simple, ii) there are limited additional data requirements and iii) it is very intuitive (Wooldridge, 2009). The limitations of this methods concern i) the more complicated interpretation of the results, ii) the likelihood of imprecise estimation and iii) the unknown size of the endogeneity problem and the lack of ways to test whether the lag is a good solution to the problem (Wooldridge, 20009). The main advantages of

[4] This is the case whenever k=0.

the instrumental variable technique are its transparency and the possibility to apply empirical tests, to verify the suitability of the instruments and to estimate the size of the reverse causality bias. However, it reduces the precision of threshold estimates as well.

### b) Multicollinearity

The issue of multicollinearity is quite important in the analysis of the effect of public debt on growth. Multicollinearity bias appears whenever two or more independent variables in an equation are highly correlated with each other. As public debt is likely to show a high correlation with many other economic and demographic indicators, such a bias is likely to appear when estimating the relation between economic growth and public debt. To minimize the effect of multicollinearity, it is important to select control variables wisely and to collect a large enough data set.

### c) Heterogeneity

In the critique of Reinhart and Rogoff written by Herndon et. al. (2013), the authors explain that heterogeneity is a big issue in the inquiry of public debt thresholds. They completely reject the idea that there exists a single universally applicable public debt threshold beyond which growth suffers from increased debt levels (Herndon, et.al., 2013). Even if one accounts for differences across developing and advanced countries, it is likely that countries react differently to increased public debt levels within the developing or advanced country categories. For instance Belgium, France and Germany do not necessarily face the same debt threshold, while Bolivia, Kenya and Panama certainly don't respond to the same "developing countries threshold". However, it is likely that threshold levels within a group of countries are more similar than threshold levels across different country groups.

Chudik et. al. (2015) contribute to the issue of heterogeneity by disentangling the threshold level from dynamic threshold effects. Country fixed effects methodologies do indeed allow for different country intercepts, but they do not allow for different country slopes. The focus of their analysis is to study heterogeneous dynamics while keeping the threshold parameter constant (Chudik, et. al., 2015).

## 2.5 What comes up next? Country comparability and the ageing population structure

As previously discussed, threshold estimation is not a simple matter. There are multiple factors that need further discussion. First, country heterogeneity never entirely vanishes even if a cluster of rather similar countries is selected as the sample. Second, the choice of the debt variable reveals to be a tricky matter. In fact, previous studies have focused on various types of debt: private debt, public debt, non-financial corporate debt. But which one is the best measure?

Country heterogeneity is a factor that will never disappear. In a mixed sample, that covers advanced as well as developing countries it is quite obvious that heterogeneity bias is present. Even though selecting countries of a same category, as for instance the euro area countries, will reduce heterogeneity compared to a mixed sample (advanced and developing countries) it is still present. Advanced countries, be they in different continents or within the same union, all show distinctive sensitivities in economic shocks and have different ways of handling these shocks and their economy. Consequently, the heterogeneity bias will never vanish completely, except if one is able to select two perfectly identical countries, clone countries, which is rather unlikely.

Including country fixed effects in the threshold analysis is substantial to catch part of some country-specific deviations. Panel fixed effects methods do however only cover differences in intercepts. There is no apparent reason why countries' growth rates would have the same sensitivity with respect to their debt level as their neighbours. As a matter of fact, the literature on this aspect is not very developed yet. Chudik et. al. (2015) introduce the concept of dynamic threshold effects that translates differences in debt coefficients once the threshold is passed in various countries.

If the analysis focuses on public debt, the most available data is based on national gross debt. As there are no exhaustive rules on how to measure national debt applicable to a range of countries, gross national debt is not entirely comparable across countries. Furthermore, debt variables are often expressed as a ratio with respect to annual GDP. As GDP calculations can vary from one country to another, the comparison of debt levels across countries can be an elaborate process, especially if the countries at hand have very distinctive ways of calculating debt and GDP levels. However, even though corruption and inefficiencies can lead to large errors in the measure of public debt and GDP levels in developing countries, it should not be too troublesome for advanced countries.

The European Union attaches great importance to the comparability of national data across its member countries. In order to attain the best possible results, it has established the European System of National Accounts (ESA 2010) which is the most recent EU accounting framework for "*a systematic and detailed description of the economy"* (Eurostat, n.d.). Nevertheless, it is important to keep in mind that there might be light variations in the measuring techniques of debt and GDP levels applied in advanced economies, especially when one compares advanced and developing countries.

Whether the selected debt variable refers to private, corporate or public debt depends on the aim of the analysis. As previously mentioned, some studies have focused on external debt, private debt, corporate debt or public debt. When the focus is set on developing countries, it is wise to use external debt, since developing countries are more sensitive to the outside world and usually heavily rely on external financing. Private debt is an interesting measure of debt because it reflects households' indebtedness. Even though firms produce the goods and have great power on the market, the well functioning of an economy eventually depends on the great number of households who consume the firms' productions. The reason why analysing the effect of private debt on growth seems so important is that without consuming households, an economy could not survive. A little private debt increases the opportunities to consume which makes the economy work. However, once households' indebtedness achieves too high levels, credit opportunities shrink and consumption decreases yielding a collapse of the economy.

Although the debt categories previously mentioned are certainly relevant in political decision making, the study of the effect of public debt on economic growth seems of greater importance in the current policy debate. Facts have proven that the unlimited feature of government debt is more a utopia rather than a reality. Moreover, after the financial crisis of 2008-2009 and the European sovereign debt crisis that followed, discussions have vigorously been oriented towards public debt sustainability and reduction measures.

Usually, (gross) government debt is defined as the accumulation of public deficits that have built up over time. It is issued by governments in order to cover the gap between government revenues and expenditures. Even though the public debt build-up crept on European countries over the past thirty years, the financial crisis of 2008-2009 has greatly contributed to it over the last decade. However, direct public debt is not all that matters: a country's fiscal and economic situation is closely bound to its contingent liabilities. These liabilities are not directly listed on a

government's balance sheet as the expenditure is conditional upon the occurrence of specific events (such as bank failures, for instance). They can be explicit or implicit in nature.

In the case of explicit contingent liabilities, the government is bound by a contract or by law to undergo some expenses once the specific event occurs (Polockova, 1999). In order to respect different conditions established by supra-national institutions (as the Stability and Growth Pact in the European Union for instance) or to simply reduce their official debt level, politics sometimes incline to hide part of their debts as government guarantees, even though the risk of higher expenses in the long-term is larger.

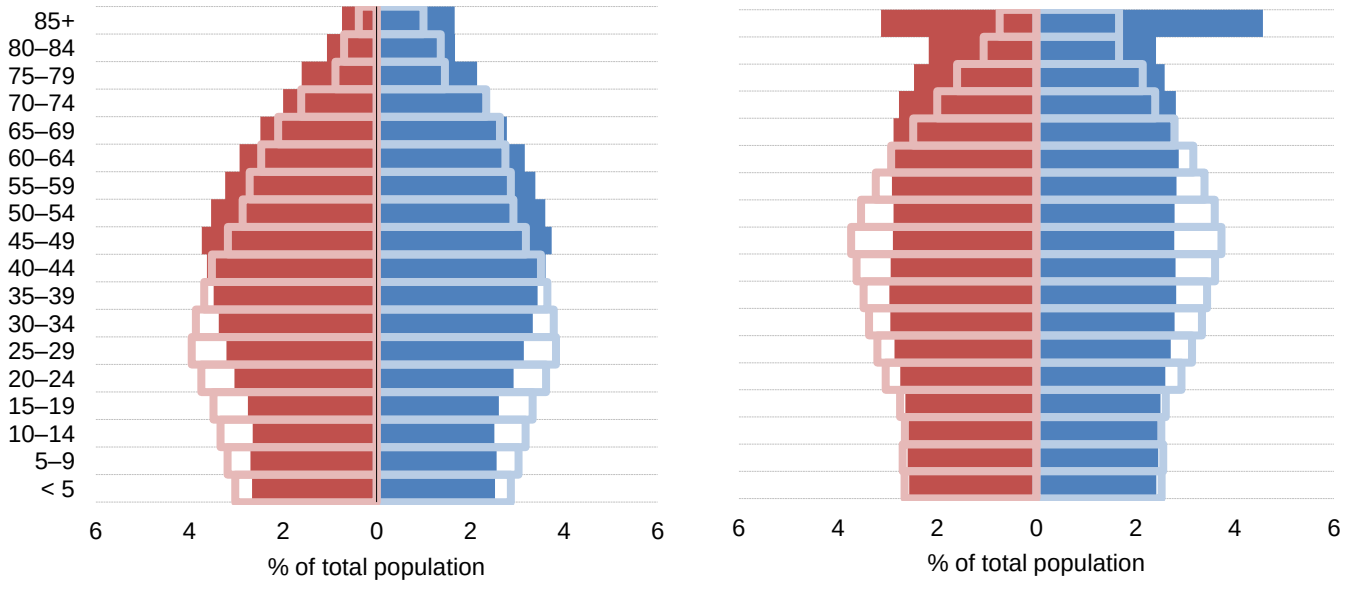
Implicit contingent liabilities, on the other hand, are unknown until the risky event takes place. The precursors of such an event, the value at risk, as well as the amount the government will have to disburse are all unpredictable. The most significant implicit contingent liability is denoted by the financial system itself because a government will usually spend massive amounts of money to rescue and pull its financial system through the crisis (Polockova, 1999). Therefore, explicit and implicit liabilities increase the vulnerability of the sustainability of public finances (Lojsch, Rodrigues-Vives & Slavik, 2011). Countries' finances were confronted with an increased financial burden due to explicit as well as contingent liabilities when the financial crisis hit the economy and banks strongly. On average, these added up to 5.5% of GDP and 6.5% of GDP respectively in euro area countries (Lojsch, Rodrigues-Vives & Slavik, 2011). From these figures it appears that contingent liabilities are significant in determining a state's financial situation.

