"Implications of public debt on Economic growth and development"

* A European study

by

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Abstract

This thesis takes an ambitious look at long-run economic growth and investigates the relationship between debt, investments and economic development in a European context. Italy and Portugal are the countries for which the author draws inference and undertakes a detailed analysis of their fiscal policy and debt management. The analysis is based on descriptive statistics, panel data regressions and various statistical tests where 3 models are being constructed. The panel consists of 17 European countries, observed across more than 30 years (1980-2012). Alongside the empirical testing, various estimation and validity issues are raised, including endogeneity and reverse causality.

The undertaken analysis suggests that Italy and Portugal have been on an unsustainable path in the last decades, accompanied by huge fiscal deficits, negative net exports and raising interest rates. In alignment with the Solow growth model, the author takes a look at the years of schooling and finds a disturbing fact that in Italy and Portugal people attend schools for fewer years on average, compared to other European countries. This suggests that there long-run economic performance may be hampered because their labor forces are less efficient.

The main findings of this research are that economic growth has a significant negative effect on public debt accumulation. It is found that as economic growth slows down it leads to an increase in the budget deficit through reduced public revenue, leading to new debt issuance. As debt piles, the cost of debt and its servicing increase substantially, leading to a decrease in investment levels thus influencing negatively long term growth. The novelty in this paper is that includes public debt as an independent variable in the growth accounting. The result is that debt does not influence economic growth directly, but crowds out investments through higher interest rates, increased uncertainty and higher debt servicing costs. As a result investments decrease, negatively influencing GDP as well.

*Keywords:* Public debt; Sustainability; Fiscal deficit; Portugal; Italy; Economic growth; Solow model; Debt dynamics; Fiscal policy

*JEL Classification:* E60; E62; E63; F32; F34; F43; O15; O16.
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“...the excellent teacher is the source of all temporary happiness and certain goodness, beginning with the production of a single good quality and the reduction of a single fault in a student’s mind and eventually encompassing all the knowledge beyond that”

Tsong-Kha-Pa

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1 Introduction

The topic of economic growth and public debt is very important as it directly concerns current taxpayers, future generations and seriously can affect expectations about the future. The more integrated the world becomes the more profound is the contagion effect of crisis such as the world financial crisis and the European debt issue. Those significant events seriously challenge the future growth prospects.

As the economic performance of European countries has worsened we can see that their deficits have been on the rise and member states are unable to pay their outstanding debt obligations. This has lead to one of the biggest "rescue missions" of the European Central Bank (ECB) and the International Monetary Fund (IMF) that had the role of lender of last resort. The stylized facts show that the average public debt in EU is around 62%\(^1\). This number shows that investigating this topic is worthwhile and the situation with the fiscal policies in European countries should be taken seriously. In this bachelor thesis the focus falls specifically on 2 countries: Italy and Portugal.

Italy has been suffering from inherently high debt levels. From 1980-2010 the median debt-to-gdp ratio in Italy has been 103% and the median growth rate 1.50% p.a. For Portugal the values are: 33.6% and 2.05%. This shows that Portugal's median debt is 3 times smaller than Italy and their median growth for the last 30 years has been higher than the growth rate of Italy by 0.5% point. For that reason both countries are very interesting for analysis because their way to this unsustainable debt development has been different. In this paper the author conducts several empirical tests as well uses descriptive statistics to draw inference about the growth-debt nexus. A big part of the economic growth literature has taken the growth-debt nexus as a one-sided phenomenon. Researchers have tried to see the impact of debt on economic growth, assuming that the causality goes in that direction. This paper looks to investigate this particular causality

\(^1\) The number is an average of the debt-to-gdp ratio of EU17 countries included in our dataset. The list of countries can be found in table
link and evaluate the effect of deficits, causing debt and in turn the effect on economic growth and investments.

The thesis is structured in a way as to allow the reader to gain key understanding about the interrelationships between deficits, debt, economic growth, investments, interest rates, current account balances, exports and imports, etc. Initially descriptive statistics are presented and analyzed in relation to Italy and Portugal. Next the theoretical framework for economic growth and public debt analysis is established. The following chapters test one by one our hypotheses. First we establish the direction of causality between debt and growth. Further several regressions are performed on public debt, economic growth and investments. The author carefully analyses each one of these key sections and discusses the results of the empirical testing. Finally conclusions are drawn from the estimations and the importance of the results is translated for Italy and Portugal.

1.1 Literature review

In this section of the thesis the author makes a wide overview of the development of economic growth, fiscal and debt management theory. In the last 50 years in the economic literature appeared several notable contributions by researchers that have addressed very actively the question of economic growth and public debt. A pioneering work on growth theory is The Solow model (1956) that was developed, based on the popular Cobb-Douglas production function. The growth model is still used as one of the primary frameworks for analyzing differences in cross-country economic growth patterns and convergence. It takes into account technology, labor and capital. Based on these factors it is argued that differences in growth could arise from two separate channels: differences in total factor productivity (e.g. workers’ efficiency and technological state) and differing levels of capital per worker in the various countries. The underlying assumptions behind the model are that savings and technological progress are exogenously given and that technological state is labor augmenting (Harrod - neutral\(^2\))

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\(^2\)Harrod neutral change has an effect on marginal productivity of labor. It can interchangeably be used as labor increasing.
(H. Uzawa, 1961). Furthermore, Solow states that the only way a country can be on a sustainable growth pattern is by only investing in research & development and education. Presumably this would have an exogenous increase in the technological level of the country and result in higher output per worker through improved effectiveness and innovation. In his work the researcher argues that sooner or later a country reaches a steady state (no change in capital per person from one period to another) unless there is a positive exogenous change in the technology. This basically implies that an increase in the savings/investment rate of a country would only move further the steady state capital per person but will not secure long-term sustained growth as the effect of capital accumulation is diminishing on output. This neoclassical model has been used in this thesis as an underlying framework for growth accounting in the research paper. Furthermore the economic literature has been enriched by the contribution of Conlisk (1967), who augmented the classical growth model by changing the technological state of the economy to endogenous\(^3\). Additionally, it was found that the saving rate does have an effect on long-term growth - something that was previously seen as inconsistent within the classical growth model.

Notable contributions to the mainstream growth economic theory have been made by Lucas (1988) who augmented even further the neoclassical Solow model by adding human capital to it. This addition is very important as it catches the effect of education and acquired skills of workers on output. Previously this factor was ignored and there was no distinction among agents in the labor force with respect to human capital. For that reason, Lucas argues that there are two types of capital: physical capital in the form of machines, buildings and resources and human capital in form of highly skilled and educated workers. Another influential economist proposed alternative view on economic growth and its sources. Paul Romer (1986) launched the idea that technological advancement; education and research & development may be all that is needed to sustain long-term growth. In other words, he adopts the idea of endogenous growth of the economy, namely that economic advancement can occur from within the economy without the need of an external factor. By combining physical capital stock with human capital in

\(^3\) A variable that is assumed to be explained by the model is called endogenous. An exogenous variable is such that its values are taken for given and not explained within the model.
a better and more effective way, an economy may find itself on a sustainable long-term growth path. The inclusion of human capital as an important factor into the growth model has been empirically tested by Romer, Mankiw and Weil (1992). They proved that this augmented version of the Solow model fits better with the data. In his version of the growth model Solow assumed that labor increasing technological change is exogenous and strongly outlined the key role of capital accumulation in economic progress.

Influenced by the neoclassical arguments of economic growth, Stiglitz and Hoff (2000) support the fact that the Solow model incorporates key determinants of economic growth. Their research augments even further the potential list of factors having effect on growth and convergence among countries. The researchers focus on constructs such as: historical background of the country, institutions, culture, government and rule of law. They argue that law enforcement, information access and non-market institutions can have pretty much the same influence on economic outcomes as limited technological advancement possibilities. Deeply rooted causes such as cultural background, working behavior, style and corruption levels can all have a significant impact on the economic performance of countries. One can summarize those factors as being fixed, since they do not change rapidly.

With the occurrence of the last financial crisis in the world and the dangerously increasing debt-to-gdp levels of developed and developing countries, the economic growth topic has been questioned more and more often. In particular the effect of public debt on economic growth poses interesting questions and gives good ground for research and analysis. Based on the endogenous growth models, the key role of governments is strongly emphasized and in particular their ability to manage properly debt. In this sense, debt can be beneficial for countries under the crucial assumption that the debt proceedings are directed towards R&D, education and appropriate growth investments. However, mismanagement of debt usually leads to adverse effects on the economy and has a negative effect on growth from a theoretical point of view. In the following paragraph the author reviews public debt management theories in more detail.
Reinhart and Rogoff (2010) analyzed financial and economic data for 44 countries, spanning across 200 years. Their main findings were that different debt levels have varying effects on economic growth. In particular, they found out that there is a weak relationship between debt accumulation and GDP growth for debt-to-gdp ratios below 90%. One very important assumption on which they build their arguments is that high debt levels lead to a lower economic growth. This underlines the causality direction from debt to growth. However, this important precondition and causality direction deserve further investigation. As a result this is the first hypotheses being tested. Furthermore, their research suggests that advanced and emerging economies have a similar threshold for public debt. Their analysis produced evidence that debt-to-gdp ratio of 60% leads to a decline in growth of around 2% p.a. Another important hypothesis which they developed is related to "debt intolerance" and the fragility of some economies as foreign borrowers, highly dependent on their previous default history. Cohen (1993) expresses his view that rising debt levels have a positive effect on growth until a certain level but afterwards become detrimental for the growth path. This resembles a "Laffer curve". In his research work (1998), he analyzed the debt management of countries from Latin America and Africa, trying to explain the reasons standing behind their poor economic development. His findings on the topic are that external debt can be very dangerous for countries if not managed properly. Furthermore, Krugman (1988) defined a new term "debt overhang" meaning a situation where a large portion of the economic output pertains to foreign lenders and thus reduces investment incentives and puts a heavy burden on future generations. His theory is mainly directed towards the negative effect of increased external debt on capital accumulation which stems from decreased investments. In a debt overhang situation, investors perceive high levels of debt as potential future increases in taxes in order to fill in the persistent fiscal gap. These events lead to lowering the ROI expectations of investors, which in turn decreases the net amount of investments in the economy.

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4 The worse is the debt management history of a country, the less it will be able to support higher levels of debt. This arises from focal differences in the perceived credibility and tolerance to handle effectively debt.
5 This curve is usually used to illustrate taxable income elasticity and has a parabolic shape
6 ROI = Return on investment
Another channel through which debt can have an influence on economic growth is total factor productivity (TFP). This idea has been expressed by Patillo (2004) and several other researchers. The theory links external debt and growth. It has been stated that as a country funds its deficits by foreign external debt, it dedicates a larger fraction of the future output to foreign entities. This in turn can reduce the incentives for higher productivity as people will not be motivated to innovate and become more efficient because foreign investors would benefit most. With dangerously high levels of debt, investments decrease and uncertainty increases. This change in expectations has a structural change in investments, which become predominantly short-term rather long-term. Those changes have a negative effect on the sustained capital accumulation since the investments bear a higher risk and uncertainty. Intuitively no investor would like to tie a big portion of capital in an investment that may be risky. This may have a negative effect on productivity in the economy. An attempt has been made to incorporate debt in the Solow model for an open economy by Villanueva et al (2006). Their findings are that in the long-run the debt-to-gdp ratio can vary substantially based on differing levels of savings, investments, depreciation and exogenous factors such as perceived risk and required risk premiums from lenders. Under their model, they assumed that in the long-term projection the equilibrium debt-to-gdp ratio is fixed but it can be altered through the above mentioned factors.

As a summary of this literature review, one can see the link between economic growth and public debt. There are several channels through which growth of GDP and debt affect each other. One of the main points of this thesis is to determine those channels and in what way does the causality go. This is an important question because otherwise one can get into endogeneity problems. Furthermore, capital accumulation, research and development, human capital and efficiency affect economic development. In turn budget deficits lead to an increase in the debt stock, higher debt service obligations and increased uncertainty which, in conclusion, affects investments. From here one can see how the loop closes and what the relationship between the two key topics of economic growth and public debt is. Those logical links will be analyzed in detail in the thesis.
1.2 Problem statement

Taking a historical perspective one can see that economic growth was a very hot topic in the 1960's and seems to have resurrected in recent years with "new growth theory". The main focus lies on the core determinants of economic growth in the long-term and as well the quantifiable effect of those factors on economic prosperity of nations. In that sense, the author of this thesis has been particularly inspired by the recent events (Debt crisis in Europe and the financial crisis from 2008) in the worldwide economy to delve deep into this topic. Those meaningful events undoubtedly provoked this research paper.

In that sense, the main questions that are to be answered and hypotheses (the underlined sentences) to be tested are:

1) *High debt levels lead to lower economic growth*
   
   *Sub question: In which way does the causality go? High debt to low levels of economic growth or low economic growth to high debt levels?*

2) *Economic growth has a negative effect on public debt accumulation*
   
   *Sub question: What is the effect of economic growth on public debt accumulation and is there one?*

3) *Debt has a negative effect on economic growth, using the Solow model framework*
   
   *Sub question: What is the effect of debt on per worker GDP growth, using the Solow framework and is there one?*

4) *Increasing public debt affects investments in a negative way and crowds them out.*
   
   *Sub question: Do increases in debt "crowd out" investments? - The main idea lies in the fact that as debt obligations rise, it takes more resources from the government budget, resulting in lower investments.*

Those questions are interesting because they would give us the opportunity to analyze more carefully the actual decisions that countries make in relation to their fiscal and growth policies. The crossing point between growth and debt are investments. After all the founding father of economics Adam Smith, stated that economics is "The study of
nature and causes of generating of wealth of a nation”. In relation to that, investigating what the interrelation of debt and growth is something worth considering in today’s world.

In an attempt to answer the research questions, the author uses descriptive statistics and panel data regression analysis. As real life examples of heavily indebted countries Italy and Portugal are explored and investigated. In approaching the problem, our fundamental analysis relies on the well known economic growth framework by Robert Solow (1956) and on an empirical investigation of determinants of public debt and investments. Furthermore, the author analyzes the accumulation of debt, the reasons behind it, and the possible actions that a country can take to reduce its debt load.

1.3 Delimitations

The main objective is to investigate the effect of economic growth and public debt in a European setting. For that reason the countries in focus are Portugal and Italy. Other big economies such as Germany, France, Spain as well smaller ones as Ireland, Finland, Austria etc. are being included in the analysis in order to include some variation. The reason why only those two countries are chosen is because they have attracted a considerable amount of academic attention in regard to their fiscal sustainability and debt management (Antonio Alfonso, 2005, Fabrizio Balassone et al., 2011, Tatiana Kirsanova and James Sefton, 2007). In that sense, this research paper is delimited in analyzing only those European countries by advanced estimation techniques and drawing conclusions for Italy and Portugal.

The data mainly comprises of key economic indicators and spans from 1980 - 2012. The dataset is called "Econ_growth_debt". Several sources have been used in the collection process for Portugal, Italy and the other countries in the dataset. The primary reason is that some datasets did not have all the years needed so a combination of several data sources was necessary. Furthermore, data for 2011 and 2012 is not available for the entire sample, so in order to provide a consistent and high quality data analysis, the author has limited the estimation time period from 1985-2010. For example some variables for Estonia, Slovakia, Slovenia, Cyprus and Malta do not include data entries
for the 1980’s. This may represent a problem in itself and bias the estimation results. In order to fix that, the author performs a regression analysis without including those five countries into the analysis. The author has been working with an unbalanced\textsuperscript{7} dataset. Additionally, the analysis in the paper takes into account gross public debt. There is a fine distinction between gross and net debt. Gross debt of a country includes public debt and inter-governmental holdings, whereas net debt is only what is held by the public. In general, it is agreed that the net debt may be a better measure of debt assessment; however the data is not readily available. The reason is that net debt-to-gdp ratio shows how much the government must rely on savings by the public in the economy in order to finance its future borrowing needs.

The main argument for choosing Italy and Portugal is that their path to debt accumulation has been very different, and in recent years one can see a strong convergence of both countries’ debt, raising to dangerously high levels (Carmen M. Reinhart and Kenneth S. Rogoff, 2010). Portugal kept a stable debt-to-gdp ratio of 50-60\% with a very small deviation, whereas Italy had chronically high debt load above 100\% for more than 20 years. The advantage of the taken approach in this paper is that it will enable us to analyze both countries more in-depth, spot particular differences relating to culture, geographic location, schooling, capital and fiscal balances by using fixed effect estimation. By limiting our focus to only two countries, the author is able to develop more insights about the similarities and differences between Italy and Portugal as our case countries.

On the other hand, this approach has its pitfalls too. By taking a narrow focus on only two countries, the researcher eliminates a big part of possible data variance because the analysis is focused on two extreme cases (countries with very high debt level without taking a look at countries with moderate levels). Making conclusions and getting inference on the basis of two heavily indebted countries may not shed light on the general relationship between debt and growth, but provide useful insights only for those two countries. In order to fix this and get higher significance of the results a bigger sample

\footnote{In case observations are missing for some of the time periods across some of the sections, the panel is called unbalanced and vice and versa.}
has been utilized. There are 17 countries\(^8\), observed across 26 years (1985-2010). Ideally, this would provide us with 312 observations (the number is lower than the product of 12*26, because there are missing observations).

2 Historical Background

In this section of the thesis, particular attention is devoted to debt management and economic performance of Italy and Portugal respectively. Time series analysis is applied and the historical development is assessed. In addition to the debt level, GDP per capita is taken into consideration and elaborated on.

