BI Norwegian Business School - campus Oslo

GRA 19703

Master Thesis

Thesis Master of Science

Buried in debt? An analysis of the heterogeneous effects of public debt overhang on growth

Navn: Juliana Damasceno De Sousa

Start: 15.01.2021 09.00

Finish: 01.09.2021 12.00

Buried in debt?
An analysis of the heterogeneous effects of public debt overhang on growth

Supervisor / Co-supervisor:
Gisle James Natvik / Jamie Cross

Hand-in date:
01.07.2021

Campus:
BI Oslo

Examination code and name:
E.g. **GRA 19702** Master Thesis

Programme:
Master of Science in Applied Economics

Abstract

Both theoretical and empirical evidence suggests that excessive government indebtedness has adverse effects on economic stability. The Great Recession left many countries with the legacy of sluggish economic growth and historically high levels of public debt – two concerns that the COVID-19 pandemic has recently reinforced. To study the impact of public debt on the dynamics of economic growth, I use a panel of 95 low-, middle-, and high-income countries from 1960 to 2015 and an empirical implementation able to capture heterogeneities across countries. The analysis relies on investigating two candidate controls often associated with output performance – uncertainty and private debt. The purpose is to verify whether these variables drive the empirical regularity documented in the literature of public debt negatively associated with lower growth. I find support for a negative non-linear relationship between public debt and growth, a positive linear association between private debt and growth, and no evidence that uncertainty drives the negative association between government debt and growth.

Acknowledgements

This thesis completes my Master of Science in Applied Economics degree at BI Norwegian Business School in Spring 2021. I want to give special thanks to my supervisor, Professor Gisle James Natvik, and my co-supervisor, Dr. Jamie Cross. Their attention, guidance, and constructive comments were crucial throughout the process. I am eternally grateful to my family for their great support during these two years and my whole life. A big thank you goes to my boyfriend for always encouraging me. I also appreciate the confidence my old and new friends had shown in me. Lastly, I thank God for another challenging and unique opportunity.

Table of contents

CHAPTER 1 – INTRODUCTION……………………………………………………. 1

CHAPTER 2 – GROWTH AND FISCAL CHALLENGES……………………….... 4

2.1 SLUGGISH ECONOMIC GROWTH……………………………………… 4

2.2 PUBLIC DEBT OVERHANG…………………….……………...….….. 9

CHAPTER 3 – LITERATURE REVIEW…………………….…………..…..... 14

3.1 PUBLIC DEBT AND ECONOMIC GROWTH……..…………...……… 14

3.2 UNCERTAINTY………………….………………………….……… 20

3.3 PRIVATE DEBT………………….………………………...……….. 24

CHAPTER 4 – DATA AND RESEARCH METHODOLOGY…………………… 30

4.1 THE DATA……………….……………………..…………………….... 30

4.2 EMPIRICAL STRATEGY…………………………………………….... 36

4.2.1 The Model Specifications ………………………...………..… 37

4.2.2 The Common Correlated Effects Estimator……………...…..…. 41

CHAPTER 5 – RESULTS……………………………………………………....… 46

5.1 PRELIMINARY EVIDENCE …...…………………………….……..... 46

5.2 CCE MODEL RESULTS………..…………………………..……….. 50

5.3 ROBUSTNESS CHECKS……………………………………..…….. 54

5.3.1 Reverse Causality………………….………………….…….... 54

5.3.2 Non-Linear Relationship…….………..……………………..... 57

CHAPTER 6 – CONCLUSION………………………………………….…..…. 61

REFERENCES……………………………………...………………….……… 62

APPENDIX………………………………..……………………..………….. 68

LIST OF FIGURES

Figure 1. Gross domestic product in constant prices
Figure 2. Contribution to OECD potential output per capita growth
Figure 3. Gross government debt as % of GDP, index 2008 = 100
Figure 4. Ratio of Debt to GDP for key economies
Figure 5. Debt coefficient comparison: debt-to-GDP thresholds
Figure 6. World Uncertainty Index (WUI): Global Index (GDP weighted average)
Figure 7. Debt migration 2000-07 vs 2008-12
Figure 8. Initial government debt-to-GDP and subsequent growth of real per capital GDP
Figure 9. Initial level of uncertainty (WUI) and subsequent growth of real per capital GDP
Figure 10. Initial private debt-to-GDP and subsequent growth of real per capital GDP

LIST OF TABLES

Table 1. Descriptive statistics – Raw variables and standard transformations
Table 2. Linear dynamic models with and without additional controls – 2FE estimator
Table 3. Linear dynamic models with and without additional controls – CCE estimator
Table 4. Linear dynamic models, subsequent growth as dependent variable – 2FE estimator
Table 5. Static non-linear models – 2FE estimator

Chapter 1 - Introduction

Public debt and economic growth are among the major challenges in the recent economic policy debate. This has been especially the case across many advanced economies since the 2007-09 global financial crisis when a rapid debt accumulation emerged from governments' large-scale fiscal responses. While there is some debate on whether the stimulus from recovery packages should have been greater, the long and lasting cost of such efforts to stabilize the economy – the sharp increase in the government debt position – cannot be denied. Nevertheless, why would a high level of indebtedness represent a problem? Macroeconomic theory predicts that high public debt increases economic volatility and limits the scope for optimal policy arrangements, adversely affecting long-term economic growth. The concern that high public debt may lower growth has led to extensive empirical research on the topic over the past decade. The general conclusion has been that high debt levels tend to negatively affect economic growth, thus providing empirical support for this theoretical prediction.

For many countries, sluggish recovery from the 2008 Great Recession has been a major economic challenge over the past decade. Numerous theories have provided different explanations for the persistence of such growth underperformance, including the idea that the current slow growth mainly results from the high debt burden and its repayments, historically observed following financial crisis episodes. According to the International Monetary Fund's Fiscal Monitor 2021, the average general government gross debt among the advanced economies amounted to 120 percent of GDP in 2020. This combination of high debt and sluggish growth has generated debates about fiscal consolidation efforts.