It is no secret anymore that implicit liabilities contribute to government expenditures and, due to financing reasons, also to government debt even though not all of them are recorded on the governments' balance sheets. Besides the contingent liabilities, non-contingent liabilities, i.e. off balance sheet items the government is not legally bound to fulfil, increase the implicit or "hidden" debt of a government. Hidden debt – or implicit debt – consequently consists of a series of expenditures a government feels morally bound to undergo in order to satisfy the pressure of the public and interest-groups (Polackova, 1999). Public pension expenditures represent a direct implicit debt because of the government's promise to provide a source of revenue to the retired population. Private pension schemes can also enter into implicit debt if there exist government guarantees in the case of a failure of the private pension fund. The increase in implicit pension debt is likely to affect especially the countries with unfunded, pay-as-you-go public pension programmes because income taxes are the main financing (Kane & Palacios, 1996).

A substantial part of the implicit liabilities for which a government is responsible are the pension rights paid out to retirees by the governments as most public retirement programmes in European countries work under an unfunded pay-as-you-go system. Population dynamics show that an ageing population has settled as general trend in most of the advanced countries over the past few decades. The population tends to get older on average because mortality rates have declined and medical care has improved. Moreover, fertility rates have decreased.

As shown in graph 1 below, the general increase in life expectancy and the lower fertility rates have forced the age-pyramid to change in the European Union. The proportion of young individuals has declined between 1994 and 2014, whereas older cohorts of the population are increasing. Moreover, given the post-war baby boom, the number of individuals who are about to reach retirement age within a few years to a decade is large. Combined with the low fertility rates and the low employment rates of the young, state retirement programmes put an increasing burden on governments' expenditures and the implicit public debt levels. Predictions for 2080 forecast that the age pyramid will get thinner. The left panel of graph 1 show how the proportion of old-aged individuals will grow in Europe between 2014 and 2080.

**Graph 1: Population pyramid of Europe, UE-28, change between 1994 and 2014 and predictions for 2080**
(in % of total population)




*Notes: Left panel corresponds to the population change between 1994 and 2014. The right panel corresponds to population in 2014 and the predictions for 2080. Red colour stands for men, blue colour stands for women. On the left, empty and full bars represent 1994 and 2014 respectively. On the right, empty and full bars correspond to 2014 and 2080 respectively. Vertical axis shows 5-year age cohorts. Horizontal axis is the % of total population.*
*Source: Eurostat.*

## 2.6 Motivation and innovation of this study

The discussion above draws the attention on two major facts: the heterogeneity bias and the implicit pension debt. First, it is important to use a sample of countries that have approximately the same methods of accounting of their GDP levels and public debt levels. The selection of such countries will help improving the heterogeneity bias as well as ease the data comparison across these countries.

Second, and most importantly, implicit debt levels must not be underestimated. Governments are bound to various liabilities, be they contingent on some events, explicit or implicit. These liabilities are often not accounted for in national balance sheets. Accordingly, they constitute an implicit public debt that represents an additional non-negligible factor in the analysis of the debt-growth relation in advanced economies. From the discussion above, it appears that the implicit pension debt will become a massive problem and drain the sustainability of public finances. It is therefore highly important to take it into account in the analysis of fiscal systems, but also in discussions that focus on public debt and the implications it could have in the future. Since the crisis, public debt lies at record-levels in many advanced economies.

One of the main innovations of this thesis is to approximate implicit pension debt levels with current public retirement expenditures and incorporate it in the study of the effect of debt on growth. In the case where implicit pension debt levels do indeed feature a relatively strong impact on public debt levels, the results could strongly differ from previous studies that focused on the link between explicit gross government debt and economic growth.

Furthermore, in order to hopefully reduce the heterogeneity bias in the analysis, this study will focus on the six oldest European countries, namely Belgium, France, Germany, Italy, Luxembourg and the Netherlands. By doing so, it is not claimed that these countries feature perfectly homogenous characteristics. The aim is to minimize the sample in order to avoid excessive heterogeneity that occurs when strongly diverging countries, such as developing and advanced are thrown in the same bucket.

A last innovative point is the time span covered in this study. Even though longer time periods allow for better data coverage and larger datasets reduce the likelihood of reverse causality bias, the use of these often covers episodes that do not reflect how public debt and growth interact in the present. Focusing on a narrower time span enables to catch the specificities of a new

economic and financial era. Nevertheless, the significance of the results might turn out rather low due to the small time coverage of the study.

# CHAPTER 3: Data and methodology

## 3.1 Data and descriptive statistics

### a) Data collection

The selected data will cover the six oldest European countries (Belgium, Germany, France, Italy, Luxembourg and the Netherlands) over the period 1995-2015. This period has been selected in order to focus on the links between debt and growth and the difficulties that occur in the 21st century and which characterise the "new economic and financial era" that began with the introduction and of new innovative financial instruments in the 90s.

Explicit debt, GDP and GDP growth, population dynamics, capital formation, human capital and inflation variables are retrieved from the Eurostat database:

- Consolidated gross government debt is selected as explicit debt variable.
- The growth rate is a chain linked volumes growth rate so that price variations are sorted out and do not affect it. The World Bank database completes the data for this variable for the year 1995.
- Population dynamics include the population growth rate as well as the old-age-dependency ratio. The ratio is useful as a proxy for population structure and ageing.
- Human capital is approximated with the percentage of tertiary education relative to the population aged 15-64 years.
- Implicit pension debt levels are estimated with pension expenditures as these will represent an increasing burden on government finances and expenditures over the upcoming years. It is expressed as percentage of GDP in order to ease the fusion of explicit and implicit debt levels. The estimation of implicit debt levels is based on data from Eurostat and the OECD database[5]. Due to data availability, the implicit debt variable covers the period 1995-2013.
- Last but not least, a variable reflecting the years of crises is created. It is a simple dummy variable that takes value 1 when the year is a crisis-year and value 0 otherwise[6].

[5] For more details see below.
[6] The crises included in the sample are the crash of the dotcom bubble in 2000 and 2001, the financial crisis in 2007 and 2008 and the European sovereign debt crisis which started in 2008 and lasted till 2012.

### b) The estimation of the implicit pension debt

In order to measure implicit pension debt adequately, the net present value of all future government pension payments must be estimated. It has been confirmed by various studies that policies in advanced and developing economies must approach the problem of these huge burdens (Beltrametti & Della Valle (2011), Holzmann, Palacios & Zviniene (2004)). In general, most studies confirm that public pension payments will cause serious disturbances in the near future. Unfortunately, there exist few data on implicit pension debt and it must be approximated somehow. The unavailability of the data comes from the fact that the increase of the impact of public pension programmes on government expenditures is a paroxysm of the 21st century. In the European Union, data has started to be collected in more exhaustive and systematic ways since 2006 especially.

Various definitions of implicit pension debt exist. Of course, each definition brings along a different estimation method as well as various assumptions. The main difference across these definitions lies on which cohort of retirees the implicit debt depends. One could, for instance, calculate the implicit pension debt based on closed groups such as the population currently retired (current implicit pension debt) or currently in the labour force (future implicit pension debt). A more exhaustive definition is based on open population cohorts, e.g. all born and unborn generations (Beltrametti & Della Valle (2011). With the former definition and methodology, estimated implicit pension debt is likely to have a downward bias because it does not take into account the current or future generations of retirees and pension payments. The latter definition implies the use of complex probabilities in order to estimate future pension expenditures. Furthermore, it is impossible to predict the impact of future pension reforms. As Beltrametti & Della Valle (2011) point out, there is no best definition of implicit pension debt. The choice of which one to use will depend on the aim of the analysis.

The implicit pension debt variable estimated in the scope of this study is based on the current cohort of retirees. Instead of making a detailed analysis of the structure of the implicit pension debt, the aim here is to show that pension expenditures do put additional strains on public finances. This “simpler” version of implicit pension debt estimation will be enough to satisfy the task. The estimation of the implicit pension debt level is based on the following equation found in Beltrametti & Della Valle (2011):

$$IPD_{i,t} = \sum_{j=1}^{v_{i,t}} \frac{P_{i,t}}{(1 + r_{i,t})^{j}} * n_{i,t} \,,$$

where $IPD_{i,t}$ stands for implicit pension debt in country *i* in year *t*, $P_{i,t}$ and $n_{i,t}$ represent the annual pension payment and the amount of individuals benefiting from it respectively, *v* is a measure of expected life duration of the retired individuals and eventually $r_{i,t}$ is the discount rate.

Because no differentiation is made across age or sex, $P_{i,t} * n_{i,t}$ is approximated with the total pension expenditure of a country in a given year. The estimation of the expected remaining life duration is based on aggregates: for every year, the country's average effective retirement age was subtracted from the total average life expectancy. This produces a measure of the average numbers of years the currently retired population will benefit from the pension payments. The discount rate is based on long term interest rates, represented by annual yields on government bonds with a maturity of 10 years.

The next section describes the selected data. It specifically gives details about the evolution of public debt levels, growth rates and government expenditures. In the end it presents the estimation of implicit pension debt levels. Overall, the data is retrieved from various datasets, particularly Eurostat and the database of the OECD.