2.1 Italy

As a first point, Italy is a very interesting case to be analyzed because throughout its recent history, the country has always been carrying a big debt load. This fact seems to endure and even aggravate the situation for the Mediterranean country. The time series from 1980-2010 show that there is a negative correlation (-0.40) between GDP growth and gross public debt. However, by observing those two variables in a longer time perspective, one can find a negative correlation (-0.64) from 1950 - 2010. (Fabrizio Balassone, Maura Francese and Angelo Pace, 2011). Despite the fact that the link between GDP growth and debt has slightly faded away in the last 25 years, it is still of big interest to identify the channels through which debt has affected the economic development in Italy. Despite the observed negative correlation between debt and GDP growth, one cannot conclude that high debt causes lower growth of GDP. For that reason, in the subsequent sections, we will derive the causality direction. One important thing is to distinguish between correlation and causality.

\(^8\) Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.
From figure 2.1 above, the reader can see that the Debt/GDP ratio has been fluctuating between 60% - 120%. Furthermore, Italy has experienced a positive growth rate in 3 cycles: 1982 until 1992; 1994-2002 and 2004-2007. The period 1994-2002 has been accompanied by a decrease in public debt from 121% of GDP to 106% in 2002. The country has also had a current account surplus in the same period, which may explain the decrease in the public debt by almost 15% percentage points as well the positive output growth due to more exports than imports. During this timeframe Italy became a net exporter (see figure 2.3). The period from 2002 to 2007 has been marked by an output growth of 1% p.a and a stable debt-to-gdp ratio fluctuating between 104% - 108%. As the global financial crisis happened, Italy’s output was badly affected as the majority of EU countries with big decline in growth rates. Since the European economy is highly integrated, Italy was affected due to the contagion effect of the crisis (Antonio Fatás and Ilian Mihov, 2003). In 2008 their debt increased immensely to a new level of 116% of GDP. Furthermore, the economy shrank by -5.2%.
Since 2008 Italy has been steadily accumulating debt due to augmenting fiscal deficits (see figure 2.2) and stagnating growth ranging between -5% - 1.2% (see figure 2.1). Debt accumulation and economic growth can be further tracked by looking at the current account and fiscal balances of Italy for the period 1990–2012.

In figure 2.3 we can see the evolution of the current account-to-GDP ratio. For the period 1994 - 2001 has had a current account surplus of 1.5% of GDP on average. This helps explain the positive output growth as well the gradual reduction of public debt. Taking a look at figure 2.2 one can identify that Italy has always experienced fiscal deficits in the last 22 years. From this fact we can infer that Italy’s fiscal policy has been in trouble as public expenditures have been traditionally higher than public revenues. As we shall see in the "Two period debt model", such fiscal account deficits can be financed by either raising taxes or borrowing. Intuitively, raising taxes may not be the best option. The primary reason is voters are usually not satisfied with decisions, leading to a reduction in their disposable income. In that sense, countries that have to finance their additional and off budget expenditures usually try to raise debt as it is less painful.

In the beginning of the 90's the fiscal deficit of Italy has been very high, reaching levels of almost 12% of GDP, coupled with negative current account balances 1990-1993.
This helps explain the dip in output growth rates for the same period. Focusing again on the period after 2002, it is visible from figure 2.1 and 2.2 that Italy once again raised its debt level, experienced increasing current account deficits, and sustained negative fiscal balances for almost a decade. Furthermore, the country narrowed its fiscal deficit band to 4% of GDP on average. However, this negative balance combined with the sharp decline in growth, resulted in a higher debt load to pre-90’s level. This analysis fits the data presented and establishes a good interlink between data and theory. In-depth look of public finance theory and debt sustainability is especially covered in the later chapters of the thesis.

2.2 Portugal

The other country that is included in the research project is Portugal. This country is suitable for analysis as its debt level has been below EU average for many years until 2008. Since then, in a time period of 3 years, the country has increased its debt-to-gdp level up to 93%. This is an increase of 24% in public debt in a very short period. Such a drastic indebtedness is worth being analyzed. Because Italy and Portugal have been different in their past debt levels and fiscal policy, it is of considerable interest to the author to analyze the case of these two heavily indebted countries.

It can be seen from figure 2.4 that Portugal has had a fluctuating growth rate pattern in the last 20 years. In particular the period 1994 - 2002 has experienced a positive growth rate and a stabilized debt-to-gdp level of 53% on average. There is a negative correlation of -0.65 between GDP growth and Debt/GDP level in the case of Portugal. The link appears to be stronger than the one visible in Italy. The development picture coincides with the European business cycle for the same period. Despite this seemingly sustainable development path with positive economic growth and stable debt level, Portugal has been incurring huge negative fiscal imbalances and as well increasingly big current account deficits.

\[\text{In 2007 Portugal's Debt/GDP ratio was 69.2\% and in 2010 - 86\%. The percentage change for the period is calculated as follows: } \frac{(86-69.2)}{69.2} = 24\% \text{ increase in only 3 years.}\]

\[\text{Author's calculations, performed in a statistical package}\]
Those disturbing facts had not been taken into serious consideration by the previous government of Portugal. The government of Socrates has not been able to effectively address the issues related to the fiscal policy of the country. In order to support those comments a useful visual representation of the current account and fiscal balances to GDP would be helpful.

First of all looking at the fiscal account, we see that in a similar manner to Italy, Portugal has experienced over 20 years of higher public expenditures than revenues. Figure 2.5 clearly illustrates that the fiscal path of the country is not sustainable. The current account displays very disturbing facts which are also to be carefully taken into account when speaking about debt and growth. One can see that since 1995 Portugal's current account has deteriorated regularly and reached a very high deficit of 12.5% of GDP. Put in simple terms this means that the country has a net importer position.\(^\text{11}\) By manipulating the "Balance of payments identity"\(^\text{12}\) one can identify that if a country imports more than it exports then it shall either decrease its savings or raise debt in order to pay for those imports.

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\(^{11}\) A situation when a country imports more than it exports to other countries.

\(^{12}\) Current account = - (Financial account + Capital account) \(\rightarrow\) Current + Capital + Financial + Statistical discrepancies = 0.
This has an effect on the constituting entities in BOP, namely Current, Capital and Financial accounts. Severe trade deficits such as those of Portugal may have a very profound effect on the competitiveness of a country and its debt servicing. In theory a positive current account balance (net exporter position) should be exactly offset by a negative capital account (net lender). In reality this is not always the case and both parts can have the same sign as was the case for China (Michael Moffett et al., 2011). In the case of the trade deficits a country could try to devalue its currency and in that way become more competitive as its goods become relatively cheaper in comparison to other countries' goods. However, this option is not possible for Portugal and Italy because they are both part of the European Union and operate under the EMS\textsuperscript{13}. Since both countries have the same currency, they cannot use monetary policy in order to influence their economies and devalue as this will have an impact on interest rates (Paul Krugman, 1998). In the case of Portugal, the current account has been steadily increasing in a negative direction, aggravating their competitiveness and causing huge capital inflows in order to pay for those increased levels of imports. Examining carefully the fiscal balance (see figure 2.5), one can see that fiscal deficit have been widening since 2008, reaching a peak in 2009 of almost 10% of GDP. Since 2007 Portugal has accumulated huge amount of debt in a very short time due to its worsened trade balance, low growth and huge fiscal

\textsuperscript{13} European Monetary System
deficits. All together combined, one can conclude that Portugal's path has been strongly affected by the economic downturn from 2007 through the contagion in Europe.

Since 2009 Portugal has adopted several steps towards stabilizing its economy and debt holding through some major cuts in public expenditure. Those measures included cuts in public workers' wage by up to 20%. Furthermore the country was facing insolvency as it was not able to pay the interest servicing of its outstanding public debt. In order to rescue the country from bankruptcy, the EU approved an immediate rescue package of 78 billion Euros (Anabela Reis, 2012) as a lender of last resort. The requirements from EU side are that Portugal will have to decrease its fiscal deficit substantially to 4.5% of GDP in 2012 and down to 3% in 2013 (Andrei Khalip, 2011). The effects of those cuts in public expenditure can be observed in figure 2.5. Since 2009 Portugal was able to reduce its fiscal deficit as well its current account deficit to 4.5% of GDP in 2012, which is a considerable improvement.

2.3 Long-term borrowing rates of Italy and Portugal

In a historical perspective it is interesting to take a look at the long-term borrowing interest rates of Italy and Portugal. In the following figure the development in yields of the long-term government bonds can be observed. The reason why the displayed period is only from 2007 is because before that the interest rates were almost identical for the countries.

![Figure 2.7 Selected EU countries long term interest rates on 10 year government bonds (2007-2012)]
However, from the beginning of 2008 a divergence between the leading economies in Europe can be observed. Substantial differences in the borrowing rates can be seen for the last couple of years. Portugal has experienced a big loss in investor confidence as their debt exploded to very high levels. This provoked foreign investors to require a much higher risk premium in order to hold Portuguese government bonds. The risk premium has increase drastically, making Portugal and many other heavily indebted European countries borrow at very high rates. Such a condition can be very bad for the economy as the newly raised debt grows at a level higher than the growth of the economy in those countries. The simple analysis of this matter suggests that debt-to-gdp ratio would continue to increase. In the beginning of 2007 Italy was borrowing at 4.26%, whereas in 2012 the borrowing rates have been 6.54% - very close to the critical number of 7%. In the case of Portugal, the spread has been even larger. In 2007 Portuguese government bonds provided an interest rate of 4.18% and in 2012 - 13.85%. One can see that in order to make investors hold Portuguese bonds there should be a huge risk premium, indicating a strong fear of default on debt and the inability of the country to repay its debt (Olivier Blanchard, 2009).

The situation of Italy is slightly different as the country has had only a minor spike in its debt raising rate. This in part reflects that investors are willing to hold Italian bonds at a lower interest rate and see a smaller perceived risk in Italy’s debt servicing. The reason behind is that Italy has traditionally had a high Debt/GDP ratio and throughout the years has been able to keep the level within narrow bands and avoid major fluctuations still keeping positive expectation about its growth prospects. As already discussed such a situation is not sustainable and poses problems of its own which will be further discussed in the following sections, when the author speaks about debt sustainability. Another key component when assessing the creditworthiness of a country are expectations and ratings on government bonds. Several agencies (Standard & Poor’s, Moody's, Fitch etc.) evaluate and assign a ranking in relation to the creditworthiness of sovereign government bonds. Such ratings heavily influence investor expectations. In July 2011 Portuguese bonds have been downgraded to “junk bonds” (Reuters, 2011) with big probability of not being able to pay interest rate at the end of the period. The credit
ratings by those agencies can be very influential and alter the public's perception of a country's ability to service its bond obligations.

Obviously, such a high rise in interest rates determines the debt growth dynamics and as a consequence affects the fiscal balance. Such drastic changes in debt servicing are worth to be discussed when speaking about growth and debt management.

3 Basic framework and model

In this section of the thesis the author proposes a framework for economic growth analysis. When speaking about growth theory one of the most used models is that of Robert Solow (1956). For that reason, his model is used in the thesis, by investigating the key determinants for economic development. Furthermore, an extended model is presented that incorporates the additional effect of schooling and education on economic growth with focus on Italy and Portugal. This factor is known as "human capital". Investments and savings are discussed and the main assumptions behind the model are being stated. One of the most important conclusions of the Solow model is that sooner or later a country reaches a steady state where there is change in capital accumulation is zero. Therefore, a special paragraph is devoted to this aspect of the growth model. In section 3.2 the author presents a two period model of debt dynamics and elaborates on the implications of different debt levels and the potential link between debt and economic growth. A particular emphasis is put on the government budget constraint and some analytical insights are provided in relation to debt sustainability policies and what can be done for highly indebted countries to return to a more sustainable development path. In the subsequent sections, an empirical analysis is carried out by using regression analysis of panel data.
3.1 The Solow model

This model has become very popular when dealing with economic growth of countries due to its logical graphical representation and clear rationale. The Solow growth model (David Weil, 2009) is based on a production function, having the following form:

\[ Y = F(K, L) \]

In this equation \( Y \) is output, \( K \) is capital stock (capital) in the economy and \( L \) is the number of workers (labor). There are two key assumptions standing behind this equation. Firstly, looking at the function, each of the explanatory variables has a constant return to scale\(^{14}\) to output. This can be represented in this way:

\[ zY = zF(K, L) \]

The second important assumption deals with the marginal product of each factor. Based on the form that the function takes, it is assumed that each factor has a diminishing marginal product to output. In other words, if we increase \( K \) by 1, output would increase by less than one. The same goes for \( L \). Logically this implies that every additional unit of input that we add will produce less than what was produced by the previously added unit. From an economic point of view, one should be more interested in defining wealth per capita than just focusing on nominal GDP of a country. The reason is that GDP or income as such does not tell us much about how wealthy a country is. Therefore, one should define wealth in per capita or per worker terms. This is useful because it enables cross country comparisons and can provide better insights in how countries are developing and what fraction of the whole wealth falls per person. Based on the rationale stated above we redefine the production function in a “per worker” form. First, we start by multiplying both sides of the function by \((1/L)\):

---

\(^{14}\) If the scale of inputs is doubled then output will also double.
\[
\left(\frac{1}{L}\right)Y = F\left(\frac{K}{L},\frac{L}{L}\right)
\]

\[
\frac{Y}{L} = F\left(\frac{K}{L},1\right)
\]

In order to manipulate easily those entities we define:

\[
y = \left(\frac{Y}{L}\right); k = \left(\frac{K}{L}\right)
\]

From now on the author sticks to the per worker representation of the production function As a result, we obtain;

\[y = F(k,1)\]

It is important to state the difference that the whole population is not equal to the workforce in the economy. However, in this chapter we manipulate the variables and express them in per-worker terms. From here we can define that output per worker is a function of capital per worker. It is more appropriate to use "per worker" terms because the model is based on a production function. Hence, not every person contributes to production. This makes the distinction between "per capita" and "per worker" worthwhile noting. The author sticks to the original Solow model that expresses the variables in per worker form.

The more important part of the model is to show the diminishing return to each factor\(^{15}\). As it was already mentioned, marginal product is important in the context of this model as it is a basic underlying assumption. The derivation of the MPK (marginal productivity of capital) is hereby presented:

\[MPK = \frac{dF(K,L)}{dK}\]

---

\(^{15}\) Increases in one of the inputs results in smaller and smaller increases in output.
As we transformed the function in per worker terms, then the marginal product of capital (MPK) is the output per worker differentiated with respect to capital per worker. It becomes as follows:

\[
MPK = \frac{dF(k)}{dk} = F(k + 1) - F(k)
\]

For that reason we obtain that output per worker has a decreasing slope. In fact this is the reason why if we continue adding capital into the economy at one point the economy will stop growing because capital input does not result in an equal increase in output. This is a situation where capital does not change from one period to another and this condition is called steady state. The author deals with this concept and clarifies the dynamics in section 3.1.3.

For the purpose of the thesis, the researcher uses a Cobb-Douglas production function. It is very similar to the previously used function but has some specific particularities in relation to the weights of capital and labor on output. Additionally human capital is present in the augmented version of the model. Furthermore, this functional form fits pretty well data of inputs (David Weil, 2009).

\[
F\left(\frac{K}{L},1\right) = AK^\alpha L^{1-\alpha}
\]

In this function, A represents the state of technology or productivity in the economy which is given exogenously. Ceteris paribus an increase in the parameter A will have a positive effect on output and vice versa. K is capital in the economy and L is labor. An important assumption of the model is that capital and labor are substitute inputs. The exponent \(\alpha\) can take values between 0 and 1. It represents the capital share of output. On the other hand \((1- \alpha)\) shows the labor share of output. There is no clear agreement on what values exactly alpha should take, however based on research on average it is equal to 0.35 (Ben Bernanke and Refet Gurkaynak, 2001). For that reason we also stick to their finding and use it in the model. Before continuing further, let’s examine the model and express income \((Y)\) in per worker terms.
\[ F \left( \frac{K}{L}, 1 \right) = A \left( \frac{K}{L} \right)^{\alpha} \left( \frac{L}{L} \right)^{1-\alpha} \]

\[ f(k) = Ak^\alpha \]

The final equation states that output is some function of capital per worker and the technological level (productivity) in the economy. In order to find the marginal product of capital in the Cobb-Douglas production function, the author derives the output per worker function w.r.t. to capital:

\[ MPK = \frac{dAK^\alpha L^{1-a}}{dK^\alpha} = \alpha AK^{\alpha-1} L^{1-a} \]

In the previous paragraph the MPK was described. Now, a clear link is established between the marginal product of capital and the capital share of income.

\[ \text{Capital share of output} = \frac{MPK \times K}{Y} = \frac{\alpha AK^{\alpha-1} L^{1-a} K^\alpha}{AK^\alpha L^{1-a}} = \frac{\alpha AK^\alpha L^{1-a}}{AK^\alpha L^{1-a}} = \alpha \]

Expressed in words, this relation shows the link and how alpha is derived. In the 90’s 3 famous researchers estimated that the capital share is around 0.60 (David Romer, Gregory Mankiw and David Weil, 1992) which seems high, based on wisdom. In order to solve this problem they decided to augment the Solow model by incorporating human capital as well. In fact their extended model fitted data better. In this paper human capital is added in the Cobb-Douglas production function accordingly.