While some argue that fiscal consolidation measures could directly prevent a robust recovery, others suggest that public debt could be harmful to growth depending on other channels rather than the level of debt itself. This hypothesis includes the quality of policies and institutions or the structure of public debt, which tend to differ a lot across countries. Therefore, even though the debt-growth topic has been broadly analysed for groups of countries, one would think that the way that public debt overhang and lower growth are associated may not be the same, implying non-homogeneous effects not only across countries but also across time.

This master's thesis conducts an empirical research of the public debt-growth dynamics from 1960 to 2015 across 95 countries. The analysis builds on Eberhardt and Presbitero (2015), a reference in modelling the public debt–growth long-run relationship within a heterogeneous environment. They applied novel methods from the time-series literature for panel data to account for endogeneity issues – an expressive shift from the standard empirical models adopted in this literature previously. I extend their analysis in two dimensions. I expand the sample from 1960-2012 to 1960-2015, and I also aim to control the effects of economic uncertainty and private debt. This extension seems important since both variables have been shown to impact economic growth. As a result, omitting these variables may result in the regression estimates presented in Eberhardt and Presbitero (2015) being biased.

First, unprecedented levels of macroeconomic uncertainty during the Great Recession and, more recently, the COVID-19 pandemic have resulted in numerous studies on the effects of uncertainty on the real economy. Indeed, the struggle with post-crisis debt levels has been surrounded by high uncertainty and volatility in fiscal sustainability measures, followed by inaccurate information about the debt carrying capacity around the world. Nevertheless, taking this higher uncertainty during debt overhang episodes as a propagation channel towards growth in a general way is not plausible. Country-specific economic conditions tend to determine the exposure to uncertainty at different degrees, with these effects tending to be larger in weaker economies. Therefore, one of the main contributions from this thesis is the novelty of exploring how public debt, once we control for the corresponding uncertainty level, may have diverse effects on growth performance across countries.

Second, on the relevance of private debt, there is a significant research gap in the finance literature about its effects beyond firms' growth. Even though private and public debt cycles are closely linked in the past decades, there is not much literature looking at both jointly. Within the macroeconomic growth debate, most of the existing studies analysing the corporate sector focus on the indirect damage of high public debt on economic activity through large financial constraints faced by companies when interest rates increase due to the default risk on government debt. However, private debt is often said to set long-run systematic risks triggering severe instability episodes in different economies, despite the lack of empirical evidence. As most advanced economies hold multiple debt overhangs, public and private debt should not be considered separately. Hence, by also including the private debt channel in addition to the public debt one, this thesis aims to address this significant gap and provide a clear understanding of the harmful effects of public debt per se.

The extensive literature review provided later by this thesis shows that some studies claim that public debt hampers growth when it is above a non-common threshold. However, these studies have not controlled for the prevailing uncertainty or private debt levels, even though the evidence supports that high uncertainty and high private debt tend to increase output volatility. By saying that, I should consider the likely omitted variable problem and verify whether these two variables are driving the empirical regularity other people have estimated for public debt. Therefore, the purpose of the study is to measure to what extent these potential omitted variables affect the existing estimates in the public debt-growth literature. Is there something about uncertainty and private debt being disregarded such that I should pay closer attention and add to this analysis? By this investigation, I aim to address some of the many potential sources of heterogeneity behind the growth determinants and verify: does the effect of public debt change significantly once I consider the corresponding levels of uncertainty and private debt in different economies?

This exercise might help shed light on the fundamental drivers behind the new normal of slow economic growth – an important step to find a feasible path to solve this broad-secular problem. Once I can better explain why and how the nexus between public debt and growth varies across countries, I can also contribute to the contemporary debate on fiscal policy. Identifying why economies behave differently when facing a high debt burden provides important lessons towards more effective policy responses to limit damages and facilitate recovery in future downturns. Also, there has been much discussion concerning the maximum level of public debt a country can sustain, without a clear answer yet. Finally, concerns over this issue have recently exacerbated, given that the massive fiscal stimulus to face the effects of the COVID-19 crisis left many countries with the legacy of a 'debt pandemic'.

The rest of this study is structured as follows. Chapter 2 presents the motivational background, discussing the public debt overhang and the recent slowdown in economic activity. Chapter 3 reviews the theoretical and empirical literature on the relationship between both public and private debt and economic growth, as well as the related research on uncertainty. Chapter 4 describes the data and provides the empirical methodology motivated by the literature. Chapter 5 presents the empirical results and robustness checks. Finally, Chapter 6 concludes.

Chapter 2 - Growth and fiscal challenges

In this Chapter, I introduce the motivational background behind the major current issues of the fiscal and economic growth debate. As both ongoing challenges have been closely related to the global financial crisis, this Chapter strictly discuss the problems of public debt overhang and sluggish economic growth within the context of this episode.

2.1 Sluggish Economic Growth

Over the past years, the growth slowdown after the 2007–09 global financial crisis has been largely discussed as many tried to identify and measure the potential explanations and mechanisms behind this "new normal", especially across the advanced economies. A succession of shocks – as the euro area crisis, the discontinuation of fiscal stimulus, and the collapse in commodity prices – prevented a continued and synchronized growth, which in turn assumed a downward long-term trend since then (IMF, 2018). As a result, the concern of avoiding the economic slowdown in growth has replaced the usual concern of stabilization – a dramatical change in the nature of macroeconomics (Summers, 2014a).

Following the global financial meltdown in late 2008, 91 economies (accounting for approximately two thirds of global GDP in purchasing-power-parity terms) experienced a decline in output in 2009 and long-lasting deviations of output from the level that would have prevailed according to its pre-2009 trend growth rate (Chen et al., 2019). Indeed, the recession that began in December 2007 and ended in June 2009 was the longest in the post-war history, with employment taking longer (51 months) to reach its pre-recession peak than in any other previous recoveries. Much of this too-slow march back to the pre-recession employment peak was attributed to the length and severity of the Great Recession itself, as the economy had a much larger hole to dig out of (Bivens, 2016).

In this way, more than a decade after the Great Recession, many advanced economies still face an anaemic recovery with low growth rates despite years of near-zero interest rates. While the annual growth in advanced economies averaged around 3.6 per cent between 1985 and 2007, it fell to 1.4 per cent during the recovery years, from 2010 to 2014. Due to a combination of cyclical weakness and structural deficiencies, the stronger growth rates typically observed during the recovery years – as economies put effort to catch up on lost activity – had been replaced by a continuously disappointing growth path and regularly downward adjusted growth forecasts, as the Figure 1 shows (Reza and Sarker, 2015).