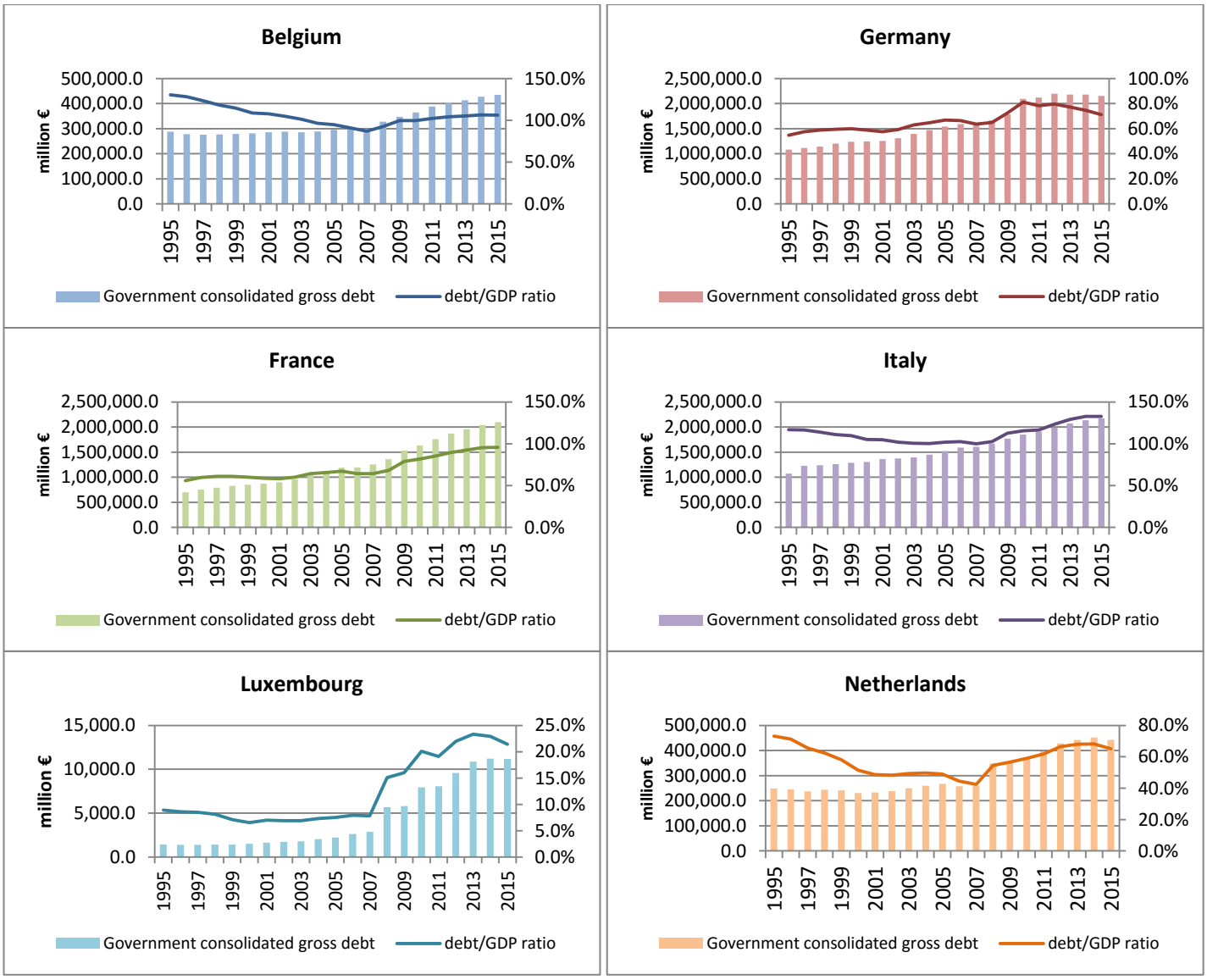
### c) Descriptive statistics

#### *Government debt*

It is no secret that government debt levels have been increasing over many years. The beginning of the period of high public debt build-up reaches back to the 1970s. European countries had recovered from the period of wars and experienced astonishing levels of growth. After the Great Recession of the 1930s and the Second World War, the social architecture of many countries in Europe changed towards collective social protection and pension systems whose financing was postponed until later in time (Colmant & Nille (2014), Tsantilas (2004)). This is where the public debt build-up that is discussed in the present, over 30 years later, started. One of the first crises of the 21st century, i.e. the world-wide financial crisis, is actually not responsible for the huge public debt levels. In fact, it has only contributed to awaken the beast that has been sleeping since the 1970s. The revelation of the dramatically high government debts eventually led to another crisis in Europe: the sovereign debt crisis.

Figure 1 below shows the evolution of public debt levels as well as the ratio of public debt to GDP from 1995 to 2015 for the six selected countries. It is clearly distinguishable that, in the case of all countries, public debt levels have been increasing slowly year after year until the crisis hit the continent in 2007. At this point in time, debt levels jumped by larger amounts due to government contingent liabilities such as banks rescue plans and the implicit debt of assuring social security in recession times. After the crisis, most government debts increased at a faster

**Figure 1: Evolution of public debt levels and the debt/GDP ratio, 1995-2015**




*Notes: Gross government debt level measured on the right axis, debt/GDP ratio on the left.*
*Source: Eurostat.*

pace than before. In figure 1, this is particularly the case for Belgium, Germany, the Netherlands and Luxembourg. Italy and France do not show such surprising jumps in their debt level. A quick look at the respective graphs reveals that public debt growth level remained rather constant

throughout the crisis. Germany is the country that has adjusted to the crisis most rapidly as it was able to impede the debt build-up quickly after it grew by 17.28% in 2010.

Debt-to-GDP ratios are a common measure of public debt because they ease the comparison across countries. The biggest issue that occurs when comparing only the level of debt across countries is that it does not tell much when countries are of rather different sizes. Nowadays, Germany, Italy or France have government debt levels which are at least 4 times larger than the debt level of countries of the Benelux. This observation seems normal once one takes into account that, as Germany, Italy and France are larger countries, they must care for more and have greater responsibilities in terms of social protection and other government expenditures. On the other hand, larger countries also have more potential to achieve higher output levels than their smaller peers. Thereupon, debt-to-GDP ratios appear as a natural alternative to general government debt levels because the differences due to the size of a country are out of the picture. Furthermore, the European System of Accounts (ESA2010) sets out accounting rules for EU member countries in order to circumvent the problems of incomparability across member states.

Over the past decade the trend has been of rising debt/GDP ratios in the euro area. This increase discloses a faster growth rate in public debt than in GDP levels: indebtedness rises faster than enrichment. Besides the evolution of public debt levels, figure 1 also shows the debt/GDP ratios. These jumped up in every selected country when the crisis hit in 2007. The reasons behind such jumps are twofold: firstly, debt levels have increased dramatically due to the numerous rescue plans and liquidity injections that followed the crisis. Secondly, the output levels of the economies have decreased as a consequence of the recession. Output levels and growth rates are discussed in further detail in the next sub-section. Combined, higher debt and lower output levels have increased the debt-to-GDP ratio after the crisis.

When the focus is set on the evolution of the debt/GDP ratio, a few things stay out. First, four out of the six countries were able to reduce the debt/GDP ratio between 1995 and 2007. These countries are Belgium, the Netherlands, Italy and Luxembourg. Impressive debt reductions are observable: the Netherlands cut its debt/GDP ratio nearly by half, dropping it from 73.1% in 1995 to 42.4% in 2007. This reduction was particularly spurred by an efficient increase in the Dutch GDP. In Belgium, the debt/GDP ratio went from 130.5% to 87% over the same period. The country was very efficient in reducing the debt ratio in order to meet the 60% of debt /GDP limit established by the convergence criteria that was introduced in the Treaty of Maastricht in 1993. Italy shows off a slightly less impressive decrease, changing the debt/GDP ratio from

116.9% to 99.8% between 1995 and 2007. Luxembourg is the country with the lowest debt/GDP ratio. During the decade preceding the crisis, it stagnated around 7-8%. The observations above represent precious arguments for the future political debate that centres on debt sustainability.

Second, many countries have experienced sharp increases in the debt/GDP ratios as a consequence of the crisis. Even though it remained the lowest, the Luxembourgish debt/GDP ratio rose by more than 100% of its pre-crisis ratio the years following the crisis. Well-defined kinks are observable on the Belgian as well as on the Dutch debt/GDP ratio curves. Even though the kink is less marked for Italy, this country's debt/GDP has constantly been on the upwards path since the crisis. Italy faces the highest ratio (132.7%) it has ever known since 1995 in 2015. The two largest countries of the sample, Germany and France, have experienced a constant increase in their debt/GDP ratios on average over time.

Finally, the graphs in figure 1 show that some countries succeeded in reversing the direction of their debt/GDP ratio after the financial crisis. Thanks to its exports-lead economy and debt stabilizing policies, Germany is the first country that could reduce its debt/GDP ratio after the crisis. If the other countries were able to reduce their debt /GDP ratio, one observes it only from the year 2013 onwards. This is the case of Luxembourg and the Netherlands. The remaining countries, i.e. Belgium, France and Italy, could only stabilize the increase. In 2015, Belgium and Italy still face debt/GDP ratios beyond the 100%, whereas France stays right below it.