### 3.1.1 Augmented model with Human capital

The reason why human capital is important is because it has huge implications on productivity, workers’ skills and as a consequence on output. The link goes that human capital can be viewed similarly to physical capital. As people in the economy pursue advanced education degrees and vocational training, they become more productive, possess more skills, use different languages and can execute a variety of tasks, compared to people with only primary education. Exactly, these key differences are within the scope of human capital. This division in \( L \) between qualified and unqualified labor force is
a great insight in economic growth theory. Such differences in human capital can partially explain the differences in the income per person across countries. One of the main sources of human capital increase is schooling. For that reason a quick view over a cross-country comparison between Italy and Portugal in their schooling rates between men and women can yield interesting insights.

As one can see, in Italy a higher proportion of males have completed at least an upper secondary education, compared to Portugal. Such differences can have a big effect on the economy of these countries. The reason is that people with completed secondary education are more skilled and productive compared to persons that do not have the same level of schooling. Despite the fact that both countries belong to the economically developed world, there is a big difference in their per capita GDP. A representative graph is shown. One can see that both highly indebted countries are way below the average level for EU21. This fact shows that their labor force productivity is not the same and such differences in human capital inevitably affect economic development. Higher schooling rates require big investments in human capital. However, an increased investment in education usually takes several decades to show the benefits. This may not be a priority for governments that usually have shorter time horizons for their decisions.

---

16 Real GDP per capita for Italy (2009): $27,708  
Real GDP per capita for Portugal (2009): $19,904 Source: Penn Tables 7.0
Physical and human capital provide a return: one in the form of rent and the other one in the form of wages. Despite, their similarities it is harder to estimate the exact share of human capital of output (David Weil, 2009).

Figure 3.2 Percentage of population that has attained at least an upper secondary education, women, by country and age (2009)

Returning back to the question of different levels of schooling, for women the picture looks similar to the one for men. Italy has a higher secondary education attainment rate, compared to Portugal. Such a pattern, clearly gives good grounds to think that difference in their income per capita arise from differences in their human capital. From this analysis it was shown that returns to education and varying levels of schooling may have a profound impact.

Figure 3.3 Life expectancy versus GDP per person (1980-2009)
In the last few decades we have seen a considerable increase in health quality and income per capita. One particular thing about which one may be concerned is the limit to human capital. In contrast to physical capital, human capital has a finite life. Intuitively, education cannot increase infinitely. In the last century a big part of the economic development of the world has been thanks to increases in human capital (health, education, innovation and research). Taking into account the idea that human capital's growth may slow down, may indicate a potential decrease in economic growth in general.

However, one should not worry because this has not been the only channel of economic development. Technological advancements will stay in place but expectations about reduced growth rate may well be anticipated due to the decline in human capital growth (Charles Jones, 2002). The distinction in capital helps understand the importance of both constituents: physical and human capital. In figure 3.3 the author has plotted data both for Italy and Portugal for a time period of 30 years. A clear positive correlation between both variables is visible on the scatter plot. It shows that as GDP per person increases, life expectancy increases as well. In fact, this is logical because as people become richer they can afford better healthcare and become better educated about health issues. However, a possible reverse causality is clearly possible as well. It goes as follows: as people are expected to live longer, they can be productive for longer time, which in turn can be clearly beneficial for the economy as they will be able to supply their labor skills longer. As a general conclusion to the impact of human capital it can be said that countries with higher GDPs per capita have higher life expectancy that in turn makes people more productive and has a positive effect on economic growth.

Relating back to the growth model, there are no big changes in the structural form of the production function besides the additional input factor - human capital. Based on the previous equation of Cobb-Douglas' function we assumed that every worker supplies the same amount of labor. This also meant that the productivity of workers is the same; their skills are the same as well as education. This big simplification was accepted in the early versions of the model. Later on, further development was made based on the Solow model by David Romer, Gregory Mankiw and David Weil (1992). They proposed the

\[ \text{0.9188 for Italy; 0.9517 for Portugal} \]
addition of human capital. As a result the new human capital augmented Solow model has this form:

\[ Y = AK^\alpha (hL)^{1-\alpha} \]

\[ Y = h^{1-\alpha} AK^\alpha L^{1-\alpha} \]

where \( h \) denotes the amount of labor that is supplied by each worker in the economy, \( K \) is capital and \( L \) is the number of workers. So now the total labor input is equal to \( hL \). As a conclusive remark to this part the author emphasizes that human capital plays an important role in output determination and has its place in the production function. Additionally, factors such as quality of education, access to higher education, culture and incentives all have an effect on human capital accumulation. Intuitively, in some countries the level of education is higher than in others and those quality differences have an impact on labor productivity and the skills of workers. The following sub-chapters focus on the rationale behind investments, depreciations and savings in an economy and analyze the effects of those on capital accumulation. The author also discusses how investments and savings are related in real life and what determines the capital stock.

### 3.1.2 Investments and savings

The next section covers extensively one of the main points of the Solow growth model, namely that every country eventually reaches a steady state of capital accumulation, depending how much capital stock it has at a specific point in time. The original Solow model was developed assuming a closed economy. In other words - savings are equal to investments in the economy. Such a simplifying assumption makes it easier to work with the model as it ignores the possibility of having investments in other countries and also having inflows of investments from abroad. Below is presented the aggregate demand function:

\[ Y = C + I + G + X - IM \]

where \( I \) is investments, \( C \) is consumption, \( G \) - government spending and \( (X-IM) \) - net exports. In our case Italy and Portugal are open economies. This is why the model is
augmented with net exports. Both countries trade and engage with foreign partners. This fact is included in the equation above because now Italian people can invest their savings in holding foreign government bonds. The same logic goes for Portugal. Such a scenario will make \( I \neq S \). One of the main differences between a closed and open economy is that in the open economy a country can borrow money from abroad, import and export products. This changes the relation between savings and investments. So now it can be represented as follows:

\[
S = I + CA
\]

where \( CA \) is current account and the other two entities are the same as before. After rearranging we obtain:

\[
S - I = CA
\]

Working with the equation in this form is more intuitive. If savings are larger than the investments in the economy, a country would experience a current account surplus. The current account consists of 3 components: trade balance (exports minus imports), factor payments (interest and dividends) and net transfer payments. For simplification purposes we can assume in this analysis that \( CA = NX \). \( NX \) simply means net exports which is equal to the trade balance (Olivier Blanchard, 2009). Recalling back the identity for an open economy:

\[
Y = C + I + G + X - IM
\]
\[
Y - C - G = I + NX
\]
\[
S = I + NX
\]
\[
S - I = NX
\]
Now we define that $S$ is equal to private and public saving together. After rearranging the identity one can see that $Y-C-G$ is in fact $S$. A good starting point is to evaluate the last equation above and see what the implications behind it are. If $(S-I)$ is positive then there will be a trade surplus - the country has exported more than it has imported. Therefore the country will be a net lender to other countries. On the other hand, if investments are higher than savings in the economy i.e. $(S-I)<0$, then this means that net exports (trade balance) are negative and the country is experiencing trade deficits and a net borrowing position. This is clearly logical and builds a basic framework for understanding the relationship between savings and investments in an open economy. In order to make better use of the equations and interrelations that were established above, the author finds it convenient to incorporate real life statistics for Italy and Portugal.

In figure 3.4 and 3.5, one can see that the data fits very well with the simple equation that was derived in relation to savings, investments and current account. The figures represent the development of those 3 important macroeconomic indicators. It can be seen that in 1993 savings were higher than investments which resulted in a current account surplus equal exactly to the difference between savings and investments for Italy (1.165%...
of GDP in 1993). Italy has had a positive current account balance in the years: 1993-1999
The CA/GDP indicator is the same that was used in figure 2.3.

Similarly, we take a look at the development of those 3 variables for Portugal as well (see figure 3.4). Similarly to Italy, the data fits well and confirms the validity of the above mentioned identity. In contrast to an open economy, in the case of a closed one, both savings and investment lines would have totally coincided because the only investment options that people and governments face is to invest domestically without having any trade relations to other countries. Looking at the savings ratio it is clear that in both countries investments and savings have been decreasing for the last 30 years. This decline is stronger in the case of Portugal where in 2011 the savings ratio was only 8.5% of GDP, compared to an average savings rate of 26.4% in the 80's (1980-1989). Similarly the average savings rate in Italy for 1980-1989 has been 21.15%. This simply means that Portugal has been saving a bigger portion of its income in this period. In the next section we see what the effect of savings on growth and capital accumulation is. In this thesis we take the investment rate as a proxy of savings in the Solow model estimation because capital accumulates when investments flow into the economy and also because this the usual approximation made in the economic growth research. The author has also provided the average savings and investment rates for the 3 decades in a table.

Figure 3.6 Average savings and investment rates for Italy and Portugal, divided into 3 periods (1980-2011)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy Savings/GDP</td>
<td>21.15</td>
<td>20.72</td>
<td>18.86</td>
<td></td>
</tr>
<tr>
<td>Italy Investments/GDP</td>
<td>23.24</td>
<td>20.14</td>
<td>20.69</td>
<td></td>
</tr>
<tr>
<td>Portugal Savings/GDP</td>
<td>26.43</td>
<td>22.55</td>
<td>13.38</td>
<td></td>
</tr>
<tr>
<td>Portugal Investments/GDP</td>
<td>31.38</td>
<td>26.39</td>
<td>23.25</td>
<td></td>
</tr>
</tbody>
</table>

18 The percentage is calculated by taking the average value of savings-to-GDP ratio for the period 1980–1989 for Portugal.
The figure reveals interesting facts about Italy and Portugal. Since the 80's the average savings decreased in both South European countries with a noticeable decline in Portugal by almost 13 percentage points. The average investment rate has been declining slightly through the 80's in Italy but stabilized in the last 20 years. Taking a look at Italy in the 90's, one can see that savings actually have been almost equal to investments even slightly higher. This would indicate that based on the algebraic derivation of savings, investments and current account, Italy has had a positive current account balance. We can additionally find support for this argument in figure 2.3 where one can see that Italy has been a net exporter throughout the 90's, which consequently helped for a partial decrease in the Debt/GDP ratio in the late 90's. The situation, however, is more disturbing for Portugal where the decline in investments has been on a negative path throughout the 90's and after the year 2000. Such a picture raises several interesting questions:

*If those countries save and invest less, then what happens to their capital stock?*

*If investments are higher than savings, how do countries manage to do the investments if they do not have enough savings?*

Those focal points and insights are the cornerstone of the next sub-chapter, which deals exclusively with capital accumulation, the role of savings, depreciation and the way capital stock is connected to those entities. Based on the observations above it is clear that when a country invests more than it saves the gap is filled by debt issuance. In other words, the difference between investments and savings in % terms of GDP is basically equal to what % of GDP shall the new debt be equal to. This idea is also in line with the two period debt model. It states that if the government spending is higher than the government revenue, then this difference has to be financed by debt or tax increase. In fact if $I>S$ this implies that borrowers are confident that at some future point in time the country will be able to repay its debt. However, as we saw in figure 2.7, the risk premium has sharply increased due to high indebtedness and inadequate fiscal policy of the most affected countries. Such an increase in interest rates further deepens the problem with
increasing Debt/GDP levels as the cost of servicing increases substantially, even if the increase is small (A. Alesina, 1988). So far the easiest ways for a highly indebted country like Italy, has been to pay those interest proceedings by raising new debt from investors. This operation is also known as roll over of debt (Andrew Abel, 1992).

Tatiana Kirsanova and James Sefton (2007) analyzed the important role of savings across UK, US and Italy and found out that there are several factors that could affect savings in a country. What their research showed is that retirement age, welfare system, credit access and income uncertainty as potentially affecting the savings rate of a nation. If a country is faced with higher degree of uncertainty, then people will save more in order to protect themselves against an unexpected economic shock (A. Deaton, 1992). In particular in Italy, the savings rate is generally stable and high due to reason that especially young people have restricted access to credit. In that sense, cultural specifics may play an important role in finding why savings rates differ so much across countries and in themselves such unobserved factors are considered as fixed effects in our estimation model. However, savings are a separate topic in itself and will not be investigated further. For the purpose of this thesis it is important to demonstrate how savings can vary and what is their implication on growth, capital accumulation and ultimately on debt in the case when savings are lower than investments.

3.1.3 Capital accumulation and Steady state dynamics

In this section of the thesis, the author provides an introduction to capital accumulation and how it is influenced by depreciation and savings in an economy. The capital share of output (\( \alpha \)) is estimated for Italy and Portugal from previous research. In the literature, it has been suggested that the average value for most European countries is 0.35 (David Weil, 2009).

The Solow growth model consists of several focal equations which are the backbone of the model:
\[ L_{t+1} = (1 + n)L_t \]
\[ K_{t+1} = (1 - \delta)K_t + I \]
\[ Y_t = F(K_t, L_t) = AK^\alpha L^{1-\alpha} \]

In those equations \( L \) is the labor force, \( K \) is capital, \( \delta \) is depreciation and \( n^{19} \) is the labor force growth. This model, assumes that there is no cross-country investments which would mean that whatever a country saves is invested in the country, meaning that \( I = S^{20} \). In the dataset we have information about investments and having in mind that this is what matters for the change in capital, we derive the values from IMF World Economic outlook (WEO) for both Italy and Portugal.

As we remember from section 3.1 the output per worker is a function of the state of technology and capital per worker in the economy\(^{21}\). Furthermore, the labor force is growing by a factor of \( n \). The capital stock next year will be equal to the investments made in the current period plus the capital that is operational from the previous period \( K(1-\delta) \). In this sense the general rule is that a country reaches a steady state when the change in its capital from one period to another is equal to 0. This is expressed as:

\[ \Delta K = I - D \]
\[ I = sY; D = \delta K \]
\[ \Delta k = sy - \delta k \]

where \( I \) and \( D \) are investments and depreciation respectively. Small \( k \) and \( y \) denote capital and output per worker. Next, the author provides further intuition behind the capital dynamic accumulation and how does an economy reach a steady state.

---

\(^{19}\) \( n \) is calculated by taking the logarithmic change in the variable \( work \) (labor force).

\(^{20}\) Taking this assumption into consideration, we proxy the savings rate with the investment rate. \( S = I \)

\(^{21}\) In an open economy \( S = I + NX \).

\[ F \left( \frac{K}{L}, 1 \right) = A \left( \frac{K}{L} \right)^\alpha \left( \frac{L}{L} \right)^{1-\alpha} \]

\( f(k) = Ak^\alpha \)
Linking the equations above, we obtain that the capital per worker in the following period is equal to:

\[ k_{t+1} = \frac{(1-\delta)k_t + sAk_t^\alpha}{(1+n)} \]

\[ \bar{k} = \frac{(1-\delta)\bar{k} + sA\bar{k}^\alpha}{(1+n)} = \left(\frac{sA}{n+\delta}\right)^{(1-\alpha)} \]

where \( \bar{k} \) represents a monotonically augmenting variable with a limit and the rest of the variables are the same as the ones used previously. This equation is derived in order to show how is capital per worker affected by alpha, labor force growth and depreciation. In relation to the value of alpha, we take the value provided by Ben Bernanke and Refet Gurkaynak (2001) and use 0.35 for physical capital share of output. There is further support of this estimate in the work of David Weil (2009).

Next the author proceeds with some estimates about the real interest rate in Italy and Portugal. The estimation is based on the Fisher approximation (Robert Barro, 1997):

\[ r \approx i - \pi \]

Where \( r \) is the real interest rate; \( i \) is the nominal interest rate and \( \pi \) is the inflation rate. In order to reach an average value for \( r \), the author uses the average values for inflation (based on consumer prices) and nominal interest rates on 10 year government bonds for the last 11 years. The geometric average \(^{22}\) interest rate has been 4.453% in Italy and 4.773% for Portugal. The reason why the author uses a geometric average for both interest rates and inflation is because this mathematical technique normalizes the range in order to prevent large values in only some periods to skew the average. In particular the reason is that in the 80's Italy and Portugal had very high inflation equal to 10.77% for Italy and 17.25% for Portugal in the period 1980-1990!

Furthermore the geometric average inflation is calculated with data, spanning from 1980-2010. The average inflation for Italy in this period has been 4.13% and 6.63% for Portugal. Now the real interest rate can be derived for the whole range of years with the

\(^{22}\) Geometric average = \( \sqrt[n]{x_1 + x_2 + x_3 \ldots x_n} \)
help of Fisher's approximation formula (Michael Moffett, Arthur Stonehill and David Eiteman, 2011) for the real interest rate. After deriving the real interest rate for almost 20 consecutive years, the author's result is that $r_t = -0.323\%$ and $r_{por} = -1.56\%$, meaning that Portugal has experienced a negative real interest rate, which seems to be a problem in many EU countries. The reason why this is a potential threat is because a negative real interest rate encourages people to borrow more and save less. The logic is simple: as the rate is negative it means that by holding money in the bank, their savings will be worth less in the future than today. For that reason, savings may decrease which as we know has a negative effect on growth since less investments will be made in the following period, thus moving the steady state to a lower level of capital per worker. In fact we can notice that the investment and savings rate in Portugal are lower than those in Italy (see figure 3.6).

With this part the author managed to perform a gentle introduction into capital dynamics and what are the potential factors affecting capital accumulation. The last section provided some calculations of the average interest rate, which was helpful in identifying the difference in Italian and Portuguese savings behavior. Next on our quest to understanding the link between investments, growth and public debt are deficits. This interrelation is covered in the following sub-chapter which deals with the Two period debt model.