While the solid blue line shows the realized GDP growth, the red dashed lines represent the IMF forecast for GDP growth regarding the following two years. The vertical axis shows the gross domestic product growth rate (in percentage) with constant prices. As we can observe, from 2007 to 2014, the real observed GDP in the advanced economies is below the GDP predicted one year and two years before – except for 2010.

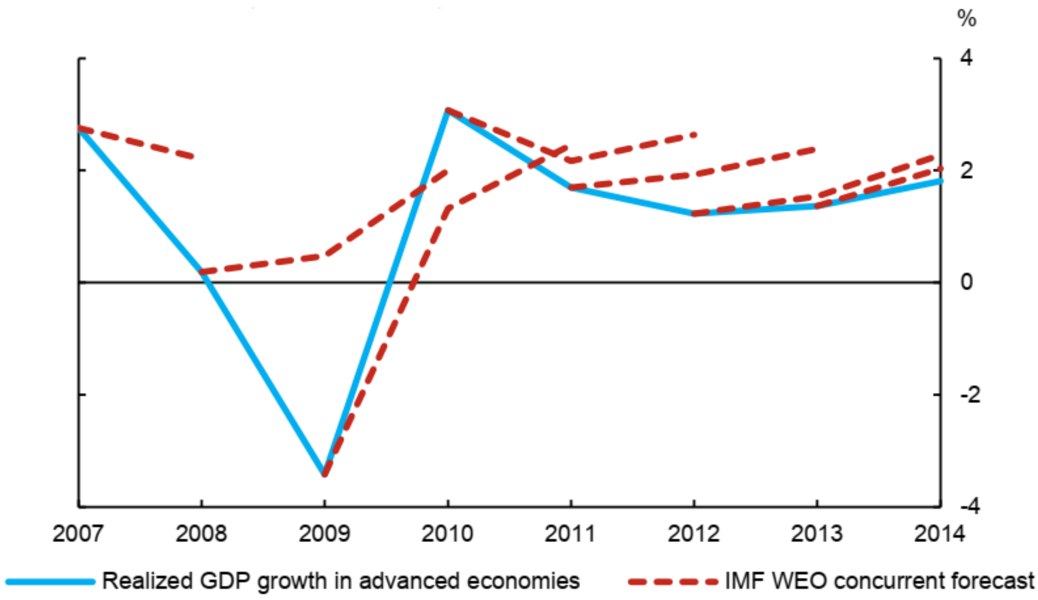

Figure 1. Gross domestic product in constant prices
Source: Reza and Sarker (2015).

The slow pace of output recovery since the business cycle trough in 2009 is still being investigated by a variety of theories that has been trying to address the persistence of such growth underperformance. There is notable controversy over why this post-crisis economic activity seems to be exceptionally driven in a different way, with a wide range of interpretations both in theory and empirics. This includes the role of lingering uncertainty, reduced supply capacity due to slowing innovation, demographics transition, excessive financial regulation, among others (Lo and Rogoff, 2015). One of the main theories, namely "secular stagnation", emphasises the contribution of a sustained deficiency of aggregate demand and the inability of conventional monetary policy to achieve full employment, satisfactory growth, and financial stability (Summers, 2014b).

Such widespread deceleration in productivity in the post-financial crisis period was seen as a presage of a new low-growth era some years ago, as this already prevalent concern among many advanced OCED countries also start to encompass emerging-market economies and be heavily characterized by high unemployment and falling labour force participation. Despite the different views about the factors responsible for the productivity slowdown, one worrying development was the marked slowdown in global trade activity relative to world production. While the business investment rates in most advanced economies remained below the needed level to sustain higher trend growth rates, weak global demand, pressures from budgetary consolidation and remaining dysfunctions in financial markets exerted a drag on trade, investment and job creation (Padoan, 2014).

While growth in many advanced economies continues to disappoint over time, institutions started to discuss a “low-growth trap” hypothesis, defined by weaker economic conditions where demand effects led to permanent supply-side effects through the process of hysteresis, which changed the dynamics of labour demand and of capital investment (OECD, 2016). At the same time, monetary policy was seen to be overburdened, leading to growing financial risks and distortions, and unable to avoid the decline in potential output in the aftermath of the crisis.

In Figure 2, the different colours represent the contribution in percentage points (vertical axis) of each factor to potential per capita growth from 1998 to 2018. The red bars and blue bars show the contribution of the capital per worker and the Total Factor Productivity (TFP), respectively. The green bars show the role of the potential employment rate, while the purple bars show the role of the active population rate. The potential employment rate refers to potential employment as a share of the working-age population, and the active population rate refers to the share of the population of working age in the total population. Finally, the solid black line represents the potential per capita growth in percentage changes.

As we can observe from this figure, the decline of potential output per capita growth in the major OECD economies – estimated to be on average almost 1 percentage point below the average in the two decades preceding the crisis – was mainly associated to weak capital stock growth (the red bars) and declining factor productivity (the blue bars).

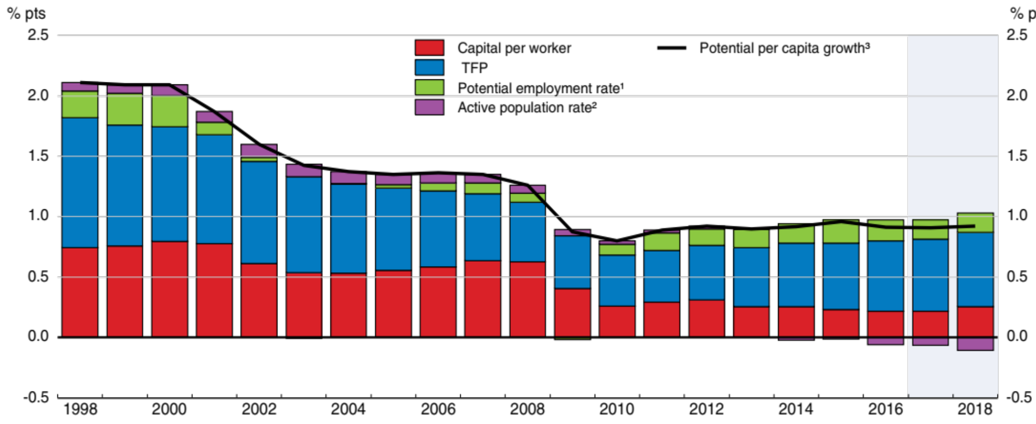

Figure 2. Contribution to OECD potential output per capita growth
Source: OECD (2016).