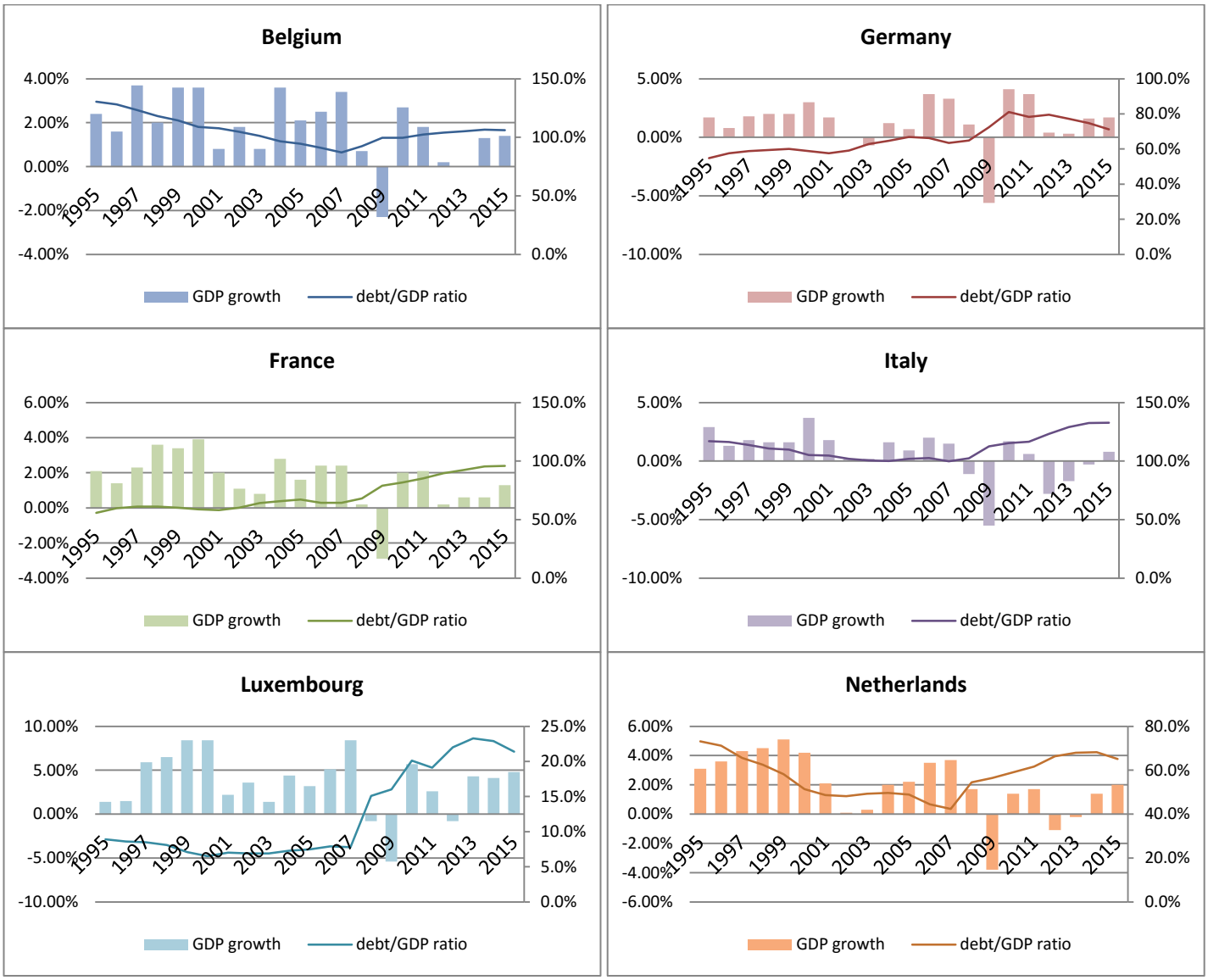
### *Economic growth*

Annual growth rates are of course quite volatile. Output and GDP levels are very sensitive to the smallest shocks that can affect an economy. Furthermore, international shocks can cause heterogeneous effects across countries, even across countries of the European Union. Figure 2 below illustrates the GDP growth of the sample of countries over the period 1995-2015. Besides the evolution of economic growth, a line representing the debt/GDP ratio is included on the graphs. Combining these two variables allows getting a first idea of the likely relation between public debt and growth. However, the graphs do not provide any significant conclusions.

In the late 90s, a general tendency is observable across all six countries. Growth and debt/GDP levels followed opposing trends: the former was on an increasing route whilst the latter decreased (or at least stabilized) over time. The dot-com bubble is certainly a factor that explains these high growth levels and the slump of the early 2000s. Another factor supporting the drop of growth rates in the early 2000s is the introduction of the common currency, the euro, which

produced some doubt about the economic power and strength of the union in the first few years, reason why it ended out being a rather weak currency right after its introduction.

**Figure 2: Evolution of GDP growth and debt/GDP ratio, 1995-2015**




*Notes: GDP growth is measured on the left axis, the debt/GDP ratio on the right.*
*Source: Eurostat.*

Relating the observations in figure 2 to those in figure 1, the following conclusions arise: firstly, most governments were able to reduce their debt level between 1995 and 2007. Then, even though these were already at historically very high levels, they spiked yet more up with the occurrence of the crisis. Secondly, it appears that the downward trend of the debt/GDP ratio between 1995 and 2007 is likely to be engendered by the growth of output (GDP) rather than decreasing debt levels. Lastly, and opposed to the latter fact, the spikes in government debt/GDP

ratio induced by the crisis are provoked by a combination of low growth rates and increasing debt levels, which were the result of the economic and financial recession in 2008.

Table 1 looks at the average growth levels and average public debt/GDP ratios for three selected periods. The columns 1 and 2 display average growth and public debt/GDP ratios for the entire period, namely 1995-2015. The columns 3 and 4 reveal the same variables for the pre-crisis period, 1995-2007. The last two columns present the average growth and debt levels for the post-crisis period, 2008-2015. This division has been selected for the following reason: as explained beforehand, the financial crisis of the 21st century has awakened the large piles of public debt of European governments. Moreover, the economies have faced severe difficulties to recover from the recession. Therefore, dividing the data into pre-crisis and post-crisis categories seems not only straightforward but also highly interesting, as it enables to see the effects of the crisis and may help to find solutions to the current difficulties faced by European governments. As expected, the figures in the table suggest a negative relation between public debt levels and economic growth. In fact, over the two first columns that cover the entire years in the sample, the tendency is that high average government debt relates to lower average growth levels. The pre- and post-crisis categories follow approximately the same trend. The country with the highest debt/GDP ratio usually exhibits the slowest growth and vice versa. Nevertheless, the existence of a linear or non-linear relation between debt and growth levels cannot be deduced from the figures in table 1. The data for the pre-crisis period hints that debt trajectory might indeed be an important factor. As shown before, the Belgian was set on a downwards trend before 2008 and, although average debt is about 108.1% of GDP, the average growth rate over this period is surprisingly high (2.45%).

**Table 1: Average growth rates and debt/GDP ratios**

| *Country* | *Average growth, 1995-2015* | *Average debt/GDP ratio, 1995-2015* | *Average growth, 1995-2007* | *Average debt/GDP ratio, 1995-2007* | *Average growth, 2008-2015* | *Average debt/GDP ratio, 2008-2015* |
|---|---|---|---|---|---|---|
| *Belgium* | 1.8% | 105.8% | 2.45% | 108.1% | 0.73% | 102.0% |
| *Germany* | 1.36% | 66.2% | 1.63% | 60.8% | 0.91% | 74.9% |
| *France* | 1.61% | 70.9% | 2.29% | 61.6% | 0.51% | 85.9% |
| *Italy* | 0.61% | 111.8% | 1.62% | 106.5% | -1.04% | 120.5% |
| *Luxembourg* | 3.57% | 12.3% | 4.65% | 7.6% | 1.81% | 20.0% |
| *Netherlands* | 1.99% | 57.8% | 2.98% | 54.9% | 0.39% | 62.4% |

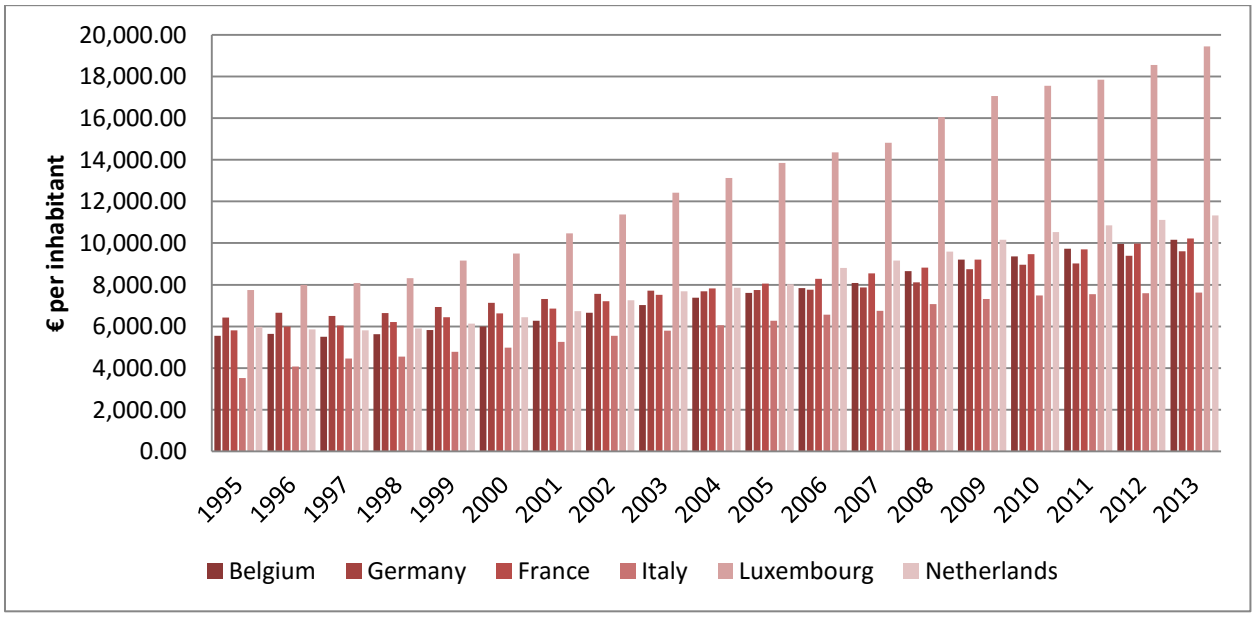
*Source: Eurostat, own calculation.*

### *Public expenditure and the implicit pension debt*

Before turning to the crux of the matter, which is the statistical analysis that will prove or refute the hypothesis of a negative relation between public debt and growth, one last point needs to be discussed.

Public expenditures represent an enormous burden on a government's finances. Many government expenditures, such as public pension and healthcare programmes act as real liabilities and there is no way a government can avoid them. These unofficial government liabilities are strongly linked to the population structure. As demographic predictions point to, the population will not stop growing until 2050 in the European Union (Eurostat, 2015). Moreover, predictions foresee that there will be a significant ageing of Europe's population over the same time span (see Graph 1). The burden of pension and health care expenses of governments will thereupon grow to even higher levels than today's. It will probably grow by such amounts that financing these programmes will most likely affect government debts in the future.