### 3.2 Two period debt model

After we reviewed and analyzed the growth model in the case of Italy and Portugal, the author focuses on the other focal component of this thesis, namely the debt side. In this particular sub-chapter a simple model is established which links several macroeconomic variables together. These are: government spending ($G$), taxes net of transfers ($T$), public debt ($D$) and as well the growth rate of the economy ($g$) and the real interest rate ($r$). The reason why it is preferred to use the real interest rate instead of the nominal one is because we are more interested in knowing how much a country owes in terms of goods. This measure is more accurate and lets us derive the debt development net of inflation ($\pi$). Additionally, the author shares an interesting economic discovery related to rational
expectations. This idea was developed by two influential macroeconomists - David Ricardo and Robert Barro. This concept is considered at the end of this sub-chapter.

When speaking about debt it is important to make the distinction between stock and flow. Debt is a stock, whereas a deficit in a particular year is a flow (Olivier Blanchard, 2009). In that sense, depending on the fiscal balance, the stock of debt may either increase or decrease. The intuitive logic suggests that if a government is running a balanced budget\(^{23}\), then there would not be any need to raise debt, assuming our analysis starts from a point where \(D=0\). In our real life examples, both Italy and Portugal have very high debt levels (above 90%), so this suggests that even if those countries run a balanced budget, the debt would still increase as interest has to be paid on it. In this sense, stabilizing the public finances does not necessarily impose a sustainable path for debt-to-gdp levels.

\[
D_t = (G_t - T_t) + (1 + r)D_{t-1}
\]

This represents the two period debt model. One can see that the debt this year will still increase by \(r\) even if \((G-T)=0\). In order to keep the debt level fixed, tax revenues should rise by an amount equal to \(r\). In this research project, it is more interesting to see the dynamics behind the debt-to-gdp ratio. So for that reason the above model is expressed in per-gdp (\(Y\)) terms\(^{24}\).

\[
\frac{D_t}{Y_t} = (1 + r) \frac{D_{t-1}}{Y_{t-1}} \left( \frac{Y_{t-1}}{Y_t} \right) + \frac{G_t - T_t}{Y_t}
\]

Here, the fraction \((Y_{t-1}/Y_t)\) was added in order to ease the interpretation. As a result we can derive that the change in the debt level from one period to the next is equal to:

\[
\frac{D_t}{Y_t} - \frac{D_{t-1}}{Y_{t-1}} = (r - g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t - T_t}{Y_t}
\]

From the equation above we can infer that in order for the left hand side to be 0 (in other words, the change in the debt to be zero), the real interest rate should be equal to

\(^{23}\) Such a budget where there is neither surplus nor deficit. In other words, \(G-T\)

\(^{24}\) For full derivation see Appendix A
the growth rate of the economy and the country should run a balanced budget. Another possibility is that if there is fiscal surplus, then the interest rate on the debt should be higher by the same amount than the output growth rate. In this section, the author laid down the core analytical framework for debt dynamics. In the next section, we plug in real data into our sensitivity model and analyze what is the current situation of Portugal and Italy, assuming fixed values for their growth and borrowing rates.

As mentioned in the beginning of section 3.2, some explanation is given in relation to "Ricardian equivalence" (Robert Barro, 1989). The main hypothesis, established by Ricardo stated that debt financing and deficits have an effect on economic growth. This statement is supported by the fact that the agents in the economy would incorporate an increase in debt levels into their consumption and savings patterns, expecting higher taxes in the following period in order to finance this deficit. In other words, people would expect taxes to rise in the following period so the incurred debt could be repaid. The contribution of Barro was an additional notion in relation to public finances and expectations. In a scenario where the fiscal balance is negative (public dissaving) so debt has to be raised in order to fill in the fiscal gap, people would save more, expecting a tax increase equal to the deficit that was incurred. Despite the fact that public savings go down, contrary private savings will go up, leaving total saving in the economy unchanged. Under such an idealistic scenario governments should not worry about their stock of debt and running public deficits. However the empirical observations are different. One can see that this proposition may have good logical grounds, but perhaps should not be assumed to always hold because otherwise this hot economic topic would not have been discussed in this research project. One reason why this particular hypothesis does not always work is the fact that projected tax increases usually follow several years after the cuts have taken place (Olivier Blanchard, 2009). The further away in the future the expected tax increases are the more probable it is that people would not take them into account in their current decision to spend or to save. As a consequence savings may not increase one to one and right away, which may lead to an unsustainable debt path.
3.2.1 Debt dynamics

As we have previously derived the two period debt model and linked expectations, using Ricardo-Barro’s proposition, the author now analyzes real data for Portugal and Italy, based on the theoretical concept outlined. Furthermore, with the help of a spreadsheet, the author has been able to model and simulate the debt development of Italy and Portugal up to 30 years ahead, assuming various scenarios of their growth, real interest rates and fiscal budgets. The important point is that this chapter outlines the seriousness and importance of fiscal discipline and serves as an illustration of how changes in the budget balance may affect debt accumulation. In chapter 4.3 we undertake an empirical investigation where the author states the findings based on panel estimation. In order to show the debt dynamics, 3 scenarios have been outlined:

Scenario for Italy:

_Growth of GDP (g) = 1%; (G-T)/GDP (Fiscal account balance) = 5.5%;_

_Real borrowing interest rates: (3%-2%-1% (D/Y<50%), (4%-2%-2% (D/Y>50%) and (6.5%-2%)–4.5% (D/Y>100%))^{25}_

The data that has been used to model the debt levels and the first scenario can be found in the appendix at the end of the paper (see Appendix B).

An important aspect that is not included in this analysis and projection of future debt levels is the population ageing factor. Despite the fact that this seems not to affect debt, indeed it does directly influence government spending. The reason is that as more people become eligible for pension a bigger fraction of GDP would have to be devoted for pensions, thus increasing the G side of the government budget (Antonio Alfonso, 2005). In this sense, the expected incremental payments to this group of people aggravate additionally the problem with public deficits, as those transfers should be seen as future borrowing i.e. debt (R. Holzmann et al., 2004, P. Rother et al., 2003). An attempt has

^{25} Those are real borrowing interest rates derived from the yield of 10Y gov. bonds. The geometric average inflation for Italy is calculated to be 2% for the period (2001-2010). The hypothetical nominal borrowing rates are derived from historical yields on Italy’s bonds for the same period and depending on the level of D/Y those rates vary.
been made to see this negative effect of labor force growth on output growth due to anticipated future borrowing. As a proxy we take labor force growth in our empirical testing. This is why the author finds it important to raise this potential caveat to public finance sustainability.

Scenario for Portugal:

Growth of GDP \( (g) = 1.93\% \); \( (G-T)/GDP \) (Fiscal account balance) = 3.7%;

Real borrowing interest rates: \( (3\%-2.16\%) - 0.84\% \) \((D/Y<50\%)\), \( (5.5\%-2.16\%) - 3.34\% \) \((D/Y>50\%)\) and \( (12\%-2.16\%) - 9.84\% \) \((D/Y>80\%)\)\(^{26}\).

The rationale behind the choice of values for the following variables is based on historical numbers. The majority of rates are taken as averages. The growth rate of GDP is calculated as an average for the period (1990-2010); the fiscal balance is the average of the budget balances from 1986 to 2012; the inflation rate is calculated as a geometric average for more than 10 years (2001-2010). Even though there is data available for inflation rates from 1980, the author has discarded those entries because of an expected bias in the actual values. The reason is that the oil crisis in the 80's has been the primary reason for sustained inflation of more than 20% p.a. for more than 5 consecutive years both in Italy and Portugal. If those periods were included the average inflation in Italy would have been 4.13% and 6.33% for Portugal. Those values could be a serious exaggeration for future projections of inflation having in mind the Maastricht Treaty rules, concerning public deficits, inflation and budget balances (European Commission, 1992). Usually in the literature, the real interest is assumed to be constant. This, in the author's view, could be a simplification of reality. The higher the \( D/Y \) ratio is, the more expensive it is to borrow for a country as the perceived risk of default increases. In the spreadsheet model developed here, two focal thresholds have been set in order to simulate the incremental interest payments due to rising debt levels. The author uses one

\(^{26}\) Those are real borrowing interest rates derived from the yield of 10Y gov. bonds. The geometric average inflation for Portugal is calculated to be 2.16% for the period (2001-2010). The hypothetical nominal borrowing rates are derived from historical yields on Italy's bonds for the same period and depending on the level of D/Y those rates vary because at high debt levels the risk premium is higher, representing the probability of default and inability to repay the obligations.
borrowing rate for debt-to-gdp levels below 50%, another one for values between 50% and 100% and a third rate for values above 100% (For Portugal the third threshold is at 80%). Arguably, there is no linear relation between Debt/GDP levels and interest rates; however one fact is clear from figure 2.7 - as countries become more indebted or investors perceive an increased risk in the country’s ability to repay its debt obligations, risk premiums increase, resulting in higher cost of borrowing. As a stylized fact: Portugal on average has been borrowing at 4.77% (2001-2012), however since April 2010 they have been able to refinance its debt at higher levels, reaching 13.8% and then 14.6% at the end of January (2012)! The case of Italy has not been very different however, their borrowing rate has remained lower (4.45% on average (2001-2012) and 6.8%-7% at the end of January), compared to Portugal, threatened with bailout. For those reasons it is not very informative to use a single borrowing level at all levels of debt, because one can clearly see that borrowing rates indeed vary a lot and seriously change the dynamics of debt movement. This crucial fact has been taken into consideration in an attempt to model the debt development and contribute to the overall predictability of the dynamics. This why the model is set up in a way so as soon as the debt-to-gdp ratio passes a threshold, the following debt increase is financed at a higher/ lower interest level as suggested by the varying interest rates accordingly.

Figure 3.7 Italy’s and Portugal’s Debt dynamics under two scenarios
Under the first scenario (see figure C-1 in Appendix C), which uses average values for several macroeconomic variables for both Italy and Portugal, the path looks clearly unsustainable. The debt-to-gdp ratio projected by our model, suggests that by 2040, assuming the given values, Italy’s ratio would rise to 445% and Portugal’s to 564%. Of course, such levels are controversial as it is rather impossible that the debt level can reach such magnitudes. For that reason the author has not included this scenario graphically in figure 3.7. For representation of this scenario see Appendix C. The other two scenarios are based on different targets for the Debt/GDP ratio in time. Scenario two represents the gradual convergence towards a 50% debt-to-gdp level by changing the fiscal budget value. Scenario 3 uses the optimized value for budget surpluses in order to keep the ratio constant. In other words, the model tells us how much of a budget surplus should both countries produce in order for their debt-to-gdp level to fall to 50% by 2039.

| Table 3-1 Italy’s and Portugal’s Macroeconomic variables values, used in the scenarios |
|---------------------------------|-----------------|-----------------|-----------------|
| Country                        | Scenario 1     | Scenario 2     | Scenario 3     |
| Growth of Y (g)                | Italy | Portugal | Italy | Portugal | Italy | Portugal |
| (G-T)/Y                         | 1%    | 1.93% | 1%    | 1.93% | 1%    | 1.93% |
| r (D/Y<50%)                    | 5.55% | 3.7%  | -2.85% | -1.53% | -1.16% | -0.91% |
| r (D/Y>50%)                    | 1%    | 0.84% | 1%    | 0.84% | 1%    | 0.84% |
| r (D/Y>100%)*                  | 2%    | 3.34% | 2%    | 3.34% | 2%    | 3.34% |
| Note: * For Portugal the threshold is D/Y>80% |

The main focus in this analysis is to determine what the surplus should be in order to fulfill the targets for debt-to-gdp ratio. If Italy is able to generate a budget surplus of 2.85% of GDP per year, then ceteris paribus in 2039 they should expect to have decreased their debt load down to 50% of GDP. The value for Portugal’s budget balance in order to achieve the same target is 1.53% of GDP. These values are derived from an optimization process of our two period debt model. Furthermore, if Italy wants to keep its debt level at the current fraction of output, then it would suffice to generate budget surpluses of 1.16% of GDP and for Portugal this value is 0.91% of output. Those results are only valid, assuming that the annual output growth and interest rates on the outstanding debt are as shown in the table. One potential improvement that could be made is to try to dynamically link economic growth with public debt with the help of a forecasting.
technique. Due to the limited time and much more sophisticated modeling requirements, the forecasting and dynamic models are left for future research.

In order to see the relationship between the current account and the primary budget, the author shows an equation that links both entities and explains the previous statements about budget surpluses. The current account (NX) can be expressed in the following way:

\[ NX = (S - I) - (G - T) \]

From this relationship one can see that as a country incurs budget deficits this would deteriorate the current account balance. The data for Portugal and Italy fit very well into this simple identity and one can verify this by referring to figure 2.2 and 2.5. Having this equation in mind and including the simulated scenarios it is clear that both Portugal and Italy have to generate current account surpluses which can come from two ways: either savings should be higher than investments or the state should run a primary budget surplus \((G - T < 0)\). In recent years Portugal has already adopted tight fiscal measures to reduce its primary budget deficit and since 2010 succeeded in reducing the fiscal gap to 4.2% from 10% of GDP in 2009 (Andre Birukoff, 2012). Most often trade deficits (current account deficits) go hand in hand with budget deficits. This is why it is very important to revise the fiscal policy of both Italy and Portugal so that the future path of public finance generated budget surpluses that would lead to an improvement in the current account. These notions gradually lead us to the next section where we evaluate the budget constraint in an intertemporal setting.

### 3.3 Budget constraint

In this section we address the question of the budget constraint which analyzes the conditions that have to hold to ensure that fiscal policies are sustainable. This part serves as an introduction to the topic of public debt sustainability. We can express the government budget constraint in the following way:
where \( g \) and \( r \) are the growth rate of the economy and the real interest rate paid on the existing debt stock. The other variables should be already familiar from the previous equations. The meaning of the intertemporal budget constraint is that the present value to infinity of primary deficits plus the current debt-to-gdp ratio should be equal to 0. In other words, if a country is piling up debt now, then based on this equation in the future it should generate primary surpluses in order to pay up the debt. In this sense an interesting question for policymakers is whether current fiscal policies address this problem and take into account the long-run implications of current debt accumulation (Reinhard Neck and Jan-Egbert Sturm, 2008). Furthermore the clear implication is that a country cannot rely on constantly raising new debt and with its proceeding paying previous interest obligations e.g. Ponzi schemes. This is not a sustainable path and violates the upper condition. Unfortunately, this practice is very common among countries as it "postpones" the painful effect of severe debt accumulation. The tiny assumption that very often is not shared by governments is that in order for the roll over of debt not to pose problems for the sustainability of public finances the growth rate of the economy should be higher than the interest rate that has to be paid on the newly issued debt. In figure 2.7 one can see the high borrowing rates of Italy, Portugal and other indebted EU countries. On top of that their growth rates have been negative for the last 2 years, clearly showing how unsustainable Ponzi schemes are in the long run. Relating the analysis to the budget constraint model above, one can see that \( r \) is much higher than \( g \), meaning a continuous increase in debt-to-gdp ratio. However, one should not worry if a country has experienced debt accumulation as long as it compensates with expected future primary surpluses or an equivalent increase in taxes.

3.4 Debt sustainability

The outlined theories and model are important because they laid down the logical direction and proper structure for debt analysis. The reason why the author touches upon the sustainability aspect of debt dynamics is because decisions, taken today in relation to
fiscal policy may have big impact on future generations. Having to pay larger and larger debt obligations has an effect on the entire monetary union in the case of Portugal, Italy and other member states of the EU. As a consequence, huge interest payments result in lower growth rates, inefficient resource allocation across time and financial instability (A. Fatás and I. Mihov, 2003). The rationale behind this statement is that as debt servicing gets larger those proceedings soak up a bigger part of the government budget, in turn crowding out investments. From a macroeconomic perspective a decrease in investments would slow down the economy. This link is empirically investigated and proved in sections 4.4.1 and 4.4.2.

The topic of sustainability of fiscal policy has been around for more than 4 decades. Intergenerational distribution of debt burden was first discussed by Robert Barro (1974). The importance of sustainability rests in the fact that today's high debt level of Italy and Portugal may compromise future growth for following generations as they may need to save more, thus reducing their consumption and dedicate a big portion of GDP to pay the debt repayment obligations. The causality direction could go either way. We can think that lower growth now would increase the debt burden because less revenue would be accumulated in the government budget, thus causing an imbalance in the fiscal account. As we already know this would lead to new debt issuance. As one can also see from the logic behind the intertemporal budget constraint and sustainability criterion, both concepts seem straightforward, however in reality a sustainable fiscal policy may be hard to achieve. This setting is towards the long-run, whereas based on Keynesian views, very long term policies and considerations do not enter the agenda of current governments as their core focus is on a short-term scope. This point makes sense because the main objective of a ruling government is to get reelected. This means that more weight will be put on policies that have a fast effect for the society. This is the reason for this mismatch in the "ideal policy focus" and the actual one that we observe across countries. This is why sustainability plays such a key role in public finances.

Sustainability can be defined in several ways, but the essence of this term, when it comes down to fiscal and debt management policy, is to ensure that future surpluses are equal to the present value of debt. One may say that adopting a Ricardian view on the
topic of debt should ensure sustainability as people would adjust their expectations and behavior in relation to changes in taxes or increase in debt. Despite the strong convincing logic, expressed by Ricardo and derived analytically by Barro (1989), we should take this topic seriously, but not overemphasizing its impact in real life.