Hence, over the last years, global economic growth has stabilized at a low level as new downside risks to worldwide growth have materialised with trade tensions, high debt, and policy uncertainty weaking business and household confidence. Consequently, the global economy has been shown to still depend on persistent policy support. Moreover, persistent growth shortfalls have thereby weighed on future output expectations and reduced current spending and potential output gains, reenforcing such negative trend. Some researchers also point that, especially for the last decade, the slowdown in structural policy ambition and some policy incoherence prevented business dynamism, trapped resources in unproductive firms, weakened financial institutions and undermined productivity growth (Mann, 2016).

As pointed before, a large number of economies registered persistent output losses – irrespective of whether a country suffered a banking crisis in 2007–08. After some time has passed, evidence suggests that policy choices in the run-up to the crisis as well as in its immediate aftermath influenced postcrisis output performance in multiple ways, especially shaping different consequent damages from country to country. Stronger banking regulation and stronger fiscal positions have played an important role in determining countries' vulnerability to the disruptive forces the financial meltdown of 2008 unleashed, and their corresponding ability to recover afterwards (Chen et al., 2019). While such policy efforts helped to avoid even worse outcomes, they did not come without costs, and actually, entailed important side effects. One of them, namely the large accumulation of government debt, is said to have eroded fiscal buffers in many economies and undermined public debt sustainability.

For several countries in Europe, the financial crisis transformed into sovereign debt crises, leaving the debt overhang problem as the prevailing obstacle to speedy recovery. Some research has shown that a debt overhang of such size is typically associated with a sustained period of sub-par growth, lasting two decades or more (Reinhart et al., 2012a). Whether the fiscal policy response could be deployed for a longer time is another question that varies across countries according to each corresponding fiscal space. Accordingly, recovery from financial crisis do not need to be symmetric, as different countries may be facing different phases of the deleveraging cycle (Rogoff, 2016). However, the data has shown the overall ability to afford fiscal initiatives as a countercyclical demand tool has been shattered at some level by the consequent depth of the public debt overhang in many economies, as discussed next.

2.2 Public Debt Overhang

The debt overhang hypothesis accounts for a situation where the debt level is so high that its debt service burden becomes not only heavy but linked to economic performance by weaking the incentives to invest (Krugman, 1988). A historically high and increasing level of public indebtedness across the advanced economies is one of the main and clear legacies of the last financial crisis. As Figure 3 shows, the gross government debt levels remain elevated relative to their 2008 levels, which is set to be one hundred in the figure for each country across the range of advanced countries. Therefore, the vertical axis shows the gross public debt level for Canada (blue line), Euro Area (red line), Japan (dark green line), the United Kingdom (yellow line) and the United Stated (light green line) – all of them indexed to its 2008's level. Since the gross government debt has risen for the entire sample, this figure indicates that high leverage still was a headwind six years after the crisis, and not confined to just one country (Lo and Rogoff, 2015).

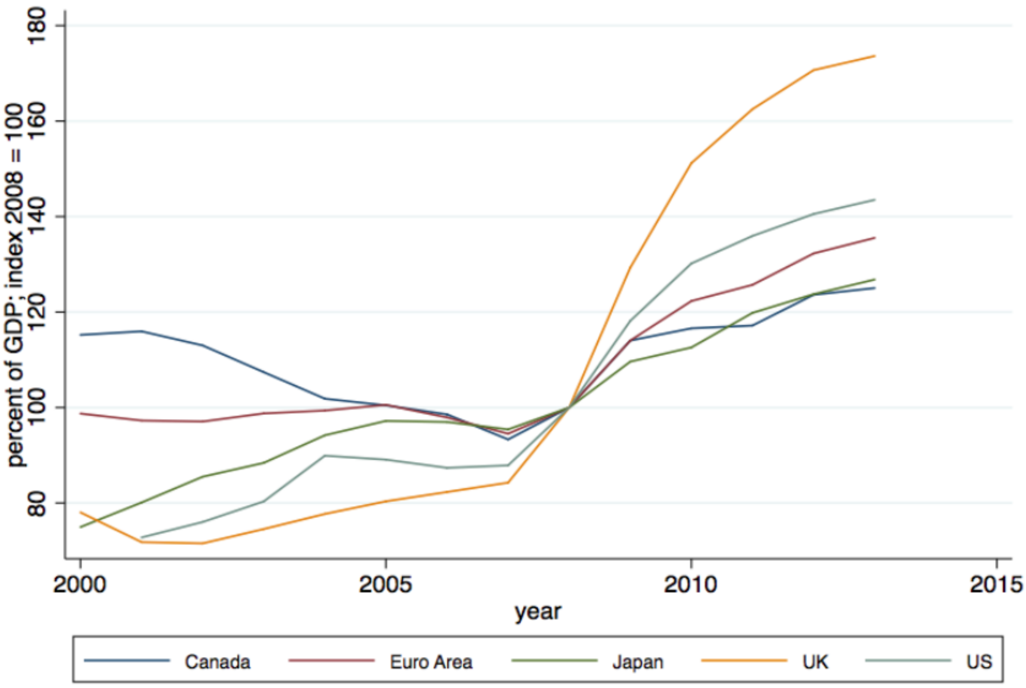

Figure 3. Gross government debt as % of GDP, index 2008 = 100
Source: Lo and Rogoff (2015).

In this case, the cyclical concerns about the consequences of high debt loads and long-term insolvency risks on economic performance were exacerbated as a record portion of the debt was recorded to be owed to external creditors. This represents a problem since it implies limited capacity for governments in forcing its creditors to absorb losses due to the increased default risk (Reinhart et al., 2012b). Also, this time, the debt issue seemed to be particularly worse than in the past, as many countries were in fact facing a 'quadruple debt overhang problem' – public, private, external and pension – where each of these forms produces distortions that, in general, hinder growth.