**Graph 2: Social protection expenditures in € per inhabitant**




*Note: Data covers period 1995-2013. No data available for 2014 and 2015.*
*Source: Eurostat.*

An implicit level of debt, which is not included in official debt statistics, is hidden in the social protection expenditures. Therefore, it becomes important to incorporate at least government expenditures linked to population-ageing in the analysis of public debt. The main effects of an ageing population are twofold: growth rates will decline due to lower labour market participation

and public debt levels will spike under the increasing expenditures which need financing. Repercussions of these effects are likely to be dramatic and may cause yet another crisis if preventive solutions are not brought up soon.

Government expenditures are, in most cases, directed by the social protection expenditures a government is responsible for. Social expenditures include items such as disability benefits, pension benefits, health care, family benefits, unemployment benefits, social housing expenses, or social exclusion expenses. Graph 2 above shows how social expenditures per inhabitant have evolved over the time in all countries of the sample. Overall, they have increased in all the countries over the period 1995-2013. It appears that Luxembourg, which is the smallest country in the sample, has social protection expenditures per inhabitant that outreach by far the per capita expenses of the other countries. The average yearly amount spent per inhabitant over the period 1995-2013 is of € 13.035,85. The country with the lowest social protection expenses per inhabitant is Italy. Here, the average yearly amount spent on social protection is about € 5.962,01 per inhabitant, which is less than half of what is spent in Luxembourg, the most generous country in terms of social protection expenses. The figures are € 8.170,44, € 7.832,87, € 7.780,53 and € 7.479,25 for the Netherlands, France, Germany and Belgium respectively.

**Table 2: Social protection expenditures and pension expenditures as percentage of total government expenditures**

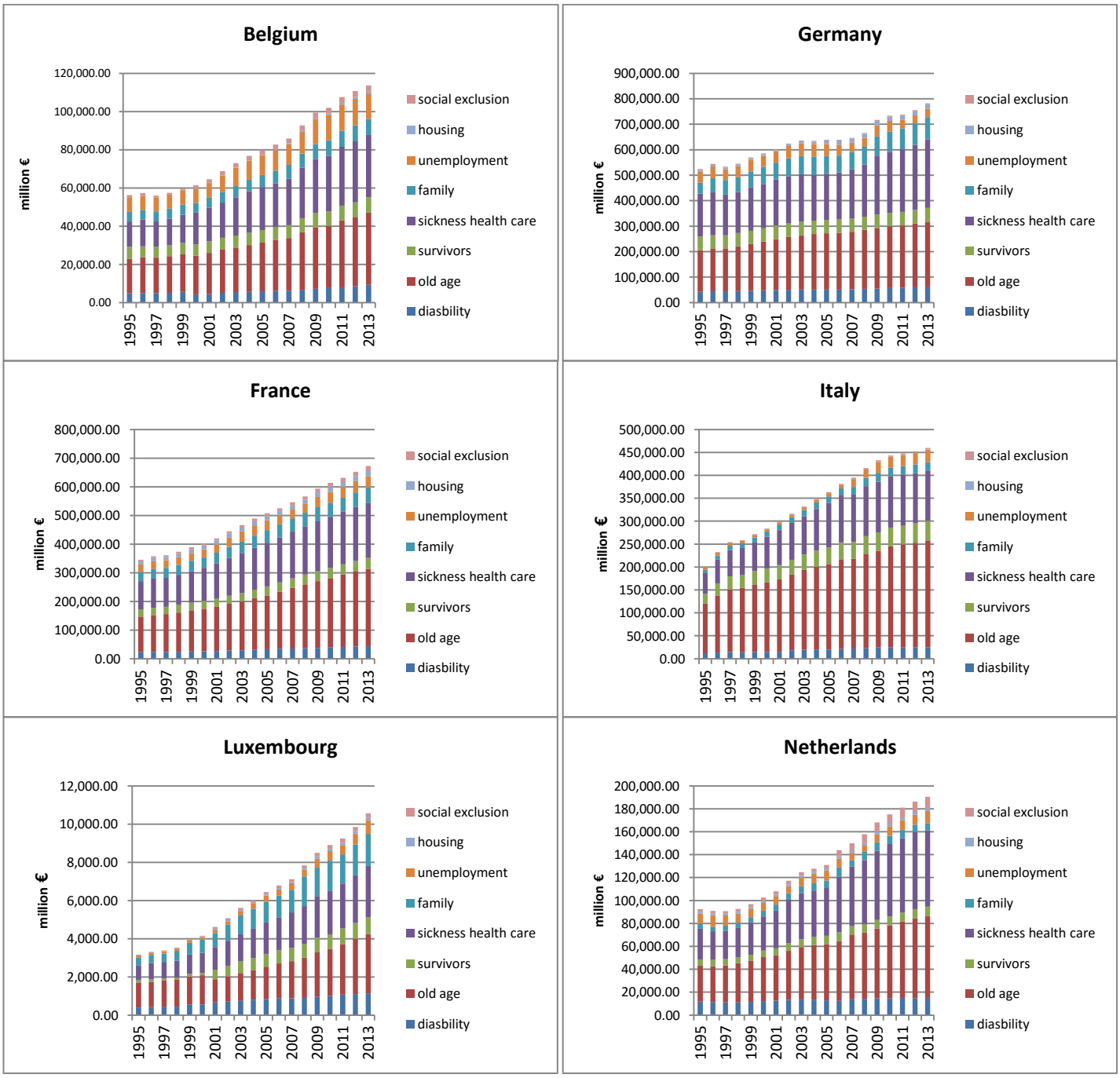
| | *social protection as % of total expenditure* | | *pension expenditure as % of social protection* | | *Pension expenditure as % of total expenditure* | |
|---|---|---|---|---|---|---|
| | *1995* | *2013* | *1995* | *2013* | *1995* | *2013* |
| *Italy* | 96.09% | 96.04% | 70.85% | 65.46% | 68.08% | 62.86% |
| *Luxembourg* | 96.55% | 98.37% | 57.71% | 48.35% | 55.72% | 47.56% |
| *Netherlands* | 93.91% | 93.55% | 52.69% | 49.67% | 49.48% | 46.47% |
| *Belgium* | 94.64% | 95.89% | 51.88% | 48.52% | 49.10% | 46.52% |
| *Germany* | 96.14% | 95.58% | 49.36% | 47.52% | 47.46% | 45.42% |
| *France* | 93.96% | 94.21% | 49.87% | 52.31% | 46.86% | 49.28% |

*Notes: Pension aggregate is defined as the sum of the following social benefits: disability pension, early-retirement due to reduced capacity to work, old-age pension, anticipated old-age pension, partial pension, survivors' pension, early-retirement benefit for labour market reasons.*
*Source: Eurostat, own calculations.*

The most important item in the list of government social protection expenditures are pension benefits. As life expectancy has been increasing over many years now, public pension expenditures have been rising accordingly, following the ageing population in advanced economies. These age-related expenditures often embody over 50% of the social protection expenditures which represent the largest part of a government's total expenditures. Table 2

above summarizes the ratios of social protection and pension expenditure to total expenditures. It turns out that pension expenditures stood between 45.42% and 62.82% of the total government expenditures across the six countries of the sample in 2013. As matter of comparison, these figures were between 46.86% and 68.08% in 1995.

**Figure 3: Evolution of total government expenditures and sub-categories, 1995-2013**




*Notes: Data covers period 1995-2013. No data available for 2014 and 2015.*
*Source: Eurostat.*

Even though the figures seem to translate a light reduction in the importance that public pension expenditures have in social protection programmes, this is only relative. Total government