As a conclusion, the author expresses his determination that the topic of debt sustainability is very important because it has direct implications on future generations' wellbeing. Irresponsible public finance management and short-term focus can become a heavy burden for the following generations that will have to pay the "price" under the form of increased debt servicing obligations on a debt stock, accumulated because of today's policies and face an economy with a stagnating growth.

4 Data and analysis

After discussing the interrelations among the core variables that influence growth, investments and debt, we proceed now to the empirical testing of our hypotheses. The causality link between debt and growth has been analyzed and derived; the effect of public debt under the Solow model framework and finally the crowding out of investments due to increases in debt levels. In order to prove the hypotheses the author uses panel data. The primary benefit of using this data structure is that we can explore it both spatially (across cross-sections) and temporally (across time). This is a big advantage as now we can track several countries on various variables across prolonged periods of time. This results in higher quality data. In comparison to cross sectional data, we miss the time dimension of data, since we track many individuals (countries, cross-sections, etc.) but only in a given year (could be months, minutes, etc.). Whereas with time series, we miss the spatial feature of data, meaning that we cannot compare our observations to other cross-sections because we have observations across many years but only for a single individual (cross section). Logically, a panel data approach can provide a very powerful and convincing study of economic growth as it is in this case, because it allows utilizing those two key features of the other two data structures (D. Gujarati, 2003).
In addition to the choice of this data type analysis the researcher also shares his choice of estimation methodology. The econometric models in this bachelor thesis are estimated using fixed effects (LSDV\textsuperscript{27}). This type of model has the same slope for the regressors for each country but a varying intercept (constant term) for each cross-section. The intercept here is said to be country-specific. This method is chosen in order to capture the unobservable effects that do not change over time, namely: geographical location, country size, culture, etc. As our dataset consists of countries varying on those parameters, their differences will be included in each country's dummy variable in the model.

The dataset for this bachelor thesis comprises of 17 countries in Europe, observed over 30 years (1980-2012). Because data entries are not available for several countries for the period 1980-1990, the working dataset has been limited to the period 1985-2010, excluding Cyprus, Estonia, Malta, Slovakia and Slovenia. The reason is that for some of the small economies (Slovak Republic, Slovenia, Malta, etc.) there are missing values almost for the whole period 1980-1990. The reason for this absence of exact data is that some of the states were under a different governmental regime, which made the data unavailable and very hard to find. For example, before 1989, the Slovak and Czech Republic were known as one under the name Czechoslovakia. In that sense data for the other countries was hardly available and including them in the estimation process would have produced biased results due to imbalances in the time period (1980-1990) and the latter one from 1990 onwards. In order to correct for this, the researcher's main estimation will be based on the dataset from 1985 to 2010, excluding the five EU states mentioned above. This does not represent a problem as now there are 12 cross sections, observed over more than 25 years.

\subsection{Variables explanation}

The majority of the variables are presented in a ratio form or as percentages and others such as: population and real GDP - in level and logarithmic form. The reason for using a logarithmic form is that when the variable of interest is bigger than 0, then the log form

\textsuperscript{27} Least Squares Dummy Variable model
very often satisfies the CLM\textsuperscript{28} assumptions. In many cases positive variables that are presented in level forms have skewed distributions. By using a log form we can eliminate this particular problem. Another benefit is the fact that the log form of a variable is usually much less dispersed, whereas a level form can have big absolute distances between observations, causing biases due to outliers (Jeffrey Wooldridge, 2009). A shortcoming of this transformation is that we are unable to take a log form of a variable if it has negative value or zero. This is why in our case $bb\_gdp$ is in level form (as \% of gdp) because some countries have periods of budget surpluses (negative sign on $bb\_gdp$) and budget deficits (positive sign on $bb\_gdp$). Furthermore, the researcher has calculated $gr\_debt$ (growth rate of debt) as $log(debt\_gdp)\times log(debt\_gdp_{t-1})$.

In this thesis the author follows a conventional way of reporting the values in the dataset. For example a debt-to-gdp ratio of 75\% is entered in the dataset as 75 as this is the percentage of public debt relative to GDP and not as 0.75 that is a proportion. Furthermore log transformation has been applied to several of the variables. The primary reason for this is to get a constant percentage effect of economic growth on public debt. Another plus is that a log transformed variable has a distribution closed to the theoretical normal one. This has importance later on when analyzing the residuals and their distribution as this is one of the important assumptions behind our model, namely that the error term ($u_{it}$) follows a normal distribution. As a proxy for human capital\textsuperscript{29} we use the average years of schooling ($school$). This measure has proved to be a good instrument for this purpose. An alternative is to use enrollment rates as a proxy, but it has been shown that they can have a biased effect on the estimates. The researcher argues that as people attend higher levels of education, they are capable of doing more tasks and activities. Such skills play an important role in economic growth as people can make innovations and put them in use. Those are the people that generate ideas which in turn are the underlying factor behind technological progress, fostering economic growth (Paul Romer, 1990). This view is commonly accepted in the endogenous growth theory.

\textsuperscript{28} CLM (Classic linear model) assumptions are presented in Appendix D of the thesis with explanations regarding the meaning. The researcher also tests the developed model in accordance to CLM assumptions.
\textsuperscript{29} Another approach taken in empirical literature is to take school enrollment rates. Those tend to be problematic. The primary reason is that current enrollment rates depend on lagged values for investments in human capital.
After sharing the reasoning and particularities of the variables in the dataset, we continue with selection characteristics of the used data.

4.2 Selection bias

In this paragraph the researcher explains the selection bias of data used for empirical testing in the following section. The countries included in the dataset are European countries as one may have expected, given the nature of the research and they are all part of the European Union. This implies that the inference drawn from this investigation may not be totally attributable to countries outside Europe. Additionally, some of the relatively newly joined countries in the EU have been excluded from our working sample, because of lack of data for long periods of time. Such a bias, of course, has led to choose only 12 out of 17 initially planned countries as already stated. In that relation the author has excluded smaller economies such as: Estonia, Cyprus, Slovakia, Slovenia and Malta. We can find support for the argument that the included countries are developed, based on the high average value of the GDP per capita (28,850 compared to 24,196) when the 5 excluded countries are in the sample. Another aspect of the data is that the majority of the countries are located in western, southern and central Europe. The dataset includes the following countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain.

4.3 Causality test and regression on public debt

In this section the author tests the hypothesis regarding the growth-debt nexus. An interesting feature of this thesis is that it challenges the assumed causality from high debt to lower growth. In this section we provide evidence why the relationship between those variables is reversed and in fact lower growth leads to higher debt.

Hypothesis 1): *High debt levels lead to lower economic growth*

*Sub question: In which way does the causality go? High debt to low levels of economic growth or low economic growth to high debt levels?*
As of now it should be clear that the topic of economic growth analysis is based on panel data, because it gives the chance to control for omitted variable, endogeneity and also explores the data across time. The model that has been estimated takes the following form:

\[
\log(\text{debt}_gdp) = \beta_0 + \beta_1 \times \text{grgdp} + \varphi x + n_i + u_i
\]

where debt_gdp is the debt-to-gdp ratio of a country, grgdp is the growth rate of real GDP in level form, X is a vector encompassing several other explanatory variables, n_i is the fixed effect that captures the effect of each cross-section (country) which does not vary across time and u_i is the idiosyncratic error, which captures the variance of data across countries and time span. The beta coefficients shall be interpreted as semi-elasticity, meaning that 1 percentage point increase in grgdp would lead to a specific percentage change (the Beta coefficient is multiplied by 100^30) in debt_gdp as we take the log of the dependent variable. Before estimating the model, the researcher shares his insights about other potential variables that may affect the debt-to-gdp ratio. Such determinants could be the budget balance-to-gdp ratio (bb_gdp) and current account balance-to-gdp (cab_gdp). The rationale behind them having an effect on debt accumulation or reduction is that as governments run a budget deficit (bb_gdp>0), they need to borrow money or raise taxes in order to fill in the gap. Previously, we have argued that distortionary tax increases are not popular among decision makers and new debt (roll over) is usually preferred. The budget balance is an important determinant of the debt-to-gdp dynamics. Another variable is the current account balance-to-gdp. It is defined as the difference between exports and imports plus net transfers and net income from abroad. From this viewpoint, one cannot be conclusive by saying that if an economy is doing well or not, just basing his argumentation on the sign of the current account balance. The important thing is to determine where the numbers come from and what do they say. The relevance of the current account balance surpluses has been emphasized by the prominent economist Roubini (2001) when speaking about debt. He argued that the discounted value of debt should be exactly equal to the future current account surpluses.

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30 For more insight how to interpret the coefficients, depending on the model, please consult Table 7-3
that a country will have to generate. This statement can be also inferred from our previous discussion about debt sustainability and our debt development simulation.

Before presenting the estimation results, one important step is considered first. The author uses a statistical method to determine in which way the causality goes. The author strongly emphasized the difference between causality and correlation. In our case, we aim to determine the former one and in this way find the answer to our hypothesis.

The researcher uses Granger causality test\textsuperscript{31} (1980), including up to 10 lags to determine the direction of the causality. On figure 4.1 one can see the negative correlation between GDP growth and debt-to-gdp ratio.

Furthermore in table 4-1 the results are summarized and along the whole lag length where we cannot reject $H_0$ that \textit{debt_gdp} does not granger-cause \textit{grgdp}. On the other hand, we have strong evidence to reject $H_0$ in favor of the alternative hypothesis that \textit{grgdp} does granger-cause \textit{debt_gdp} at 1\% significance level. This test is a contribution to the overall understanding of the causality direction and lays a solid ground for further investigation. As it often happens, one should not take one theory or approach as the only correct choice and consider some pitfalls or alternatives. For that reason, the author raises some limitations of this statistical concept. This method relies on overfitting of the data to make sure that the serial dependence is removed. This is not harmful in relation to unbiasedness, but may result in inefficient OLS estimator. As a result this technique is highly appropriate for determining the significance of causality but should not be used for structural coefficient estimation. Finally, the author states that we reject our hypothesis that higher debt leads to lower growth in favor of the alternative

\textsuperscript{31} The Granger causality: One could think that a variable X causes another variable Y if and only if the expected value of Y given the historical value of X is different from the unconditional expectation of the variable Y.
that points toward a reversed causality between economic growth and debt. So our conclusion is that based on the testing performed in this section, we can confidently say that lower growth rates lead to piling up of debt.

Table 4-1 Pairwise Granger Causality test

<table>
<thead>
<tr>
<th>Lag length</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis: $H_0$</td>
<td>2.3185 (0.1002)</td>
<td>1.9423 (0.1035)</td>
<td>1.6837 (0.1252)</td>
<td>1.5815 (0.1312)</td>
<td>1.2851 (0.2406)</td>
</tr>
<tr>
<td>grgdp does not granger-cause debt_gdp</td>
<td>8.5526* (0.0002)</td>
<td>6.0028* (0.0001)</td>
<td>4.6441* (0.0002)</td>
<td>4.5163* (0.0000)</td>
<td>3.7434* (0.0001)</td>
</tr>
<tr>
<td>Observations</td>
<td>299</td>
<td>297</td>
<td>273</td>
<td>249</td>
<td>225</td>
</tr>
</tbody>
</table>

Note: * and ** indicate significance at 1% and at 5% respectively.

Now the clear directional link between those 2 key variables has been established. This permits the research to continue further and empirically test the following hypothesis. Next, the author presents the estimation method and the results from the regression analysis of GDP growth on Public debt.

Hypothesis 2): *Economic growth has a negative effect on public debt accumulation*

*Sub question: What is the effect of economic growth on public debt accumulation and is there one?*

Additionally, some tests are performed to prove that the model satisfies the CLM assumptions. In section 4.3.2 the author discusses potential caveats with the estimation and potential violations of the key assumptions for efficiency and unbiasedness of the OLS estimator. With the help of the above methodology we found an answer to the first hypothesis. It was shown that low growth leads to higher debt accumulation. Slower economic growth as a consequence leads to less public revenue than anticipated. Because revenues are not enough to run a balanced budget (government spending does not change), governments have to borrow in order to fill this fiscal gap (John Irons and Josh Bivens, 2010). As a result public debt increases. Consequently, higher debt levels increase the borrowing rate because of higher perceived risk of default. One can find
support in figure 2.7 where the borrowing rates have increased substantially for the most indebted countries in Europe. Such a development can "crowd out" private investments and in turn reduce growth even further. Such a scenario sounds reasonable and represents the so called "feedback loop" where in fact some of the independent variables are endogenously determined by the level of economic growth. Further in the thesis, we will test the crowding out hypothesis by regressing \( \log(\text{inv}_gdp) \) on \( \log(\text{debt}_gdp) \) and several other explanatory variables. The expectation of the results is that indeed there is a crowding out effect and investments decrease when debt levels increase, everything else being equal.

Similar to the empirical investigation of the already existing literature, factors that could influence the debt of a country is growth of GDP, the budget balance, current account balance and savings. As we already mentioned big focus falls on the GDP growth effect. The estimation results are presented below:

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>OLS (3)</th>
<th>OLS (4)</th>
<th>OLS (5)</th>
<th>OLS (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>4.051*</td>
<td>4.043*</td>
<td>3.948*</td>
<td>5.567*</td>
<td>5.258*</td>
<td>3.546</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.284)</td>
<td>(0.040)</td>
<td>(0.119)</td>
<td>(0.125)</td>
<td>(6.571)</td>
</tr>
<tr>
<td>grgdp</td>
<td>-0.030*</td>
<td>-0.025*</td>
<td>-0.015***</td>
<td>0.022*</td>
<td>0.006**</td>
<td>-1.592*</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.007)</td>
<td>(0.002)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>bb_gdp</td>
<td>0.021*</td>
<td>(0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cab_gdp</td>
<td>-0.016**</td>
<td>(0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sav_gdp</td>
<td>-0.075*</td>
<td>(0.005)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.915*</td>
<td>(0.018)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( R^2 \) 0.725 0.730 0.744 0.826 0.979 0.381
Observations 301 300 278 301 298 277
DW coeff. 0.140 0.144 0.110 0.219 1.697 1.69
Cross-sections 12 12 12 12 12 12

FE - Italy 0.636 0.626 0.743 0.553 0.510 -1.474
FE - Portugal -0.327 -0.417 -0.297 -0.486 0.236 1.062

Note: *, ** and *** indicate significance at 1%, 5% and 10% respectively.
† Convergence has been achieved after 11 iterations.

One can see that in total 6 equations have been estimated in relation to the second hypothesis. Equation 6 has as a dependent variable \( \text{grdebt} \) (growth of debt) in level form.
The main objective has been to assess the significance of $grgdgp$. The hypothesis for the GDP growth’s coefficient is as follows:

$$H_0: \beta_i = 0 \text{ (meaning that growth of GDP does not have an effect on debt)}$$

$$H_1: \beta_i \neq 0 \text{ (meaning that growth of GDP has an effect on debt dynamics)}$$

This is how we test the significance of the variables. In this bachelor thesis we use fixed effect estimation\(^{32}\) as a methodology. After the causality direction was identified, it is a good idea also to link similar research results into the paper. For example, Manmohan S. Kumar and Jaejoon Woo (2010) reach a similar conclusion that, in contrast to the widely accepted wisdom about debt causing lower growth, there is evidence for reverse causality. On the other hand, Maria Cândida Ferreira (2009) argues that the causality always goes in both directions. This statement has validity because once the debt-to-gdp ratio increases, a more substantial part of the government budget will have to be dedicated for debt servicing (payments in the form of interest), thus decreasing investments and this resulting in lower GDP growth. Exactly this scenario is going to be tested in section 4.4.2. Next, the estimation results of log of debt-to-gdp regression are discussed and analyzed.

### 4.3.1 Interpretation and analysis

The several estimated equations attempt to see whether their effect is significant on the dynamics of public debt. The author states with certainty that across all specifications growth of GDP is significant at 1% (in eq. 1, 2, 4 and 6) and at 10% (in eq. 3 and 5). In equations 1-3 and 6 we see the expected signs on economic growth ($grgdgp$). However, as additional explanatory variables were added, such as budget balance-to-gdp and current account balance-to-gdp ($cab\_gdp$) the effect of GDP growth on public debt has been decreasing. The range of point estimates is between -0.015 and -0.030, meaning a negative effect of 1.5% to 3%. The interpretation goes as follows: An increase in growth of

\(^{32}\) Fixed effects estimation is an econometric method for panel data. With this method one can “isolate” and capture all the effects that are country specific (in our particular case, such as: geographic location, culture, endowments, etc. that do not vary over time. This means that for each cross-section we will have a separate constant estimate in our model. For further information see Christensen, Ronald. 2002. *Plane Answers to Complex Questions: The Theory of Linear Models*. New York: Springer.
GDP by 1 percentage point would lead to a decrease in Debt/GDP by 3% (in eq.1), 2.5% (in eq.2) and 1.5% (in eq.3) everything else being equal. The negative relationship is as predicted by the economic literature (John Irons and Josh Bivens, 2010, Manmohan S. Kumar and Jaejoon Woo, 2010). Attention should be paid when assessing the robustness of the results in this case. The reason is that there are clear signs for autocorrelation, based on the very low DW statistic that we get, ranging from 0.11-0.14 for equations 1 to 3. This issue is going to be address and dealt with in section 4.3.2 of the thesis.