Hence, understanding both the length and the depth of the financial crisis – as well as the modest economic recovery – requires an analysis of the debt dynamics. This is this case since it is widely accepted that the sharp increase in the public debt burden have played a crucial role in the 2007-09 global financial crisis, exactly like many previous crises. This recent episode actually provided fresh evidence about how the resolution of severe crises can be extremely costly, especially for those countries that had accumulated larger debt imbalances during the pre-crisis period (Buttiglione et al, 2014). In the extreme, one can envisage a 'debt Laffer curve' determining a cut-off where even creditors are better off by the redemption of debt to a more sustainable level.

This is why one of the main theories about this low-growth trap in most parts of the global economy suggests that the time to recovery has being prolonged by the remaining post-financial crisis debt burden as well as the effort to reduce it. Rather than believing that the world sunk into a period of chronic deficiency in global demand within the context of secular stagnation, some argue instead that the weak postcrisis growth reflects the post-financial crisis phase of a significant deeper debt cycle (Rogoff, 2016). If this is the case, the so needed deleveraging effort under the chronic risks of excessive debt would represent a persistent drag on growth as it adversely affects the macroeconomic performance.

Such need for fiscal consolidation for most OECD countries could not be avoided given the widespread and rapid build-up of debt left by the massive recovery effort after 2007-09 (Elmeskov and Sutherland, 2012). The deleveraging process historically observed following financial crisis episodes implied, especially in this case, a negative feedback loop after the Great Recession of 2008 involving growth, debt overhang and deleveraging (Lo and Rogoff, 2015). The vicious circle between the latter two could be observed as lower growth resulting from debt overhang makes even more difficult breaking the leverage cycle, which feeds back into growth taking more time to normalise (Buttiglione et al., 2016).

Although there is still a debate on whether the fiscal stimulus from the unprecedented support packages should have been greater, there is far more agreement about the cost incurred to stabilize the economy – the large increase in the government debt position. By public debt position, this work uses the IMF's definition[1], which includes the debt of the public sector as a whole and refers to the financial and nonfinancial public enterprises as well as the central bank. It has been a long time since the advanced world entered an era characterized by massive overhang of public and private debt, which has often been cited as the main factor

[1] See the 2014 edition of the IMF's Government Finance Statistics Manual and Public Sector Debt Statistics Manual.
https://www.imf.org/external/datamapper/G_XWDG_G01_GDP_PT@FM/ADVEC/FM_EMG/FM_LIDC

weighing on global growth. But why would a large debt burden be so detrimental for economic activity?

Theoretically, as the public debt service flows resources out of the government, the reduced budget available for government spending implies an expected negative pressure on growth due to limited demand-side policies. Additionally, such a government debt may affect private sector investment decisions by tightening the credit constraints, mainly through the interest rate channel – the so-called crowding out effect. The challenges placed for policymakers by the public debt issue cannot are not unprecedented as many countries have already faced big debt crises in the past. However, there is reason to believe that the spillovers of the outlined crisis on the macroeconomic setup changed somehow the economic growth dynamics.

This is the case because, different from the most likely textbook explanation of the above-mentioned crowding-out effect – that is to say a rise in real interest rates due to fiscal unbalance causing economic deterioration – these recent high-debt cases have been observed while interest rates were either declining or flat. As the discussion of a negative debt-growth relationship dates back to much earlier than the ongoing slowdown, such coexistence of low growth and low interest rates requires, then, some review of the recent mechanisms arising from policy implications in the real economy.

Figure 4 shows the total debt-to-GDP ratio, where the left vertical axis corresponds to the level of total credit to the nonfinancial sector as a percentage of GDP for the United States (dark blue line), China (red line), Germany (black line), the Eurozone (light blue line), and the United Kingdom (yellow line). Due to the higher scale, Japan (grey line) is represented in the secondary vertical axis (at the right side). Although the different debt trajectories, these key economies faced an upward trend observed until 2016, followed by some stabilization at a high level – except for Germany.

On the composition of overall indebtedness in the past decade and across the advanced economies, households in general had deleveraged while corporations increased their leverage – offsetting more or less each other. This explains why the government debt is often pointed as the primary driver of the upward dynamics seen in this Figure. The mentioned new era of extremely low interest rates helps to explain, by its turn, how such historically high debt burden have been sustained over time even in its record level. The concerted effort from central banks to further increase monetary easing and stimulate global economic growth was, however, pointed sometimes as a risk to the return of increasing debt-GDP ratio trajectories (Estenssoro, 2019).

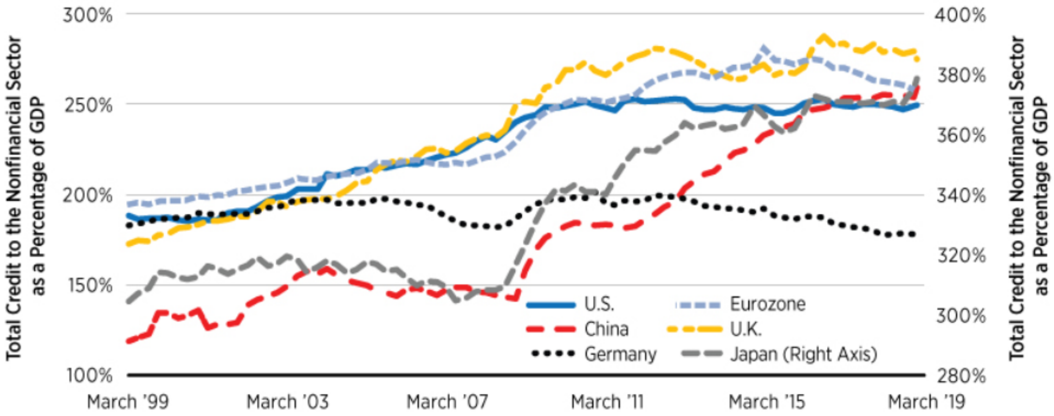

Figure 4. Ratio of Debt to GDP for key economies
Source: Estenssoro (2019).