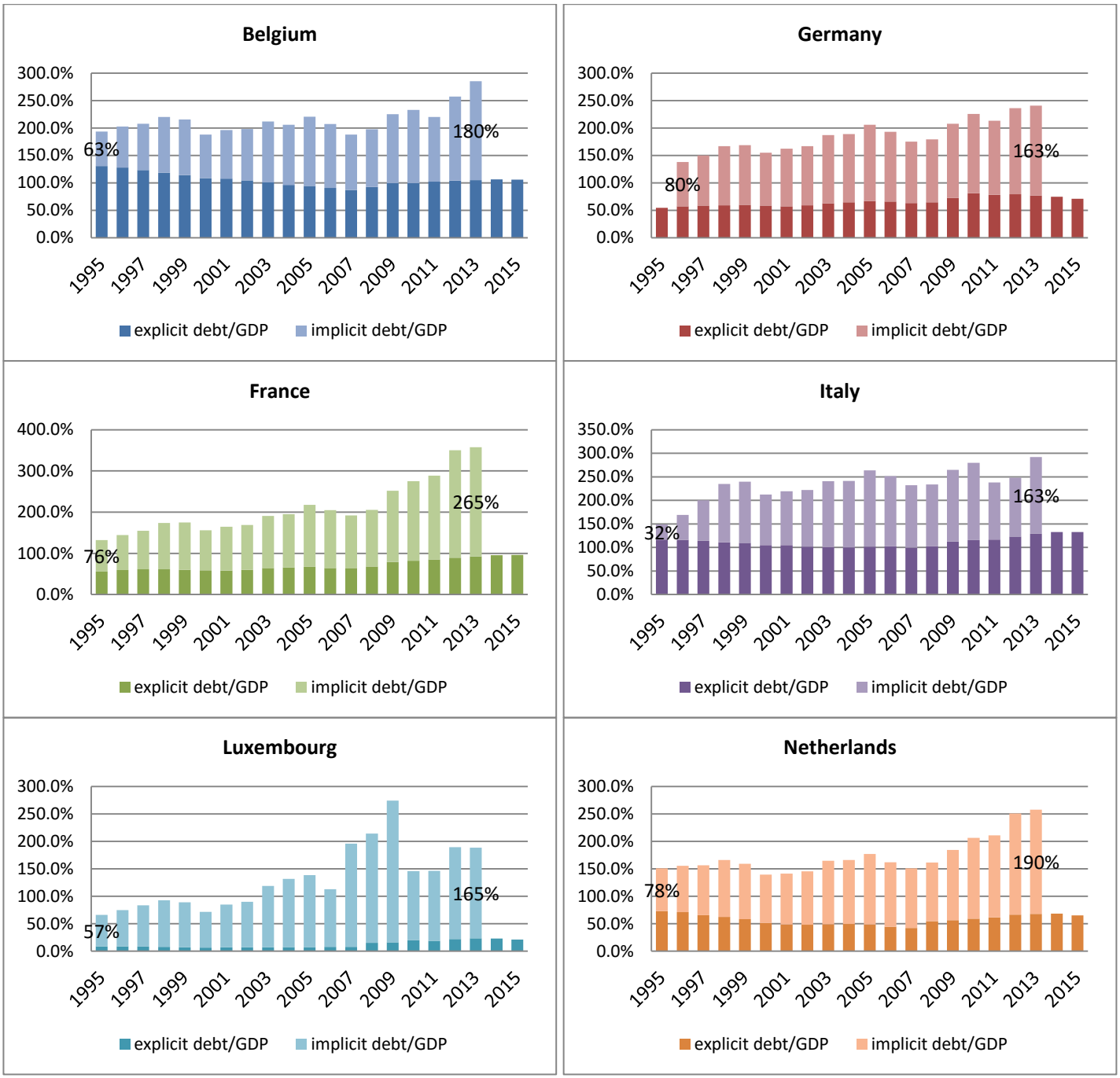
expenditure levels have increased continuously over the past twenty years. In fact, when looking at figure 3 above, it becomes clear that pension expenditures have risen over time. Today these expenditures attain peak levels. Taking into account sickness and healthcare, the graphs in figure 3 show that pension and health care cover almost the totality of government expenditures (between 70% and 90% depending on the country). Not surprisingly, these rapidly growing expenditures are age-related. The older generation of the population consequently causes a huge dent in government expenditures. Unless the country undergoes a restructuring of its fiscal and social protection system, it is unlikely that a government will be able to avoid paying out these huge sums.

In order to look at the problem of the increase of age-related public expenditures, the subsequent analysis studies the relation between debt and growth in two different ways. The comparison of the results when using only explicit debt as a debt parameter on the one hand, to those of the same analysis taking into account a measure of the implicit pension debt level allows estimating the impact of such significant government expenditures.

Implicit pension debt ratios are added to the explicit public debt ratio in Figure 4. Overall, the estimated implicit pension debt averages around 118% of GDP across the entire sample. Figure 4 below suggests that pension-related implicit debt has been increasing at a much higher pace than the explicit debt ratio. The implicit pension debt has been increasing strongly: between 1995 and 2013 it grew 117 percentage-points in Belgium, 83 percentage-points in Germany, 189 percentage-points in France, 131 percentage-points in Italy, 108 percentage-points in Luxembourg and 112 percentage-points in the Netherlands.

Furthermore, as it is forecasted that the retired population will increase further over time, it is easy to deduce that implicit pension debt will continue to rise at an increasing pace. Implicit pension debt consequently represents a non-negligible component as it raises government debt levels by more than 100% of their initial value: in the year 2013, it added up to 180% of GDP in Belgium, 163% of GDP in Germany, 265% of GDP in France, 163% of GDP in Italy, 165%% of GDP in Luxembourg and 190% of GDP in the Netherlands. In short, implicit debt adds a substantial amount of percentage points to the ratio of explicit debt. Once it is accounted for, all countries face public debt ratios far beyond 150% of GDP. In Luxembourg, which is the country with the lowest explicit debt, the implicit pension debt multiplies the government debt burden by a factor of 7 (Table 3 below). This multiplier ranges between 1.26 and 2.87 for the remaining 5 countries.

**Figure 4: Aggregate debt levels divided into explicit and implicit debt categories**




*Notes: Data covers period 1995-2013. No data available for pension expenditures in all countries in 2014 and 2015. Missing implicit debt data for Germany (1995), France (1995-1998) and Luxembourg (1995-1999). All figures are expressed as percentage of GDP.*

*Source: Eurostat, OECD, own calculations.*

**Table 3: Public debt multiplier of the inclusion of implicit pension debt (year 2013)**

| | *implicit pension debt, (% of GDP)* | *explicit government debt (% of GDP)* | *Public debt multiplier* |
|---|---|---|---|
| *Belgium* | 180% | 105.20% | 1.71 |
| *Germany* | 163% | 77.20% | 2.11 |
| *France* | 265% | 92.40% | 2.87 |
| *Italy* | 163% | 129% | 1.26 |
| *Luxembourg* | 165% | 23.30% | 7.08 |
| *Netherlands* | 190% | 67.90% | 2.80 |

*Notes: The public debt multiplier refers to the ratio between implicit and explicit debt. It represents the increase in total government debt once the implicit pension debt is accounted for.*
*Source: Eurostat, OECD, own calculations.*

The figures above confirm the seriousness of the situation. Note that the calculated implicit debt levels only encompass pension promises and expenditures to current retirees only and are therefore underestimated. Beltrametti & Della Valle (2011) discuss that the use of current pension payments exclusively has 5 important motivations: i) the implicit debt variable is more similar to public debt and the comparison becomes easier; ii) pension reform costs are lower if they do not alter the ongoing pensions; iii) estimations are less biased by assumptions about labour market data; iv) data is more comparable across countries; and v) discussions with respect to the definition of implicit pension debt are excluded because all of them come down to the same if only current pensions expenditures are taken into account. If data were to include all future pension payments, implicit pension debt would be even higher than outlined in the present study.

As indicated by the figures in table 3, it is of high priority that implicit pension debt should be included in the political debate and that financing solutions should be developed. Furthermore, pension reform discussion must lead towards changing public pension programmes from unfunded pay-as-you-go systems into funded pension systems in order to reduce the drain on public expenditures and debt. Even though short term effects of such a change are negative on the population welfare, it will show large positive effects on government finances over the long run (Tsantilas, 2004 & Eckstein, Eichenbaum & Peled, 1985).

## 3.2 Methodology

This section lays out the methodology used in the statistical approach. The procedure follows several steps: first, the analysis will verify the arguments of most influential authors in the

literature, Reinhart and Rogoff. Here, the 90% threshold level is used exogenously in order to see how the correlations behave at this specific threshold. Second, the analysis will look at the linear and non-linear relation between public debt and growth. The conventional method for estimating nonlinear relations is the use of a quadratic regression. Next, the implicit pension debt approximation is added to explicit debt levels in order to find out the effect of the "total" government debt on economic growth. Here again the linear as well as quadratic estimations are applied in order to verify for a nonlinear relationship. This last phase will reveal how important implicit pension debt is.

The relation between debt and economic growth is modelled using a Solow-model type of equation. In the neoclassical Solow model, income per capita growth depends not only on population growth but also on the saving rate as well as the rate of technological progress. The proxies for the latter two variables are physical and human capital respectively[7]. The main conclusion of the Solow-model is that, over time, an economy will converge towards its stable steady state.

Thereupon, the analysis in the present study departs from the assumption that the main drivers of the economic growth rate of an economy are the population growth rate, its capital accumulation rate (the savings component) and the technological progress (approximated with the population's education level). Furthermore, other factors such as the inflation and the occurrence of an economic, financial or political crisis can also affect the rate of growth of an economy. After a quick regression test of this hypothesis, it appears that the major significant drivers of growth in the selected sample are the physical and human capital components, as well as the crisis variable. Single- and joint- significance tests prove that population growth and the inflation rate can be left out of the analysis.

Consequently, the equation modelling the relation between debt and growth is as follows:

$$g_{i,t} = \alpha_i + \varphi D_{i,t} + \boldsymbol{\beta X_{i,t}} + \mu_i + \varepsilon_i,$$

where $g_{i,t}$ represents the growth level of GDP of country *i* in period *t*, $D_{i,t}$ is the ratio of public debt/GDP of country *i* in period *t*, and $X_{i,t}$ refers to a range of variables including physical capital, human capital, population structure and ageing[8], and a dummy variable reflecting

[7] The proxy for human capital is the ratio of the population that achieved tertiary education.
[8] The proxy used for population structure and ageing is the old-age dependency ratio.

whether the year at hand suffered from an economic or financial crisis. The population growth rate and the inflation rate are left out because of the arguments above.

As noted previously, endogeneity is an important caveat in panel-technique estimations, especially for policy-related questions. Endogeneity between the dependent and one independent variable raises issues of reverse causality that can trouble the entirety of the results. In order to limit the reverse causality bias two methods are applied. First, a lagged term of public debt is included in the explicit debt as well as the total debt models. This is the "quick-fix" solution to endogeneity problems. Its applicability is, however, difficult to prove. Second, the instrumental variable method is applied to limit the reverse causality bias. Here, the coefficients are estimated using a two-stage-least-squares (2SLS) method. The instruments used for explicit and total debt variables are the average explicit and total debt of the other countries in the given year (Checherita-Westphal & Rother, 2012). These instruments are unlikely to be strongly correlated to the dependent variable, the growth rate, and therefore represent a good choice.

The estimation follows country fixed effects. Most of the existing literature that has studied the relation between debt and growth has focused on the differentiation between various groups of countries, such as differences between advanced and developing economies. Here, opposed to this literature, country fixed effects estimation techniques are used in order to partially catch the heterogeneity bias. In policy analysis, it is important or even unavoidable to include country fixed-effects estimations. This follows from the fact that all countries have different systems that might have an influence on the variables. Country-fixed-effects take account of these country-specific characteristics and allow measuring the "pure" impact of one variable on another. This technique also allows estimating changes within a country (Cecchetti, et. al., 2012). Moreover, estimators are corrected for heteroskedasticity and serial correlation whenever it is possible.