In equation 4, a regression with savings is also performed. The sign in front of economic growth is positive, meaning that an increase of 1 percentage point in economic growth would lead to an increase of 2.20% in debt-to-gdp ratio. This is surprising and the coefficient is significant at 1% level. On the other hand, the effect of savings is as expected and it displays a considerably strong negative effect on public debt. One could interpret the coefficient in front of sav_gdp in equation 4 as 1 percentage point increase in savings would lead to a decrease of 7.5% in debt-to-gdp ratio. One potential explanation of the positive sign of grgdp could be that when the savings increase, consumption falls because people in the economy would have less disposable income. In turn this would reduce the economic output. Consequently, this will result in a higher debt-to-gdp ratio as the denominator would decrease, consequently increasing the value of the whole ratio. Savings have a significant and high negative effect on public debt. They can be used to repay debt obligations and in this way reduce the debt load of a country. Furthermore, an additional regression (eq.6) has been performed on grdebt (growth of debt), using cab_gdp (current account balance-to-gdp), bb_gdp (budget balance-to-gdp), grgdp (growth of gdp) and sav_gdp (savings as percent of GDP) in order to see whether there is a big change in the coefficients and effect magnitudes. It is clear that our results from this specification are close to the previously estimated equations 1 to 3 and of the expected sign.

---

It is very important to stress the difference between percentage point change and percentage change. For example, let’s take the value 50%. A 5 percentage point increase would mean that the new value will be 55%, whereas a 5% increase in this value would be equal to 50%*1.05- 52.5%. This distinction is crucial for the correct interpretation of the sophisticated results. The reason for that is that we are dealing with variables expressed as proportions and percentages.
Equation 6 shows that the effect of current account balance, growth of GDP and the budget balance are different than 0 at 1% significance level. The signs are once again as expected, showing no disruptions in the data and inconsistencies with our logic. The coefficient for grgdp can be interpreted such that 1 percentage point increase in economic growth would lead to 1.59 percentage point decrease in debt growth per year everything else equal. The effect of the budget balance ratio-to-gdp shows that 1 percentage point increase in the variable would lead to 0.90 percentage point increase in growth of debt. This makes sense, because the budget balance is represented in the following way: (G-T)/Y. As government expenditure increases, this would increase the deficit (assuming that T (taxes) stay fixed) which in turn would make the government either raise taxes or increase its debt load. One can see that the effect is almost 1 to 1. After having considered the following estimations, the author summarizes the two sets of established equations: log-level and level-level\(^{34}\). In the author’s opinion the most conclusive estimations are 3 and 6. Even though they are in different specifications, they best represent the relationship between growth of GDP and public debt, based on our expectations and the results from similar empirical studies. The obtained results are similar to what the literature has established (Manmohan S. Kumar and Jaejoon Woo, 2010).

As a conclusion to this sub-chapter, the author proposes a specific correction for the persistent problem of autocorrelation in the residuals. Serial correlation is a violation of assumption 6 from the CLM conditions (see table 7-5) and thus should be adequately discussed and taken into consideration when performing panel data estimations. Equation 5 includes an AR(1) term which has been included as an autoregressive error of first order as this is the autocorrelation that we suspect exists in the residuals. The transformation is done a la Cochrane-Orcutt\(^{35}\) iterative procedure with the inclusion of this term (see Appendix E). The reason why we need to approach this problem seriously and effectively is because the OLS estimator is inefficient otherwise. The variance of the regression coefficients will be biased and inconsistent as well. So we apply this correction

\(^{34}\) For reference how to interpret coefficients, depending on the form, see Appendix A, table 7-3
\(^{35}\) This is a statistical manipulation in order to correct for autocorrelation, developed by two researchers. For more information on the procedure, see appendix E
technique in order to restore serial correlation. From the estimation table it is visible that
the DW statistic significantly improved and the coefficient for economic growth became
smaller, but still keeping the expected negative sign (equation 5). Such an estimate could
fit well our analysis as it displays a milder effect on public debt. The coefficient in front of
AR(1) does not have any economic meaning, so it is just used to control the dynamics of
the model. The $R^2$ that shows the explained variance in the data is very high (0.97) and
cannot be reliably interpreted in comparison to the other estimations. Resolving
autocorrelation we obtain a coefficient or $grgdp$ of 0.006, which is significant at 5%
confidence level other things equal. The interpretation is that an increase in GDP growth
of 1 percentage point, would lead to an increase in debt as a fraction of GDP of 0.6%.
Obviously the sign is surprising but the specification is the same as in eq. 4 just here we
have resolved the autocorrelation issue. Also the savings exhibit the same strong negative
effect on debt-to-gdp development. This hints that our interpretation is similar the one we
established for eq.4 and now our current coefficients are robust in comparison to eq. 4.
And the effect fell considerably from 0.022 to 0.006.

As a conclusion to this section, a summary is presented. Here we discuss the results
of the estimations and their relevance to the hypothesis that has been tested:

"Economic growth has a negative effect on public debt accumulation"

Our answer is yes, that economic growth has an effect on public debt and this
supports are initial expectation in relation to the effect direction. In this case we do not
reject our null hypothesis that the sign in front of economic growth is negative. We
obtained persuasive results that the negative effect of GDP growth on public debt can
range somewhere from -3% to 0.6% and the author argues why perhaps the specifications
with the negative effect would suit reality better. Furthermore, several estimations have
been done with additional explanatory variables that are expected to affect the dynamics
of public debt. Those variables also showed a significant effect on the
accumulation/reduction of public debt of a country. Specifically, budget balance-to-gdp
has a positive effect on public debt, meaning that an increase in $bb_gdp$ would lead to an
increase in $debt_gdp$. Despite the fact that those results support our expectations in
relation to the signs and direction of the effect, there are several crucial assumptions and issues that should be addressed with caution and perhaps implemented in further research.

A big part of the potential issues are covered next with some additional technical details in the appendices. One particular improvement in relation to the autocorrelation problem is to use Arellano Bond’s methodology by GMM estimation. However, this technique is way beyond the academic level of this thesis, so this is why the author sticks with more comprehensive resolving procedure - the one proposed by Cochrane and Orcutt.

4.3.2 Tests and Potential issues

In order for a model to have strong predictive power, it should be prone to various caveats and potential data problems. This is why the author thinks that such a section deserves a merit. Here, we address some of the more important cautionary points in relation to our model and specification.

One of the most important issues was already mentioned and corrected. This was the case of serial correlation, which made the OLS estimator biased and inefficient. The author identified that there is clear evidence of first order serial correlation (see figure E-1), which signals that perhaps there is an unobserved country-specific effect in the error term, making the residuals serially correlated. With a resolving procedure we managed to correct for this problem. Further in our quest for quality of analysis, we test the normality assumption of the residuals’ distribution. This condition implies that the error terms are normally distributed and have a mean of 0. In our baseline regression model, we perform this test and obtain strong results that residuals follow a normal distribution. The visual representation of the residuals can be seen in Appendix E. It shows a broad consistency between the normal hypothesis and actual result. As an addition, the author has provided more details about the iteration procedure and the critical assumptions behind our analysis.
The next issue that should be raised is endogeneity. This can be a serious problem, despite the fact that with the current data structure, we potentially can control this problem. The main issue here is that the regressors may be correlated with the error term. Such a scenario would affect the consistency of our results when using fixed effects estimation.

In this research paper the focus has been on examining the growth-debt nexus. We use initial levels of GDP growth to see the impact on public debt. This approach, however, does not necessarily resolve the endogeneity problem. This means that there may be an omitted variable in the error term, which in fact may determine the levels of public debt and economic growth. This is also known as the omitted variable bias. This problem is difficult to address because there could be many other factors influencing economic growth and public debt dynamics (Steven N. Durlauf, 2001). Consequently this is why the error terms from one period to another are correlated because this omitted variable bias is included in the idiosyncratic term.

Another important assumption in our model is the absence of multicollinearity. This problem arises when several independent variables are perfectly correlated or are a function of another independent variable. In our regression model, such a problem does not exist and there are no variables that have perfect linear relationships with other regressors.

After assessing the potential caveats of our empirical analysis, we now take an ambitious look towards growth accounting and estimate a model, predicting investments as share of GDP, based on a "core set" of well known variables (Xavier Sala-I-Martin et al., 2004.). Additionally, we add public debt in order to test our crowding out effect hypothesis and see whether sustained fiscal deficits have a negative impact on investments. Such a result was reached by Robert Barro (1990). Growth on the other hand is assessed with the help of the Solow model framework that was presented in the beginning of the thesis. There are several possibilities how to empirically estimate the model. As regressors of economic growth per worker we include variables such as growth of the labor force, depreciation and take technological growth as fixed. Next a lagged
capital-to-output ratio is added in the model along with investments and average years of schooling as a proxy to human capital. It has been widely proven that long-term economic growth is determined by savings, capital accumulation, technological state, depreciation and population growth.

4.4 Investments and growth

In this section of the thesis we continue our investigation of growth, expanding further chapter 3. The author discusses some particularities of the investment-deficit-growth relationship.

In chapter 3.1.2 we identified that $S \equiv I + NX$. We use this identity in order to analyze what the implications of prolonged deficits are. As a government runs sustained public deficits (in other words government spending is higher than the tax revenues) public savings decrease. In connection to the identity above, this means that the decrease in S shall be exactly offset by a decrease in either investments, net exports or a combination of both. Considering the first channel, investments may decrease because public dissaving reduces loan availability to businesses and the public. The impact of that: interest rates go up, which reduces investments (Laurence Ball and Gregory N. Mankiw, 1995). Investments have a positive effect on economic growth as they play a huge role in capital formation. Secondly, budget deficits tend to result in trade deficits, which affect the current account of a country. Those trade deficits are in fact financed by the sale of domestic assets abroad. However, this deterioration of the capital account makes foreign investors less and less willing to possess domestic bonds. In fact growth lower than expected leads to higher debt levels, which in turn leads to reduced investments and savings, again affecting growth even further. This shows that there is double channel effect, which makes this topic even more important to policymakers to consider, having in mind its serious consequences.

In the case of Italy and Portugal in figure 3.6, we can see the reduced levels of investments and savings in both countries with the biggest decline being in Portugal. Such a path means that in the long-run Portugal's growth and capital accumulation will be constrained more than that of Italy. The primary reason is that by investing less, capital will not be renewed and will depreciate. This of course will affect the economy's output. The sustained budget deficits for almost 25 years would necessarily lead to draconian measures for future generations under the form of tax raises or big spending cuts. Ironically said, by having no fiscal and debt policy discipline a country shifts the debt burden to future generations. So we can conclude that "winners" are current taxpayers and the "losers" are future generations which will have to bear the consequences of their ancestors' activities.

To make things look even worse, we can take into account population ageing. This factor is particularly important because when a country's population becomes older, more people would fall under the social security system (medical care, pensions, etc.). Italy and Portugal's populations are ageing because of the increased life expectancy and low birth rates. We find proof of this statement in the following figure.

![Figure 4.2 Birth rate and life expectancy: Italy and Portugal (1980-2009)](image)

An interesting observation is the life expectancy. In figure 3.3 and 4.2 we see the positive trend that Italy and Portugal became richer, their populations are expected to live longer as now they can afford better healthcare and living conditions. This would
imply that retirement age shall be increased because if not those people, expected now to live longer, will rely on government spending until their last day. Figure 4.2 is a simple but nevertheless a very exact representation of those trends happening in both countries that could affect seriously the fiscal balance and as consequence investments.

During the last several decades a lot of research has been devoted to economic growth. The primary purpose has been to understand what causes cross-country differences in their income levels. In this thesis, we do not seek to provide an answer for that as much research has already been conducted on that particular matter (Peter J. Klenow and Andres Rodriguez-Clare, 1997, David Romer, Gregory Mankiw and David Weil, 1992). However, one thing that the research does is an attempt to evaluate and expand further the knowledge horizon by using empirically the Solow model and adding debt as a potential regressor. Previously, we hypothesized that debt may have an impact on growth. However the results in this paper suggest that the causality is reversed. Similar studies point that in fact the Granger-causality is always bidirectional. In part the author agrees with this suggestion because a growing debt would absorb a greater part of the fiscal budget, thus leading to decreased investments and as well new debt issuance. One can call this a feedback effect that forms the core of our last hypothesis. It states that increased levels of debt crowd out investments.

It is worthwhile to say that the Solow model is not easy to replicate and translate into an exact empirical specification as practice shows (Erich Gundlach, 2007). Logically, there are various ways the model is estimated and presented, depending on the assumptions and rationale behind it. The growth model suggests that cross-country differences in income are due to different technological levels, given the same amount of capital-to-output ratio. However, an alternative method which has attracted a lot of academic attention and which is in fact followed in this thesis, is the one applied by David Romer, Gregory Mankiw and David Weil (1992)\textsuperscript{37}. The human capital augmented Solow model that is estimated, tries to predict cross-country differences on the basis of capital accumulation, keeping technological level constant. One possible problem that may appear is that the original Solow model says that steady-state growth is stimulated by

\textsuperscript{37} Referred to as MRW in parts of the text
exogenous changes in the technological level, whereas the path towards the steady state is determined by the amount of capital available in the economy. Linking this to our two focus countries - Italy and Portugal, will imply that differences in their technological level explain the gap in between their income per capita levels (see Appendix F and G). The author of the thesis challenges this argument in a European context. The reason is that more or less our dataset consists of technologically homogeneous countries in comparison to many less developed countries around the world where the differences are much more profound. Second of all, we try to draw inference in particular for Europe and not the entire world. Third, Portugal and Italy belong to the developed world and the transfer of technology and methods of production are commonly widespread across countries in Europe. Such an argument would support the methodology adopted by MRW to explain cross country differences on the basis of their different levels of capital, assuming that technology is fixed and has a constant growth. Portugal and Italy have a gap in their output per capita rate of about $7500 (see Appendix F). This gap has pertained across time. For that reason in our estimation of the Solow model, we will keep the TFP in the constant term. Such a restriction does makes sense along the reasoning established above and is supported by similar comments and findings regarding the problem of estimating the technological state (Christopher Freeman, 1994). Further support of this specification is that technological differences are unobservable in the real world. This makes it hard to decompose income differences between countries into what is due to technology differential and what is due to differing levels of capital accumulation (R. R. Nelson, 1973). This big problem can be partly overcome by adding instrumental variables such as institutional quality, property rights enforcement, health technology etc. (Daron Acemoglu et al., 2001). In the following section we analyze the results from the model that we establish and test our last two hypotheses.
4.4.1 Interpretation and empirical analysis of growth

After introducing the reader into the particularities of the growth and investments link it is time to analyze our results in relation to growth first and for investments afterwards. Our question deals with the incorporation of debt into the Solow model\(^{38}\).

**Hypothesis 3):** *Debt has a negative effect on economic growth, using the Solow model framework*

*Sub question: What is the effect of debt on per worker GDP growth, using the Solow framework and is there one?*

The author specifies empirically the model by using as a dependent variable growth of output per worker, which is derived as the change in the natural logarithm of \(Y/L\)\(^{39}\). The model is specified as follows:

\[
g_{it} = \alpha + \beta_0 g_{i,t-1} + \beta_1 d_{it} + \beta_2 X_{it} + \eta_i + \epsilon_{it}
\]

where \(g_{it}\) is the growth of per worker GDP, \(g_{i,t-1}\) is the per worker output at the initial level, \(d_{it}\) is the log of debt-to-gdp, \(X_{it}\) is a vector of explanatory variables such as average schooling years, investment rate (as a percent of GDP), labor force growth, depreciation and assumed constant technological level and \(\eta_i\) is the unobserved country specific effect. We add the log of debt-to-gdp in order to test our hypothesis whether public debt has any effect on growth per worker.

The estimated equation is in a log form:

\[
\text{grgdp}_w_{it} - \alpha + \beta_0 \text{grgdp}_w_{i,t-1} + \beta_1 \ln(\text{debt}_gdp)_{it} + \beta_2 \ln(\text{school})_{it} + \beta_3 \ln(n^+g^+\delta)_{it} + \beta_4 \ln(\text{inv}_gdp)_{it} + \eta_i + \epsilon_{it}
\]

where \(n^+g^+\delta\) is the sum of workforce growth, technological growth and depreciation respectively. In the empirical literature it has been found that \(\delta\) and \(g\) all together sum up

\(^{38}\) The visual representation of the Solow model (1956) can be seen in Appendix G

\(^{39}\) \(\log(Y/L)_i - \log(Y/L)_{i-1} = \text{growth rate of } Y/L\)
to 5% (0.05) (Nazrul Islam, 1995) and the growth of the workforce is derived as the logarithmic change in the workforce. The author sticks to this formulation as well. We take the log form of the explanatory variables, meaning that the coefficients should be interpreted as semi-elasticity since the dependent variable is in level form. The coefficient for debt_gdp in eq. 5 (see table 4-3) shall be understood as the percentage change in the GDP per worker due to 1 percent increase in debt-to-gdp ratio. It is obvious that debt is not significant in this specification and furthermore the coefficient is of very small magnitude. We can clearly see that this is a log-log interpretation. The data for "school" has been taken from the dataset\(^{40}\), constructed by Robert Barro and Jong Lee (1996). Because in this dataset the observation frequency is different than the data format used in our research, the author uses an imputation technique to calculate the values in between the periods. In this project's dataset we work with annual observations, whereas in the original dataset (Robert Barro and Jong Lee, 2010) the observations are made every 5 years. The main reason why the author uses average years of schooling as a proxy for human capital is because enrollment rates (enrollp & enrolls) could be problematic as they tend to exaggerate the accumulation effects of human capital. Additional to that, using those rates as proxies can lead to misinterpretation of the role of labor force growth which is captured in \(n*d+g\) variable.