Looking deeper into the public debt-growth equilibrium relationship across economies, there are plenty of reasons to presume that distinct features play a relevant role in determining diverse effects of being buried in debt. First, the debt intolerance may vary systematically due to the country's own history of default and high inflation, as well as institutional weaknesses. Second, the debt composition – not only its level – matters, since past episodes of debt accumulation usually indicate that domestic debt is preferred to promote economic growth rather than foreign debt. The literature on this relationship and how output growth is additionally related to individual levels of uncertainty and private debt accumulation is discussed in the next chapter.

Chapter 3 - Literature Review

This Chapter discuss the literature review of both theoretical and empirical literature that has motivated this thesis. It includes the most relevant contributions on the relationship between public debt and economic growth, as well as on the uncertainty and private debt variables towards growth.

3.1 Public Debt and Economic Growth

The argument that fiscal deterioration in terms of accumulation of public debt has adverse effects on economic growth goes mainly through the expected following process of consolidation and its negative impact on the cycle both in the short and long term. Elmeskov and Sutherland (2012) argue that even though countries have good reasons to reduce their debt overhangs, like creating some room to react to future shocks, the scale of the adjustment needed probably indicates how painful fiscal consolidation might be. Adam (2010) states that higher government debt levels give rise to larger risks to fiscal budget and to tax rates, which makes it optimal to reduce public debt over time. In the process of doing it, fiscal policy is likely to use distortionary labor income taxes to finance public goods provision and interest payments on pending debt, placing additional harmful effects on labor supply and output. From a macroeconomic perspective, regardless of the channels, public finances become more vulnerable under high debt as it constrains the government's ability to engage in countercyclical policies (Bornhorst and Ruiz-Arranz, 2014).

Previous research also found that a heavy debt burden could act as an implicit tax on the resources of a country, reducing the size and the quality of investments, and thus, the growth opportunities (Cordella et al., 2005). The challenge of adjusting the pace of consolidation towards the acceptable level of public debt while balancing its negative effects on the economy usually represents a non-trivial trade-off. To deal with the disincentives arising from the returns being partially taxed due to debt, enhanced efforts on debt sustainability further magnify both the risk and the cost of fiscal retrenchment. Solving this problem seems to require the use of instruments that are friendly to long-term growth, such as reforming transfer systems, eliminating some tax expenditures, and collecting more revenue from less distortionary tax bases (Elmeskov and Sutherland, 2012).

As mentioned previously, the public debt overhang theory, according to Krugman (1988), refers to the scenario where debt exceeds a country's repayment ability, making the expected debt service likely to be an increasing function of the country's growth. By consequence, returns from investments in the domestic economy would be effectively taxed away, and new investments discouraged. Following this perspective, Ebi and Imoke (2017) point that beyond the standard multiplier effect that would justify more debt, there is a threshold from which more debt becomes detrimental to growth. Such a threshold defines the debt carrying capacity of a country, that is, the maximum amount of debt that a country can owe and the "wrong side" of a hypothetical debt Laffer curve. The original debt overhang literature, however, stems from the corporate finance framework as it accounts for how high indebtedness levels of firms discourages private investments. The original contribution from Myers (1977) emphasized the sub-optimal investment strategy arising from unfavourable states of nature, when the firm is financed with risky debt, and thus, pass up valuable investment opportunities that could have a positive net effect on its market value due to the default risk.

The related macro literature applied to sovereigns focused, however, on the effect that public debt overhang could impose to economic growth due to the reduced countries' ability to finance further capital. Nevertheless, Krugman (1988) clarifies that the analogy between a debtor firm and a debt country is not exactly the same since the debt payments from the latter is determined by its willingness to pay, which relies on the cost of default and internal political implications. Also, as the benefits of a country's good performance may be largely directed towards existing creditors rather than itself, the country's incentives could be distorted and attracting creditors for new lending may be not easy. The reasonable limit for borrowing was also analysed by McKinny (2004), who emphasized the relevance of knowing precisely the debt-carrying capacity of a government, which depends on the quantity and quality of resources available to be legally and practically used.

Based on aggregate and neoclassical growth models, former studies early concluded that the rise of public debt typically places a gross burden on the future. Considering individual consumption decisions and taxes to finance debt and interest payments, high indebtedness shrinks disposable income as well as lifetime consumption, and thus, savings and capital stock, reducing the overall flow of goods and services (Modigliani, 1961; Diamond, 1965). However, the debt non-neutrality has been under question, as in Barro (1974), who argued that government bonds would not imply wealth effects if not perceived as exceeding the following future tax liabilities. In this case, the Ricardian equivalence theorem holds, and no effects are observed on interest rates, capital accumulation and aggregate demand, since public debt and taxation behave equivalently as both cover public expenditure.

On the other hand, a large empirical investigation of the crowding out hypothesis of debt on private investment in both short and long-run broadly reported the negative consequences of debt-financed fiscal policies on economic activity and private spending through the investment channel (Stein, 1976; Zahn, 1978; Butkiewicz, 1979). A complex discussion of the crowding out concept was conducted by Buiter (1976), with a multidimensional perspective and an important taxonomy to understand the different mechanisms behind such a phenomenon. Along with the analysis of the degree of crowding out, a direct crowding out episode is defined to be the case where the government activity directly takes part in structural private behavioural relationships. Even though the apparent weakness of an entirely direct crowding out episode raises some uncertainty in policy-oriented models, it should not be dismissed the likelihood of a limited degree of direct crowding out.

In this setting, Blanchard (1985) characterized the optimal debt policy able to smooth aggregate consumption in the face of fluctuations in output as the one taking into account both the level of debt and the expected sequence of deficits, since anticipated fiscal policy matters for the dynamic behaviour of an economy where agents have finite horizons. Overtime, the analysis of debt-related fiscal rules has advanced towards optimal policies in terms of correcting the intertemporal trade-off and finding the long-run optimizing behaviour – i.e., fiscal sustainability and sustainable growth – including the idea of prudent growth-maximizing debt targets rather than a desirable safe zone or ‘fiscal space’ (Beetsma and Bovenberg, 1997; Checherita-Westphal et al., 2014; Fall and Fournier, 2015).