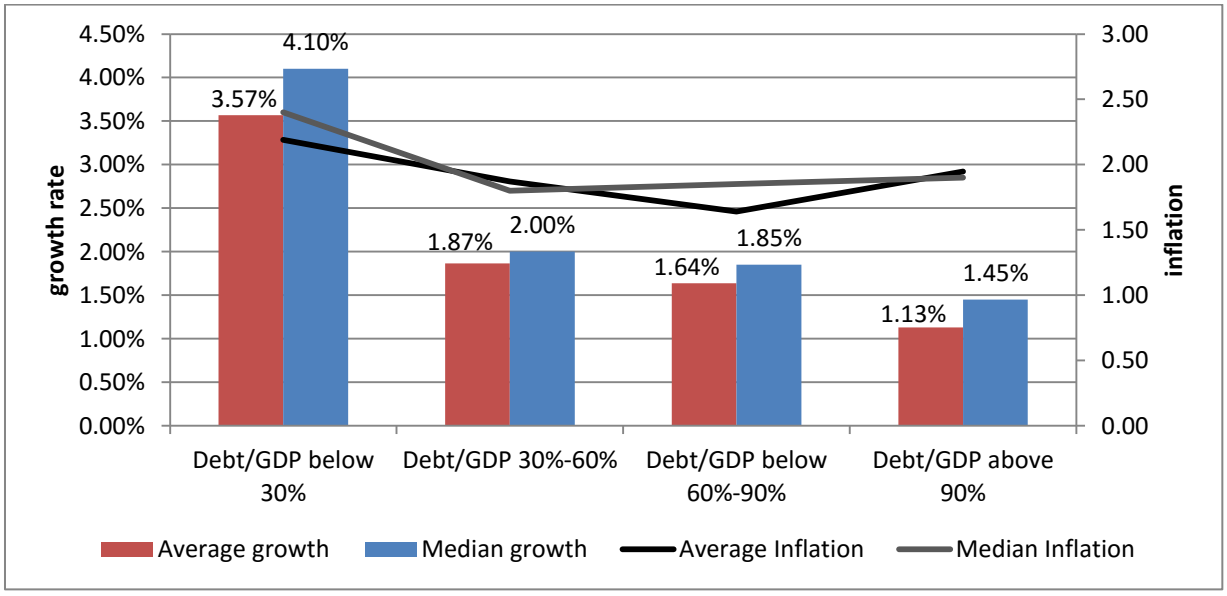
# CHAPTER 4: Results

## 4.1 Following the footsteps of Reinhart and Rogoff

Graph 3 is the result of the replication of Figure 2 found in the Reinhart and Rogoff's (2010) paper. It illustrates summary statistics for gross government debt ratios, growth rates and the inflation rate for Belgium, Germany, France, Italy, Luxembourg and the Netherlands over the selected period 1995-2015. As in Reinhart and Rogoff (2010), annual observations are grouped into different debt categories: the years where the debt/GDP ratio was below 30%, the years where it was between 30% and 60%, the years where it was between 60% and 90% and the years where it was above 90%.

At a firsts glance, it looks like there is an obvious relation between debt and growth levels: growth decreases as one moves from low-debt to high-debt categories. Between the lowest and highest debt categories, average and median growth rates drop by approximately 2 and 3 percentage-points respectively. However, it must be noted that the first debt category, i.e. the years with a debt/GDP ratio below 30%, only covers data from Luxembourg because it is the only country of the sample that has experienced such low debt ratios over time. Once the low-debt category is ignored, a decreasing trend is still recognizable. It appears that average and median growth levels reduce by 0.74percentage-points and 0.55 percentage-points between the 30%-60% debt and the above 90% debt categories respectively. As in Reinhart and Rogoff (2010), no significant relation is found between growth and inflation rates.

**Graph 3: Government debt, growth and inflation: 1995-2015**




*Source: Eurostat, World Bank, own calculations.*

The main drawback of this replication exercise is that the number of observations is rather low, compared to Reinhart and Rogoff's exercise. The figures shown in Graph 3 are therefore not very representative and no significant conclusion can be drawn. A sub-sample regression analysis confirms the lack of evidence for the relation between debt and growth in the four debt categories. The reason for that is most likely the small number of observations present in each category. In fact, the number of observations for each category is 21, 23, 38 and 44 respectively.

Next, the 90% threshold is analysed. Therefore, simple linear regressions are performed for two different categories: years where debt ratios were below the 90% threshold and years where government debt was above this ratio. In order to check for some complex nonlinearities, the same two regressions are replicated, this time including a quadratic term. Table 4 below summarizes the main outcome. The results confirm that there is no evidence for the impact of inflation has on the growth rate. In fact, the coefficients of this variable are far from the conventional significance levels. Further, the results do not correspond to Reinhart and Rogoff's conclusion: in the linear approach, the coefficient on debt ratios above 90% is positive and insignificant.

What the results in table 4 do confirm is that there is a significant negative linear relation between debt and growth at debt ratios below 90%. At these levels, a 1 percentage-point increase in the debt ratio yields a drop in the growth rate of 0.04 percentage-points. The nonlinear estimations also do not confirm any results for debt levels beyond 90%. However, the squared term of debt is significant at the 5% level. The coefficient of the non-squared debt term is not significant but it is not far from it: with a p-value of 0.116 it can be assumed that once more data would be included, the coefficient will turn out significant.

**Table 4: Linear and nonlinear estimation of the 90% threshold**

| | *Linear* | | *Nonlinear* | |
|---|---|---|---|---|
| | *below 90%* | *above 90%* | *below 90%* | *above 90%* |
| *debt/GDP²* | - | - | **-0.0011**** | 0.0019 |
| *debt/GDP* | **-0.0446**** | 0.0062 | 0.0919 | -0.4113 |
| *inflation* | -0.0987 | -0.3377 | -0.1311 | -0.4367 |

*Notes: * p<0.1; ** p<0.05 ; *** p<0.01*
*Source: Eurostat, OECD, World Bank, own calculations.*

The following conclusions arise from this exercise: firstly, the 90% threshold promoted by Reinhart and Rogoff and other authors cannot be confirmed based on the results. However, there is some evidence that the debt ratio exercises a downwards pressure on economic growth at debt

ratios below the 90%. Secondly, assuming that a p-value of 0.116 is not too far from the 10% significance level, there is partial evidence that the relation between debt and growth below the 90% level is nonlinear and follows a bell-shaped trend. In order to confirm the latter conclusion, one should however broaden the database in order to hope for improved significance levels.

## 4.2 The impact of explicit government debt on growth

This section looks at the relation between the explicit gross government debt level and economic growth. As described in the methodology, the analysis is divided into three parts: the first part is based on a linear model. In the second part, this model is augmented with a quadratic term for government debt in order to verify for nonlinearities. These methods are applied to three different scenarios: first, endogeneity issues are ignored; second, the attempt is to take account of endogeneity by simply lagging the debt variables with respect to growth; and in the last scenario endogeneity between public debt and growth is fought against with the instrumental variable technique.

**Table 5: Linear and nonlinear estimation of the relation between explicit government debt and economic growth**

| | simple FE | | Lags | | IV | |
|---|---|---|---|---|---|---|
| | *linear* | *squared* | *linear* | *squared* | *linear* | *squared* |
| *Debt* | -0.0001 | 0.0002 | 7E-06 | -8.41E-06 | -0.0004 | 0.0017 |
| *debt²* | - | 1.21E-06 | - | 8.82E-08 | - | **-1.27E-05**** |
| *physical capital* | 0.0871* | 0.0861** | 0.1476*** | 0.1477*** | 0.0811** | 0.0685** |
| *human capital* | 0.0001 | -4.85E-05 | 0.0034*** | 0.0034*** | 0.0014 | 0.0005 |
| *dependency ratio* | 0.0008 | 8.46E-04 | 0.0035** | 0.0035** | 0.0021 | 0.0027 |
| *Crisis* | -0.0081 | -0.0081*** | -0.0069** | -0.0069** | -0.0078** | -0.0082** |

*Notes: * p<0.1; ** p<0.05 ; *** p<0.01*
*Source: Eurostat, OECD, World Bank, own calculations (Stata).*

Table 5 above summarizes the main results of the simple fixed effect regression that do not take any measures against endogeneity, the lagged regressions and the instrumental variable regressions. All regressions control for heteroskedasticity and serial correlation. It appears that the coefficients of the debt variable and the squared debt variable are not significant, expect for the nonlinear IV estimation in which the coefficient of the squared term is significant at the 5% level. The results show that the main driver of growth is physical capital, which has a positive and significant effect on growth across all estimation methods. The crisis variable also represents

an important component. Not surprisingly, it has a negative effect on economic growth which is significant in most of the estimation techniques.

From the results above, it is difficult to confirm any type of relation between gross government debt and economic growth. Tests have proven that average explicit debt levels of other countries were a relevant instrument for explicit public debt levels. Nevertheless, as previous studies have mentioned, it seems that there is a lack of evidence for the relation between explicit debt and growth.

## 4.3 Adding the implicit pension debt to the picture

This section repeats the previous analysis and replaces the explicit debt variable with the total public debt variable that adds implicit pension debt levels to the picture. Table 6 below summarizes the main results.