![Table 4-3 OLS estimation results for grgdp_wor and ln(gdp_wor)](http://www.barrolee.com/data/full1.htm)

\(40\) The dataset can be fully accessed at: [http://www.barrolee.com/data/full1.htm](http://www.barrolee.com/data/full1.htm)

\(41\) \(n\) stands for labor force growth, \(d\) depreciation and \(g\) technological growth
Taking a look at the output table, one should note the presence of an unobserved country specific effect because the DW statistic is close to 1.3, indicating the presence of possible autocorrelation. Unfortunately, this problem is associated with every estimated equation and is often seen in growth regressions. The author interprets this as evidence that the error term of the equation contains an omitted variable, causing the residuals to be serially correlated. Particularly, the estimation of GDP growth per worker, the author tries several forms in the quest for the most reasonable specification. The author tests whether \textit{debt\_gdp} has a significant effect on growth, according to the augmented Solow model framework. This is done in order to test hypothesis 3, which seeks to identify the effect of debt. In equations 1 to 4 all the independent variables are significant at 1% level except for debt-to-gdp. The average years of schooling display both negative signs. In equation 1, which is the baseline augmented Solow model, one can see that average years of schooling have a negative impact on per worker gdp growth. This is surprising as one would expect that as people become more educated they will contribute more to output. On other hand, one possible explanation in relation to the negative sign could be that as people pursue advanced degrees and further education they enter the labor force later, thus decreasing the economically active part of the population. For that reason this may mean that GDP growth could be negatively affected by this. In contrast, in eq. 5, we see that schooling is highly significant and has a positive effect on GDP per worker. This supports the main reasoning behind the beneficial effect of education that people can now execute a variety of tasks and be more efficient at their workplaces. In the same specification debt-to-gdp is insignificant, showing that the effect is not different than 0. In eq. 3 debt is again insignificant and in eq.4 it is significant at 10% level, but displays a very small effect on growth of per worker GDP. The effect is the following: Everything
else equal, 1% increase in debt-to-gdp level, would lead to $0.920/100 = 0.0092 \%$ point increase in growth. As one can see this is a negligible effect.

After investigating the years of schooling in our dataset an interesting trend can be observed. Based on figure 4.3 it is obvious that the schooling in Italy and Portugal is below that of EU on average and even further - Portugal’s values are below these of Italy. This may help partly explain why there has been a difference of almost $7,500 in per capita GDP for several decades. The explanation goes that as people attend schools and universities for longer periods of time they enhance their skills and become more effective on the labor market. This directly means that now one unit of human capital in Italy can produce more on average compared to Portugal. Such differences are also captured in the technological advancement of countries which is partly due to varying levels in human capital. Our estimates in the table are very close to those seen in the empirical literature and the coefficients are of the expected sign, except for the one on the log of debt-to-gdp ratio. In equation 4, debt-to-gdp as an explanatory variable is significant at 10% level, but insignificant in eq. 3. In eq. 5 we can interpret the coefficient in a log-log model as the direct percentage change. Logically a 10% in \textit{debt\_gdp} would lead to 0.05% decrease in the output per worker.

It is obvious that the effect is very weak and basically is significant in only 1 of the

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure4_3.png}
\caption{Average years of schooling in Italy, Portugal and Average EU-12 (1980-2010)}
\end{figure}
estimated equations. Even though it was expected that debt would display a significantly negative impact on long-term growth (Emanuele Baldacci et al., 2004), our results show that the effect is basically insignificant across the estimated equations. This means that we reject our initial hypothesis that debt has a strong significant effect on per worker growth, based on the Solow model framework. According to this empirical paper this conclusion is also important in the sense that it outlines once again that the causal relationship goes from economic growth to debt. Had we obtained a significant effect of debt on growth of GPD per worker then that would have meant that the causality direction is bidirectional as argued by some researchers.

In particular the researcher considers equation 3 and 5 to be the best from the listed above. The reason is that it shows the insignificant role of debt and displays similar results to the estimates in the literature. On the other hand estimation 5 shows the highly significant impact of schooling and the insignificance of debt. Additionally, the logs of investments-to-gdp are all significant and display the expected positive sign. As more investments are made the GDP per worker is expected to increase as their will be more capital in the economy. The coefficient in eq. 5 can be interpreted as 10% increase in investments as a fraction of GDP would lead to 2.49% increase in GDP per worker. In eq. 3 the rationale is: 10% increase in the level of investments-to-gdp would lead to 0.342 percentage point increase in growth of GDP per worker.

In conclusion to this section one can say that public debt does not have a strong impact on per worker GDP growth and the level of GDP per worker. In only 1 of the specifications debt-to-gdp is significant and despite this fact, it displays negligibly low effect on the dependent variable. On the other hand we also get both positive and negative signs for schooling. The author shared his views for the reason why this may be. Finally we obtain significant effect of investments on the per worker GDP level across all estimated equations. The effect is positive as expected.

4.4.2 Interpretation and empirical analysis of investments

In this final section of the thesis, the author tests the fourth hypothesis which deals with the effect of debt on investments. Namely, we want to see:
Hypothesis 4): Increasing public debt affects investments in a negative way and crowds them out.

Sub question: Do increases in debt "crowd out" investments? - The main idea lies in the fact that as debt obligations rise, it takes more resources from the government budget, resulting in lower investments.

Our preliminary expectation is that increases in debt would crowd-out investments and the coefficient will have a negative sign. This means that the expected sign in front of log(debt_gdp) is negative. As the debt increases more and more resources from the government budget are spent on servicing the debt. Furthermore countries with high debt levels are also perceived as riskier countries for investments. This view is also expressed in the literature (Laurence Ball et al., 1995, Laurence Ball and Gregory N. Mankiw, 1995). The estimated model for investments is the following:

$$\log(\text{inv}_gdp)_i = \alpha + \beta_0 \log(\text{debt}_gdp)_{i,t-1} + \beta_1 \text{bb}_gdp + \beta_2 X_i + \eta_i + \varepsilon_i$$

where the dependent variable is the logarithm of investments as percent of GDP and the explanatory variables are logarithm of lagged debt-to-gdp in percent, the budget balance as percent of GDP and a vector of several other explanatory variable which affect the investments in the economy, based on the vast empirical literature. Such variables are: openness, savings, schooling etc. Several specifications are provided in the quest of the most robust model for investments.

Table 4-4 OLS estimation results for log(inv_gdp)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>linv_gdp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS (1)</td>
</tr>
<tr>
<td>Constant</td>
<td>3.177*</td>
</tr>
<tr>
<td></td>
<td>(0.340)</td>
</tr>
<tr>
<td>ln(debt_gdp)</td>
<td>-0.161*</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
</tr>
<tr>
<td>ln(school)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(gdp_cap)</td>
<td>0.056***</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
</tr>
<tr>
<td>bb_gdp</td>
<td>-0.016*</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
</tr>
<tr>
<td>ln(open_gdp)</td>
<td>-0.251*</td>
</tr>
<tr>
<td>ln(sav_gdp)</td>
<td>0.056***</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
</tr>
</tbody>
</table>

\[ R^2 \] 0.67 0.70 0.69 0.71 0.75
Observations 265 277 265 265 265
DW coeff. 0.56 0.54 0.59 0.54 0.69
Cross-sections 12 12 12 12 12
FE - Italy 0.025 0.020 -0.095 -0.142 -0.208
FE - Portugal 0.157 0.142 0.244 0.318 0.466

Note: *, ** and *** indicate significance at 1%, 5% and 10% respectively.

Based on these results the reader can see that in accordance with our hypothesis, the debt-to-gdp from a previous period affects negatively investments. This can be deduced from all the estimated equations. As we have a log-log relation between the dependent variable and debt_gdp this means that the point estimate is the percentage change in inv_gdp due to a 1% increase in the lagged debt-to-gdp ratio. Those estimates range from -0.16 to -0.08 and are all highly significant at 1% level. One reasonable interpretation could be that a 10% increase in the debt level of a country from a precedent year will result in a 0.7% decrease in investments (according to eq.4). For equation 1 the effect is a decrease of 1.6% in the level of investments. So we can see that the effect is negative and ranges within the stated band.

The author argues that specification 5 is the most suitable one for our analysis because all the variables are significant at 1% level and we obtain higher explanatory power compared to the other estimations. Furthermore, we get a negative coefficient in front of log of openness_gdp, which is surprising as one would expect that a more open economy should benefit investments. In eq.4 and 5 we get a negative effect of the budget balance on the investment level. This is as expected and the coefficient with the expected sign. The point estimate ranges from -0.014 to -0.017, fairly consistent with the literature. It is important to note that bb_gdp is in level form, which means that the beta coefficient shall be interpreted as 1 percentage point increase in the fiscal budget would lead to a decrease in investments of about 1.4%-1.7% (see table 7-3).
Additionally, the researcher adds the log of schooling in the investments regression. As expected increases in schooling affect positively investments and the point estimate is 0.672, significant at 1% level. This means that 1% in the average years of schooling would lead to 0.672% increase in investments-to-gdp. In fact this result can shed some light why we got negative effect of schooling in the augmented Solow model estimation. One explanation is that the effect of schooling may have already been included in the investments rate, when we estimated the growth of per worker gdp. This shows that the regressor can have a significant effect both on economic growth and on investments, which jointly determine each other. This shows the feedback loop. With the established model we are able to find strong evidence that debt has a negative effect on investments, consequently affecting growth and the economical development of countries. This is in accordance with our expectation about the sign of the independent variable. In short, we cannot reject our null hypothesis that debt affects negatively investments. In addition, one can now see the complex interrelationship between growth, debt and investments through the feedback loop.

Finally the author concludes the main findings, implications and effects of debt. An overall comment is given in relation to future research. The significance of the relationships is being assessed and the overall results are interpreted in connection to Italy and Portugal, taking into consideration their historical development.

5 Conclusions

Every journey starts initially with a small step and the time has come where we make the final step and take a look back at what has been done. In this bachelor thesis the author performed a vast and in depth analysis of economic growth, public debt and investments. More importantly the research explores the relationship among those entities. The reason why this topic was chosen is because of the great importance of economic growth on human wellbeing and development. In this sense analyzing the potential factors affecting growth shall be investigated in order to draw policy implications.
This paper has provided an empirical investigation of Italy and Portugal in a European context. Along 10 other European countries, the author utilizes a range of econometric techniques to study the effect of economic growth on debt, the effect of debt in a Solow model framework and finally investigate the hypothesized crowding out effect of debt on investments. Methodologically this paper is constructed, based on a vast economic literature, concerning economic growth and debt management that explore the effect of increased public debt on economic development. This topic is of high concern because high debt levels may lead to higher uncertainty, distortionary future taxation and reduced investments. These are focal factors as they directly influence investment stimuli, thus having an impact on economic growth.

First, based on the descriptive statistics and theoretical concepts in the main body of the thesis, it is found that Italy and Portugal have been experiencing fiscal deficits in the last 20 years. According to our models such a scenario implies heavy borrowing as tax increases are unpopular among decision makers. Furthermore, Portugal has been a net importer throughout the whole period of investigation. This supports the notion that such a development path is unsustainable and detrimental to future generations because of the perceived future borrowing.

The results, based on the panel data analysis suggest an inverse relationship between debt and economic growth. Contrary to a big body of empirical literature, in this thesis the author finds evidence for the direction of causality from low economic growth to high debt levels. This paper differs in that it challenges the commonly accepted reasoning about high debt levels, leading to lower growth. Our results suggest that on average 1% point increase in growth of GDP would lead to a reduction of debt-to-gdp ratio by 3% to 1.5%, everything else equal and depending on the specification. This shows that debt is affected by economic growth. Clearly the relationship shows that Portugal and Italy have to be very careful about their growth projections as misalignment between reality and expectations can very seriously affect the fiscal budget and in turn public debt.

Looking further into our results, the author expands the augmented Solow model by adding debt-to-gdp as a potential regressor. Along the majority of the estimations we find
that debt is insignificant and occasionally having a very small effect on growth of per worker GDP. These results provide further support for our previous findings that debt does not influence directly economic growth but vice versa. Despite this seemingly clear relationship the reality is much more complex. In the last hypothesis testing, we find significant evidence that debt has a negative effect on investments across all specifications, which indirectly impacts economic growth. Our point estimates show that on average 10% increase in the debt-to-gdp level from the previous period will lead to a 0.7% to 1.6% decrease in the level of investments. Further testing is done for the fiscal balance. The results are also significant at 1% level, showing that 1% point increase in the budget balance-to-gdp ratio would lead to decrease in investments of 1.4% to 1.6%. This is in line with our expectations and we obtain results close to those of Benedict Clements et al. (2004) for the effect of debt on investments-to-gdp. The main reasoning is that as debt levels increase as a fraction of GDP, investors perceive higher risk of default of this country, investment incentives decrease and, most importantly, more resources from the government budget are needed to service the growing outstanding debt. Along this line of thinking, the author strongly believes that rolling over debt is not a sustainable way for a country to go.

Italy and Portugal are one of the most indebted countries in Europe. This research sheds light on the channels and causal relationships through which debt and growth interact. The main contribution of this paper is that it identifies a reversed causality link and finds evidence of crowding out effect on investments via increased debt levels and shows that debt-to-gdp per se does not affect significantly growth of GDP per worker. The main point is that Italy and Portugal shall focus on attracting investments and stabilize their public finances. Historically their investment levels have been decreasing, affecting economic growth in a negative way and predetermining an increase in debt due to slower growth.

However, our empirical findings require further testing and robustness checks. For example, one could use different estimation techniques such as GMM system, random effects, models with new regressors and addition of new cross-sections into the sample.
6 References


7 Appendices

Data sources and variable definitions:

Appendix A

In table 7-1 two sets of values are reported. The ones in brackets are for the entire sample (1985-2010), including Cyprus, Estonia, Malta, Slovakia and Slovenia. The other entries are for the working sample, excluding those five countries. This is why there is a difference in the number of observations, mean and standard deviation. The purpose is to let the reader see how much is the data affected by excluding those specific countries.

Table 7-1 Variables and Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Source (database)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bb_gdp</td>
<td>Budget balance-to-GDP ratio</td>
<td>279 (352)</td>
<td>2.754 (2.742)</td>
<td>4.306 (4.085)</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>cab_gdp</td>
<td>Current account-to-GDP ratio</td>
<td>301 (398)</td>
<td>0.299 (-0.961)</td>
<td>4.832 (5.286)</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>enrollp</td>
<td>Primary School enrollment</td>
<td>282 (397)</td>
<td>103.953 (102.657)</td>
<td>6.357 (6.396)</td>
<td>WDI 11 (World Development indicators)</td>
</tr>
<tr>
<td>enrolls</td>
<td>Secondary School enrollment</td>
<td>283 (392)</td>
<td>104.1 (100.443)</td>
<td>15.836 (15.300)</td>
<td>WDI 11 (World Development indicators)</td>
</tr>
<tr>
<td>exp_gdp</td>
<td>Government spending-to-GDP ratio</td>
<td>279 (352)</td>
<td>47.049 (45.773)</td>
<td>6.399 (6.513)</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>fert</td>
<td>Fertility rate (Births per woman)</td>
<td>300 (425)</td>
<td>1.563 (1.594)</td>
<td>0.243 (0.291)</td>
<td>WDI 11 (World Development indicators)</td>
</tr>
</tbody>
</table>
| gdp | Real GDP in billions ($ 2005) | 312 (442) | 719.5526 (514.585) | 796.8734 (740.938) | World Economic Outlook, IMF (Sept. 2011), WDI 11 (World Development Indicators), World Bank

42 ‘This time is different’ by C. Reinhart and K. Rogoff: http://www.reinhartandrogoff.com/data/browse-by-topic/topics/9/ 