This topic turned up once again lately in the spotlight as a hotly debated issue in academia and among policymakers, mainly because of the seminal contribution of Reinhart and Rogoff (2010a,b). Leading the way for a growing empirical discussion, Reinhart and Rogoff (2010a,b) found evidence that high debt-to-GDP ratios (90 percent and above) are associated with remarkably lower growth outcomes, both in advanced and emerging economies. Before that, the empirical literature was relatively scarce, mainly focused on the impact of external debt on growth in developing countries or, in the case of the euro area, focused on the impact of fiscal variables through indirect channels affecting economic growth (Checherita and Rother, 2010).

Cochrane (2011) evaluated whether fiscal stimulus can indeed stimulate economic growth, concluding that this is only the case if people do not expect upcoming tax changes to pay off the increased debt, once future financial repression are anticipated when high public debt is perceived. Bornhorst and Arranz (2014) looked at previous deleveraging episodes, showing that a deteriorated macroeconomic scenario may lead to tighter financing conditions and increased rollover risk. Also, repaying debt makes life-cycle consumption smoothing or investment return of lower relevance, depressing the demand and creating self-reinforcing feedback loops across sectors. Finally, these feedback loops exacerbate downturns, especially with simultaneous deleveraging of the private, financial, and public sectors.

Reinhart et al. (2012a) also dedicated themselves to single episodes, looking at major public debt overhang episodes in advanced economies since 1800. Over again, these times were often associated with lower growth than other periods. According to them, the growth-reducing effects of public debt overhang do not seem to be disseminated exclusively through high real interest rates as the enhanced vulnerability varies substantially accordingly to each country. Once more, for Lo and Rogoff (2015), the analysis of the common course of deleveraging across advanced countries to deal with the post-financial crisis debt overhang proved to be crucial to the following slowdown of growth, given the fiscal prudence reactions to debt as reducing expenditures or raising taxes. Reza and Sarker (2015) also argue that, historically, financial crisis recoveries are finished when deleveraging completes its natural course. After the 2007-2009 crisis, however, as many countries resorted to fiscal stimulus in order to support demand, public debt has increased sharply making the later fiscal consolidation become a barrier to a vigorous recovery for many advanced economies.

Apart from the largely documented negative correlation between public debt and economic growth, there is also a concern about the channels through which this relationship materializes. In the case of growth enhancing factors being impacted by public debt, they could thereby affect growth itself, as in Clement et al. (2003), who found reductions in external debt service and stock providing an indirect boost to growth through the public investment channel. By adding to the analysis also the indirect transmission mechanisms, the association of public debt overhang to lower growth may not be exact the same across countries, especially if taken into consideration the variety of country-specific characteristics.

Reinhart et al. (2003) empirically found “safe debt thresholds” differing for each economy, largely dependent on history, with the degree of debt intolerance varying systematically due to the country’s own past of default and high inflation, as well as institutional weaknesses. Dell'Erba et al. (2013) additionally concluded that more than a simple reflection of institutional weaknesses, it is not only the debt level, but also the debt composition that matters, as the presence of foreign currency debt amplifies the financial fragility and implies suboptimal macroeconomic policies. Also, not only the proportion between foreign and domestic-currency denominated debt is relevant, but also the maturity structure of debt (short-term debt and long-term debt) and the government guarantees used as a security instrument. By allowing the effect of debt on growth to also vary across different indebtedness levels within a country, nonlinear relationships seem to appear and indicate that countries’ features do matter to determine country-specific thresholds, above which the indebtedness level imposes a marginal significant negative effect on growth (Cordella et al., 2005).

Consistent with this line of argument, Eberhardt and Presbitero (2015) discussed whether the debt–growth nexus between public debt and growth is basically uniform or there are significant disparities across countries. Based on a large panel of countries, they investigate the existence of common or country-specific thresholds beyond which the effect of public debt on growth changes in magnitude. By trying to identify non-linearities both across and within-countries, the authors respectively found: i) no evidence of any systematic change in the debt-growth correlation due to countries shifting from 'low' to 'high' debt regime (see different slopes for the debt coefficients at Figure 5); and ii) no evidence of a common pattern or clear association between debt overhang effects and the debt cut-offs tested.

Figure 5 shows the results from their heterogeneous dynamic regression models, accounting for unobserved common factors by inclusion of cross-section averages (in the left column of plots) as well as two further lags of the cross-section averages (in the right column). The plots consider subsamples for an adopted threshold of 90% (top) and 60% (bottom) for the debt-to-GDP ratio, for each specification. The values on the x-axis are the average debt/GDP ratios (in logarithms) for the lower and higher regimes. The y-axis captures the estimated long-run debt coefficients, that are allowed by construction to differ cross countries and regimes.

A positive slope indicates the debt coefficient has increased, that is, had a positive or less negative impact on growth in the higher debt/GDP regime. On the contrary, a negative slope indicates the debt coefficient has decreased, which implies a larger negative effect on growth in the higher debt/GDP regime. Based on the hypothesis that a shift to the high debt regime would have an additional negative impact on long-run growth, the arrows should run from NW to SE, i.e. indicate a negative relationship. However, as we can see, this hypothesis is not borne out by their empirical results: there is no evidence for a systematic shift in the relationship between debt and growth when countries move from a 'low' to 'high' debt regime, as only around half of all countries experiences a drop in the debt coefficient.