**Table 6: Linear and nonlinear estimation of the relation between explicit and implicit government debt and economic growth**

| | simple FE | | Lags | | IV | |
|---|---|---|---|---|---|---|
| | *linear* | *squared* | *linear* | *squared* | *linear* | *squared* |
| *Debt* | -0.0002 | -0.0001 | 0.0001 | 0.0002* | -0.0013 | -0.0055 |
| *debt²* | - | -8.99E-08 | - | -3.93E-07 | - | 6.54E-06 |
| *physical capital* | 0.1106** | 0.1119** | 0.1557*** | 0.1608*** | 0.1124* | 0.0175 |
| *human capital* | 0.0008 | 0.0008 | 0.0032*** | 0.0032*** | 0.0087 | 0.0162726 |
| *dependency ratio* | 0.002 | 0.0021 | 0.0035*** | 0.0037*** | 0.0109 | 0.0163 |
| *Crisis* | -0.0071*** | -0.0071*** | -0.0049** | -0.0058** | -0.0204 | -0.034 |

*Notes: * p<0.1; ** p<0.05 ; *** p<0.01*
*Source: Eurostat, OECD, World Bank, own calculations (Stata).*

A first thing that needs to be mentioned is the following: as opposed to the previous section, instrument relevance tests have shown that average total debt of other countries is a poor instrument for total government debt. The IV regression model therefore reveals to be of poor quality. The results confirm this statement, as most of the coefficients are insignificant. Therefore the output is ignored in the present discussion.

As in the previous section, the main driver of growth appears to be physical capital. The crisis variable also exercises a negative and significant influence on the growth rates. The coefficient

on population ageing structure is rather surprising: it is positive and becomes significant once endogeneity is taken into account with lagged variables.

The linear term of total debt has a significant positive coefficient in the quadratic lagged regression. As the coefficient on the squared term is negative, the relation between total debt and growth follows an inverse U-shaped relation economically, but there is no statistical significance. Consequently, no conclusion can be drawn with respect to the nonlinear aspect of the link between total government debt and growth.

# CHAPTER 5: Discussion

## 5.1 Limitations of the model

The results in the previous chapter are unable to confirm a significant relationship between public debt and economic growth, except for the negative linear relation at debt ratios below 90% of GDP. This lack of significance is probably due to several limitations of the models. The most important limitation in estimating the effect of public debt on growth is the reverse causality issue. It represents a never-ending debate in the literature. In fact, lags and instrumental variable techniques are welcome but they will never completely banish the reverse causality. In the present analysis, reverse causality is reinforced by the shortness of the selected time span. A time span of twenty years does not allow taking very long lags of the possibly endogenous variable. Furthermore, a lag of too many years could jeopardize the meaning of the results: as the aim is to check for the presence of a debt threshold with respect to growth, it would not have been interesting to use a lag of 5 or even 10 years on the debt variable. This would complicate the interpretation of the results. Besides, even though lags help to mitigate the reverse causality bias, there is no way to verify whether the method is adapted to the data, nor whether the bias has been reduced.

When it comes to the instrumental variable regression, it is not always easy to find the right instruments. This is especially the case when the instrumented variable is the public debt ratio. Public debt levels are closely linked to the state of an economy and the possible instruments are therefore very limited. The use of the average public debt ratio of the other countries as instrument suggested by Checherita-Westphal and Rother (2012) revealed to be a good instrument for the explicit public debt levels. It was however not the case for the total debt ratio which includes the implicit pension debt besides explicit gross government debt.

In some cases, as in the present case, good instruments are very hard to find. Moreover, in the present analysis that attempts to look at the exact effect of public debt on growth, approximating public debt with an instrument might not be the best option. Controlling for endogeneity and the reverse causality bias definitely leads to less precise estimates and troublesome interpretations. These represent an important controversy in the discussion of public debt thresholds.

Another limitation of this study is the rather small amount of data. The dataset could have been increased by going farther back in time or covering a larger range of countries. The first solution

is not desirable in the context of this thesis because it aims at looking at the relation between public debt and economic growth that is present today in the European context. It has been argued that the 21st century is characterised by the appearance of limitations of how the economy functioned and of substantial crises. Thereupon, reaching farther back in time would have biased the results through the post-war reconstruction period and the Golden Age of the 50s, 60s and 70s. These periods are not representative for the times that followed the creation of the European Union.

On the other hand, the selection of a larger range of countries, which represents the second potential solution to the small size of the dataset, is not optimal because it would have increased the heterogeneity bias of the results. The oldest six European countries were selected in order to have more similar countries, even though large differences still exist between these countries. Nevertheless, as these countries were the "creators" of the European Union it can be argued that all six have had the same opportunities and that their institutions have achieved similar developments. For these reasons, it has been decided that these six countries deserve some special attention in this study.

## 5.2 The dangers of the 21st century

In the study of the relation between public debt and growth it becomes a priority to focus on the 21st century. Public debt levels have never attained such high levels as today and solutions to resolve the problem are inexistent. The economy has been functioning in the way it was used to, without seeing the dangers and disasters that were coming up. This is also why the financial crisis has hit the world economy as strongly as it has. The 21st century bears the stamp of economic recessions and troubles to get out of it. Particular dangers of the 21st century are the diminishing rates of interest, synonym of poor economic performance, and the ageing of the population.

Low interest rates are supposed to discourage savings and encourage investment. The European Central bank has attempted to induce this effect with its quantitative easing programme but results are scarce. With respect to public debt levels, sustained low interest rates represent a danger as they stimulate governments to issue more debt. Even though negative interest rates are unattractive for savers, they are for the state because it can issue debt at very low cost. In 2015, the financial world faced the appearance of negative interest rates, meaning that governments can earn some money by issuing more debt. This consequence goes in the opposite direction than the

debate on public debt sustainability and public debt reduction. If high public debt levels would really represent an economic disaster – and there are no reasons why they would not – governments would better not follow their instinct to take advantage of this "easy" liquidity. It would be interesting to include these low interest rates in the present analysis but as it is a new phenomenon data is scarce.

Another rising danger of the 21st century is the ageing of the population. Life expectancy increases as a general trend, and birth rates decrease. Governments' pension expenditures will consequently rise drastically in the upcoming years. As most advanced countries have unfunded (pay-as-you-go) pension systems, the financing of future pension plans is not ensured yet. Therefore, low interest rates and increasing implicit pension debt together may motivate governments to issue more debt. It is important to find solutions to these problems in order to reduce the likelihood for future large government debt build-ups.

Even though the results of this study do not strongly confirm a negative relation between public debt and growth, it has been noted that the inclusion of implicit pension debt in the analysis has substantially improved the results: when implicit pension debt is included in the regressions, the p-values of the debt variables came closer the 10% significance level. In the case of the instrumental variable technique, the linear debt term even turns significant and the squared debt term shows off a p-value of 0.124. These observations reinforce the belief that a larger dataset will certainly yield significant results for a nonlinear relation between public debt and growth.

## 5.3 Compelling directions for future research

This thesis and the arguments above leave some room for improvements and further research. As mentioned, the data coverage is rather small. It is strongly believed that once that dataset covers a longer period, the estimations will show more significant results. Once the data covers a longer period of time, the use of more advanced statistical methods will also be applicable: it will not only be possible to check for the presence of exogenous debt thresholds, but the larger dataset will allow to delve into the investigation of endogenous debt thresholds.

Endogenous threshold levels can be estimated using the – more conventional, but also less precise – simple nonlinear estimation techniques such as quadratic regressions, or they can be estimated with sample splitting or threshold models, such as those formulated by Hansen (1999,

2000). In order to investigate threshold effects in non-dynamic panels, Hansen (1999) develop a model which divides the observations into two regimes (a larger amount of regimes is also possible). Whether an observation belongs to one or the other regime depends whether the threshold variable (in the case at hand, public debt) is smaller or larger than the endogenous threshold. The least squares estimation of the threshold value(s) will seek to minimize the concentrated sum of squared residuals. Hansen (1999) uses bootstrap resampling for the inference of the threshold levels. Other methods have been used by other authors, such as the threshold tests of Chudik et. al (2015) that are based on Monte Carlo experiments.

The discussions above motivate further research in the field of implicit pension debt and the relation between public debt and growth in the 21st century. Implicit pension debt is underestimated in the present study because it takes account of only the current pension expenditures. The collection of more detailed data on public pension expenditures must be spurred in order to build better estimations of the impact that public pension programmes have on government finances and the economy. Furthermore, many of the existing studies reach farther back in time and the results may not correspond to the present. As a matter of fact, it is highly encouraged to increase research in the field of public debt and economic growth of the 21st century in order to find out the impact of explicit as well as implicit debt levels on growth and to come up with solutions to the current economic problems.

# CHAPTER 6: Conclusion

The research performed in this thesis is of major importance for the political debate around public debt and economic sustainability in the European Union. The hypothesis that high levels of public debt discourage economic growth arises from the recent incidents that occurred in the developed world. Crashes, crises and economic turmoil appear to transfer faster and faster across advanced economies and the consequences are tremendous. The financial crisis and the European sovereign debt crises have left deep scars in the European economy and have revealed some dysfunctions of government finances and the European economic system as a whole.

Government gross debt levels have risen substantially over time and the recent events have accelerated their surge. As populations are ageing across all European countries, the future public pension programmes represent a large, unavoidable expenditure for national governments.

The results of the empirical analysis performed in this study provide little evidence for a negative impact of public debt on growth. The only significant conclusion is that explicit public debt levels affect growth negatively at ratios below 90% of GPD. However, the description and discussion of the implicit pension debt levels has provided some convincing insights that the increasing public debt levels – be they explicit or implicit – represent a serious problem for the future and the sanity of public finances.

There is a strong likelihood that larger datasets will allow to get more significant results and to confirm the bell-shaped or more complex relation between public debt and growth. Therefore, it is advised that future research focuses on the collection of larger datasets, the improvement of threshold regression model and the possibilities to reduce issues such as the reverse causality bias or heterogeneity. The study of the consequences of negative interest rates on government finances and the economic development is a branch that will add great value to the political debate.

The overall conclusions are as follows: governments must keep an eye on public expenditures and debt levels. Drastic increases are not advised. Furthermore, they need to adapt to the ageing population, develop further on the existing pension reforms and find financing solution for future pension programmes in order to avoid the collapse of a European economy built on public indebtedness.

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