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<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>gdp_cap</td>
<td>PPP Converted GDP per capita (Laspeyres)</td>
<td>300</td>
<td>(413)</td>
<td>28850.09</td>
<td>(11580.4)</td>
<td>PWT 7.0 (Penn World Table) 44</td>
</tr>
<tr>
<td>gdp_wor</td>
<td>PPP Converted GDP per worker (Laspeyres)</td>
<td>300</td>
<td>(409)</td>
<td>60611.84</td>
<td>(53441.41)</td>
<td>PWT 7.0 (Penn World Table)</td>
</tr>
<tr>
<td>grdebt</td>
<td>Growth of public debt</td>
<td>300</td>
<td>(372)</td>
<td>3.042</td>
<td>(2.862)</td>
<td>Author's calculations, World Economic Outlook, IMF (Sept. 2011), C. Reinhart and K. Rogoff</td>
</tr>
<tr>
<td>grgdp</td>
<td>Growth rate of real GDP</td>
<td>312</td>
<td>(442)</td>
<td>2.614</td>
<td>(2.748)</td>
<td>Author's calculations: log(gdp)<em>t-log(gdp)</em>{t-1}, WDI 11</td>
</tr>
<tr>
<td>grgdp_cap</td>
<td>Growth of GDP per capita</td>
<td>300</td>
<td>(410)</td>
<td>2.152</td>
<td>(2.275)</td>
<td>Author's calculations from gdp_cap</td>
</tr>
<tr>
<td>grgdp_wor</td>
<td>Growth of GDP per worker</td>
<td>300</td>
<td>(406)</td>
<td>1.491</td>
<td>(1.777)</td>
<td>Author's calculations from gdp_wor</td>
</tr>
<tr>
<td>grpop</td>
<td>Growth of population</td>
<td>300</td>
<td>(425)</td>
<td>0.506</td>
<td>(0.505)</td>
<td>Author's calculations from pop</td>
</tr>
<tr>
<td>grwork</td>
<td>Growth of labor force</td>
<td>300</td>
<td>(406)</td>
<td>1.107</td>
<td>(1.00)</td>
<td>Author's calculations from work</td>
</tr>
<tr>
<td>infl</td>
<td>Inflation</td>
<td>305</td>
<td>(410)</td>
<td>3.362</td>
<td>(4.114)</td>
<td>WDI 11, World Bank</td>
</tr>
<tr>
<td>inv_gdp</td>
<td>Total Investments-to-GDP ratio</td>
<td>312</td>
<td>(409)</td>
<td>21.799</td>
<td>(22.522)</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>k_form</td>
<td>Capital formation of GDP</td>
<td>312</td>
<td>(435)</td>
<td>21.895</td>
<td>(22.918)</td>
<td>WDI 11, World Bank</td>
</tr>
<tr>
<td>k_wor</td>
<td>Capital per worker</td>
<td>300</td>
<td>(409)</td>
<td>13276.54</td>
<td>(11999.11)</td>
<td>Author's calculations from k_form, work and gdp</td>
</tr>
<tr>
<td>lgdp</td>
<td>Logarithm of Real GDP</td>
<td>312</td>
<td>(442)</td>
<td>5.875</td>
<td>(4.953)</td>
<td>Author's calculations from lgdp</td>
</tr>
<tr>
<td>lgdp_cap</td>
<td>Logarithm of GDP per capita</td>
<td>300</td>
<td>(413)</td>
<td>10.210</td>
<td>(10.044)</td>
<td>Author's calculations from lgdp_cap</td>
</tr>
<tr>
<td>linv_gdp</td>
<td>Logarithm of investments as % of GDP</td>
<td>312</td>
<td>(409)</td>
<td>3.071</td>
<td>(3.098)</td>
<td>Author's calculations from inv_gdp</td>
</tr>
<tr>
<td>lndg</td>
<td>Logarithm of the sum of depreciation, labor force growth and technological growth</td>
<td>299</td>
<td>(402)</td>
<td>1.782</td>
<td>(1.757)</td>
<td>Author's calculations</td>
</tr>
<tr>
<td>lpop</td>
<td>Logarithm of Population</td>
<td>300</td>
<td>(425)</td>
<td>9.422</td>
<td>(8.776)</td>
<td>Author's calculations from lpop</td>
</tr>
<tr>
<td>open_gdp</td>
<td>Trade openness as % of GDP (Openness at 2005 constant) prices</td>
<td>312</td>
<td>(430)</td>
<td>85.821</td>
<td>(96.302)</td>
<td>PWT 7.0 (Penn World Table)</td>
</tr>
<tr>
<td>pop</td>
<td>Population (in thousands)</td>
<td>300</td>
<td>(425)</td>
<td>25325.87</td>
<td>(18466.04)</td>
<td>PWT 7.0 (Penn World Table)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>rev_gdp</th>
<th>Public revenue as % of GDP</th>
<th>279 (352)</th>
<th>43.816 (42.650)</th>
<th>6.293 (6.238)</th>
<th>World Economic Outlook, IMF (Sept. 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sav_gdp</td>
<td>Savings-to-GDP ratio</td>
<td>312 (409)</td>
<td>22.271 (21.750)</td>
<td>5.016 (5.161)</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>School</td>
<td>Average years of schooling</td>
<td>312 (312)</td>
<td>9.149 (9.149)</td>
<td>1.312 (1.312)</td>
<td>R. Barro &amp; J. Lee (1996)</td>
</tr>
<tr>
<td>T</td>
<td>Trend variable</td>
<td>312 (442)</td>
<td>17.5 (17.5)</td>
<td>7.512 (7.508)</td>
<td>Author's derivation</td>
</tr>
<tr>
<td>tsq</td>
<td>Trend squared</td>
<td>312 (442)</td>
<td>362.5 (362.5)</td>
<td>267.682 (267.55)</td>
<td>Author's derivation</td>
</tr>
<tr>
<td>work</td>
<td>Labor force (in thousands)</td>
<td>300 (409)</td>
<td>11961.11 (8972.39)</td>
<td>12849.01 (12073.49)</td>
<td>Author's calculation</td>
</tr>
</tbody>
</table>

Table 7-2 Data sources

<table>
<thead>
<tr>
<th>Figure nr.:</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1</td>
<td>World Economic Outlook, IMF (Sept. 2011), C.Reinhart and K. Rogoff, WDI 11 and author's calculations (log(gdp_t)-log(gdp_{t-1}))</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 2.3</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 2.4</td>
<td>World Economic Outlook, IMF (Sept. 2011), C.Reinhart and K. Rogoff, WDI 11 and author's calculations (log(gdp_t)-log(gdp_{t-1}))</td>
</tr>
<tr>
<td>Figure 2.5</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 2.6</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 2.7</td>
<td>European Central Bank (ECB), 2012, Harmonised long-term interest rates</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>OECD, Education at a Glance 2011; Indicator A1: To what level have adults studied?</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>OECD, Education at a Glance 2011; Indicator A1: To what level have adults studied?</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>World Bank, 2012. Indicator: Life expectancy</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 3.6</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 3.7</td>
<td>World Economic Outlook, IMF (Sept. 2011), C.Reinhart and K. Rogoff and author's calculations based on two scenarios</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>World Economic Outlook, IMF (Sept. 2011), C.Reinhart and K. Rogoff and author's calculations: log(gdp_t)-log(gdp_{t-1}), WDI 11</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>World Economic Outlook, IMF (Sept. 2011)</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>R. Barro &amp; J. Lee (1996) - &quot;International Measures of Schooling Years and Schooling Quality&quot;</td>
</tr>
</tbody>
</table>

Table 7-3 Summary of functional forms involving logarithms and levels in regression analysis

<table>
<thead>
<tr>
<th>Model type</th>
<th>Dependent var.</th>
<th>Independent var.</th>
<th>Interpretation of $\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level - Level</td>
<td>$y$</td>
<td>$x$</td>
<td>$\Delta y = \beta \Delta x$</td>
</tr>
<tr>
<td>Level - Log</td>
<td>$y$</td>
<td>log($x$)</td>
<td>$\Delta y = \left( \frac{\beta_1}{100} \right) % \Delta x$</td>
</tr>
<tr>
<td>Log - Level</td>
<td>log($y$)</td>
<td>$x$</td>
<td>$% \Delta y = (100 \beta) \Delta x$</td>
</tr>
<tr>
<td>Log - Log</td>
<td>log($y$)</td>
<td>log($x$)</td>
<td>$% \Delta y = \beta % \Delta x$</td>
</tr>
</tbody>
</table>
Appendix B
Two period debt model derivation:

\[ D_t = (G_t - T_t) + (1 + r)D_{t-1} \]

\[ D_t = D_{t-1} = 1 \]

\[ 1 = (G_t - T_t) + (1 + r) \]

\[ T_t - G_t = (1 + r) - 1 \]

\[ T_t - G_t = r \]

This derivation supports the initial statement that in order to keep the debt level unchanged from one period to another the tax revenues should be higher by \( r \) than the public spending in order for debt level to stay fixed.

Now, establishing and analyzing the debt-to-gdp ratio, we reach the final equation in the following way:

\[
\frac{D_t}{Y_t} = (1 + r) \frac{D_{t-1}}{Y_{t-1}} \left( \frac{Y_{t-1}}{Y_t} \right) + \frac{G_t - T_t}{Y_t};
\]

\[
\left( \frac{Y_{t-1}}{Y_t} \right) = \frac{1 + r}{1 + g}; \frac{1 + r}{1 + g} \approx 1 + r - g
\]

\[
\Rightarrow \frac{D_t}{Y_t} = (1 + r) \frac{D_{t-1}}{Y_{t-1}} \frac{1}{Y_t} + \frac{G_t - T_t}{Y_t}
\]

\[
\Rightarrow \frac{D_t}{Y_t} \frac{D_{t-1}}{Y_{t-1}} = (r - g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t - T_t}{Y_t}
\]

The fraction of last year’s output to the current output can be expressed as \((1/(1+g))\), where \( g \) is the growth rate of output. Furthermore, the fraction \((1+r)/(1+g)\) can be presented in the following way \(-1+r+rg\) (Olivier Blanchard, 2009).
Appendix C

Figure C.1 Italy’s and Portugal’s Debt dynamics under 3 scenarios

Table 7.4 D/Y development under 3 scenarios for the fiscal budget - Italy and Portugal

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1 for D/Y:</th>
<th>Scenario 2 for D/Y:</th>
<th>Scenario 3 for D/Y:</th>
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<tbody>
<tr>
<td></td>
<td>Italy</td>
<td>Portugal</td>
<td>Italy</td>
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<tr>
<td>g = 1%</td>
<td>1%</td>
<td>1.93%</td>
<td>1%</td>
</tr>
<tr>
<td>(G-T)Y</td>
<td>5.5%</td>
<td>3.7%</td>
<td>-2.85%</td>
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<tr>
<td>r_1 = 1%</td>
<td>1%</td>
<td>0.84%</td>
<td>1%</td>
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<tr>
<td>r_2 = 2%</td>
<td>3.34%</td>
<td>3.34%</td>
<td>2%</td>
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<td>r_3 = 4.5%</td>
<td>9.84%</td>
<td>9.84%</td>
<td>4.5%</td>
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<tr>
<td>Target:</td>
<td>No change</td>
<td>D/Y =50% by 2039</td>
<td>D/Y = current level</td>
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<td>Year</td>
<td>Italy</td>
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<tr>
<td>1990</td>
<td>94.65%</td>
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<td>1991</td>
<td>98.04%</td>
<td>60.80%</td>
<td>98.04%</td>
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<td>1992</td>
<td>105.20%</td>
<td>55.26%</td>
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<tr>
<td>1993</td>
<td>115.59%</td>
<td>54.44%</td>
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The various real interest rates are based on geometric average calculations of the inflation for the last 12 consecutive years for both countries. The idea of differing interest rates, depending on the D/Y ratio has been incorporated.

r_1 based on D/Y<50%; r_2 based on D/Y>50% and r_3 based on D/Y>100% (>80% for Portugal)
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This scenario based simulation shows what shall happen to the fiscal budget in order to fulfill the objectives of each trial. In this particular situation the author has kept fixed the assumed growth rate of the economy per year and as well the derived real interest rates on the outstanding debt. Scenario 1 assumes the average fiscal budget ratio to GDP for Italy and Portugal (fiscal deficits equal to 5.5% and 3.7% of GDP respectively). In other words this scenario shows what will happen with the debt ratio if nothing is changed in relation to their fiscal policy and debt management. Clearly the development of debt does not look encouraging.

As also stated in the main body of the thesis, Italy would have to have fiscal surpluses (or current account surpluses) equal to 2.85% of GDP in order to reduce their debt-to-gdp level down to 50% by 2039. For Portugal this required surplus of GDP is equal to 1.53% under scenario 2. In the third scenario one can see that just to keep their debt levels at the current ratio to gdp, Italy and Portugal would need to maintain a surplus of 1.15% and 0.91% of GDP respectively.

Appendix D

CLM Assumptions in the case of multiple regression analysis. Here one can see the distribution of the residuals. The figure shows that the residuals follow a normal distribution and have a mean of 0. If some of the assumptions are not totally satisfied, then we may have a misspecification error. This may lead to unreliable estimators, inconsistent and wrong estimators, etc.

Table 7-5 CLM assumptions and conditions

<table>
<thead>
<tr>
<th>Assumption of CLM:</th>
<th>Mathematical representation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The model has linear form</td>
<td>$Y_t = \beta_0 + \beta_1 x_{it} + u_{it}$</td>
</tr>
<tr>
<td>2) The independent variables are not constant</td>
<td>$Var(X) \neq 0$</td>
</tr>
<tr>
<td>e.g. there is variation</td>
<td></td>
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<tr>
<td>3) Non-stochasticity</td>
<td>$Cov(X_{it}, u_{it}) = 0$</td>
</tr>
<tr>
<td>4) Expected value of the error term is 0</td>
<td>$E(u_{it}) = 0$</td>
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<tr>
<td>5) Homoskedasticity assumption</td>
<td>$Var(u_{it}) = C = \sigma^2$</td>
</tr>
</tbody>
</table>
6) No serial correlation \[ \text{Corr}(u_{t,j}, u_{t,j-1}) = 0 \]

7) Normally distributed error terms \[ u_{it} \sim N(\mu, \sigma^2) \]

8) No perfect linear relationship between Xs \[ \sum_{t=1}^{N} (\beta_i X_{it} + \beta_j X_{jt}) \neq 0 \]

There is a clear negative correlation between grgdp (growth rate of GDP) and grdebt (growth rate of debt). One can see the negative slope of the regression line as well the plot of each observation.

Appendix E

Cochrane-Orcutt iterative procedure and DW statistic for equation 6:

The main problem that we suspect as it often happens with growth regressions is that: \[ u_t = \nu u_{t-1} + \varepsilon_t \], where \( u_{t,j} \) and \( u_t \) are the residuals from the previous period and from the current period respectively. Under the DW test, we have the null hypothesis as \( \nu = 0 \), meaning that there is no serial correlation. The alternative hypothesis is that \( \nu > 0 \).

The crucial assumptions for the Durbin-Watson test to be valid are that there should be a constant in the regression; the serial correlation is of first order and that there is no lagged dependent variable included in the model (Dimitrios Asteriou and Stephen G. Hall, 2007). Those assumptions are respected and taken into account in our FE estimations of the model.
This is how the residuals from $t-1$ and $t$ look like in this model, which in fact is equation 1 from table 4-2:

\[
\log(\text{debt}_t - \text{gdp})_t = \beta_0 + \beta_1 \times \text{gdp}_{t-1} + n_t + u_t
\]

Clearly we see very high positive correlation implying, that $\nu > 0$. In this scenario it is important to correct this by using the suggested procedure by Cochrane - Orcutt for resolving autocorrelation. So in this situation we would like obtain an estimate for $\nu$. After estimating the model again, but this time including AR(1). In fact the coefficient in front of the autoregressive term is in fact the best estimate for $\nu$, that we can obtain. Based on table 4-2, we obtain a coefficient equal to 0.915. In fact this is the estimate of $\nu$.

Normality distribution of the residuals from eq.1 in table 4.2:

Figure E-2 Distribution of the residuals from equation 1
Figures E-2 and E-3 represent the theoretical normal distribution of the residuals. In our case, one can see that the residuals are normally distributed and follow pretty consistently the red line, except for small tail deviations, should not prevent us from concluding that the residuals are normally distributed.

In order to show how the residuals look after we applied the iterative procedure to solve for the autocorrelation, the author presents the figure below.

It is visible that now there is not autocorrelation and the residuals resemble a cloud and do not represent a pattern as previously. This figure applies for eq.5 in table 4-2.

In order to argue for the chosen method of fixed effects, the author presents the results of a Hausman test. This procedure is utilized to determine whether fixed or random effects shall be used. A very important assumption when using random effects is the condition that the random effects are uncorrelated with the independent variables. This is why the researcher tests this assumption. As it would have been very overwhelming to present the outcome for every single estimated equation, the writer presents the Hausman test results for only those OLS estimations that are considered to be best representing the particular relationship. All of the specifications are better to be estimated with fixed effects except for only 2 where the Hausman Chi square statistic is very small, indicating that random effects may have been
the more powerful method. However, in order to avoid confusion with the reader, the author sticks to the fixed effects (LSDV) estimation method.

Table 7-6 Hausman test results for selected OLS estimations

<table>
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<th>Hypothesis 2: Growth - Debt</th>
<th>Chi square statistic</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Eq. 3</td>
<td>7.74</td>
<td>0.020</td>
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<tr>
<td>Eq. 4</td>
<td>4.37</td>
<td>0.111</td>
</tr>
<tr>
<td>Eq. 6</td>
<td>15.58</td>
<td>0.003</td>
</tr>
<tr>
<td>Hypothesis 3: GDP growth - Debt</td>
<td>Chi square statistic</td>
<td>P-value</td>
</tr>
<tr>
<td>Eq. 3</td>
<td>22.22</td>
<td>0.000</td>
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<tr>
<td>Eq. 5</td>
<td>3.02</td>
<td>0.554</td>
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<tr>
<td>Hypothesis 3: Inv. - Debt</td>
<td>Chi square statistic</td>
<td>P-value</td>
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<tr>
<td>Eq. 5</td>
<td>86.62</td>
<td>0.000</td>
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The yellow painted cells indicate the equations that could have benefitted from random effects estimation instead of fixed effects. This means that we cannot reject H₀ which states that Random effect is the more appropriate and parsimonious method. However, this particular improvement is planned for further improvement and implementation. On the other hand, one should be careful relying solely on the Hausman test as it is not a very robust test. For that reason we stick to fixed effects estimation as it can be considered a better fit for our research purpose, namely economic growth and cross-country effects.

Appendix F

Figure F-1 represents the GDP per Capita development in the last 30 years for 6 countries from our dataset. The financial crisis from 2008 is purely visible in the declining level of per capita income for all the countries.
Appendix G

Figure G-1 Human capital augmented Solow model (1956)
Appendix H

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