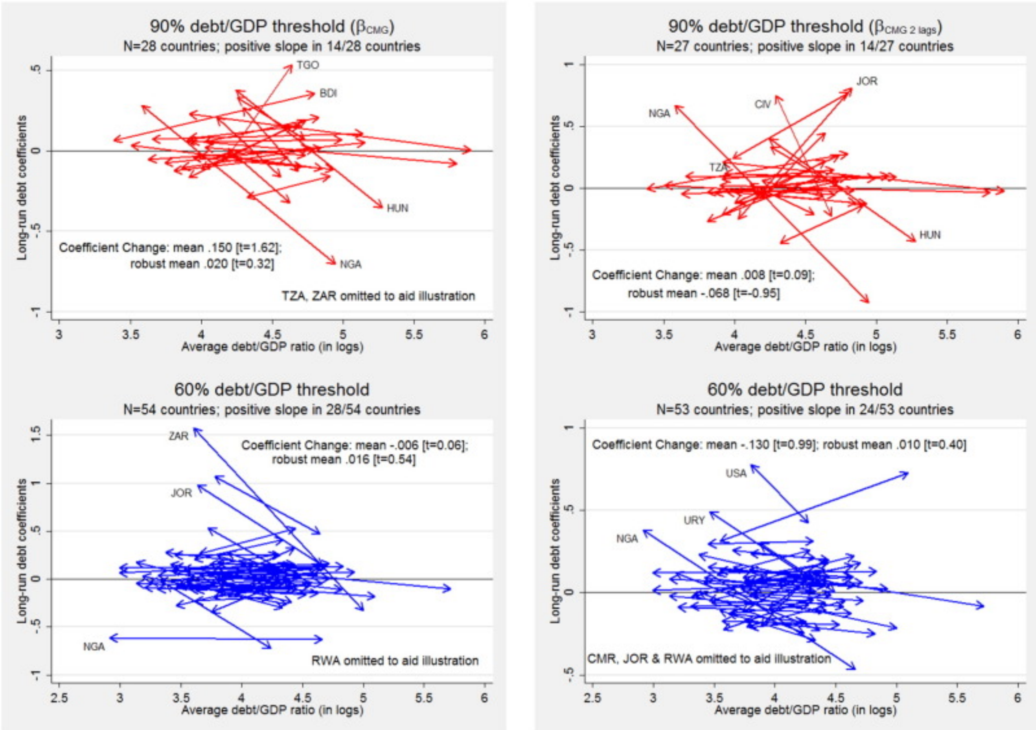

Figure 5. Debt coefficient comparison: debt-to-GDP thresholds
Source: Eberhardt and Presbitero (2015).

The novelty of Eberhardt and Presbitero's (2015) paper emerges from the application of methods typically seen in the time-series literature adapted, then, for use in the panel. By doing that, they were able to properly address endogeneity issues, contrasting the standard empirical models from the previous literature – as I discuss in detail in Chapter 4.

3.2 Uncertainty

The discussion of how the real economy behaves in the face of uncertainty has been intensified over the last years as policy predictability assumed increased risks under modern factors, such as technology. Frequently, the contemporary macro literature finds uncertainty about the future to be a fundamental driver of economic fluctuations as the economic slowdown and sluggish recovery has been increasingly shown to be caused by uncertainty, which remains robust when using various proxy variables (Jovanovic and Ma, 2020). In short, political and economic instability lead to increased levels of uncertainty, discouraging investment and hindering economic growth. At the same time, a growing body of studies show how several sovereign debt crises were associated with extreme political uncertainty (Koh et al. 2020). Following the reported correlation of uncertainty with both lower growth and higher debt, these circumstances are said to add urgency to the need of rebuilding macroeconomic policy space.

According to the IMF (2018), the balance of risks to the global growth forecast has shifted to the downside in a context of elevated policy uncertainty. Such level of uncertainty surrounding the pace of economic growth – which has been historically high across the globe, particularly since 2012 – reflects the increasing role of global factors in driving unpredictability, rather than country-specific contributions (Ahir et al., 2018). This can be seen in Figure 6, which brings the global World Uncertainty Index (WUI), a new measure computed by tracking the uncertainty through text mining. The index is based on the percent of word "uncertain" (or its variant) in the country reports of the Economist Intelligence Unit. The red line in the graph shows an average global index for 143 countries weighted by the GDP. A higher number means higher uncertainty and, as we can see, recent levels of global uncertainty are exceptional high.

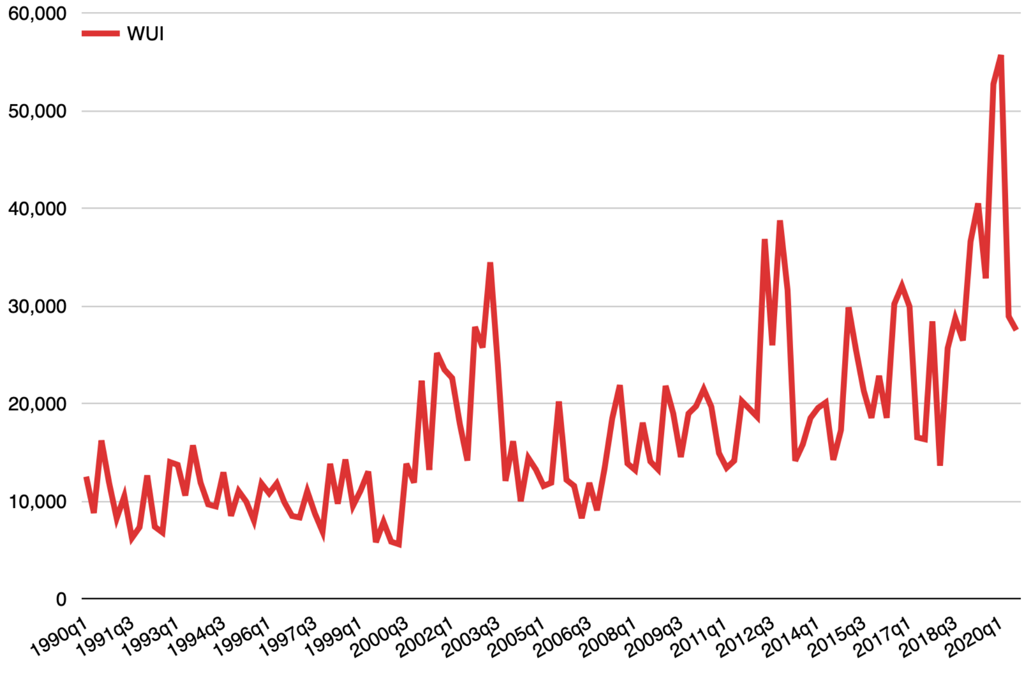

Figure 6. World Uncertainty Index (WUI): Global Index (GDP weighted average)
Source: World Uncertainty Index database.

Since long ago, the impact of uncertainty shocks has been highly correlated with increased volatility, followed by large negative effects on output and productivity growth (Bloom, 2007). Even with some evidence that uncertainty may stimulate innovation in the long-run, fluctuations in uncertainty also proved to matter in a negative sense as larger levels of uncertainty seems to reduce short-run investment and hiring by firms as well as individuals spending. Moreover, the increased uncertainty in 2008 was likely to be play a relevant role in shaping the economic contraction, worsening the Great Recession, and hampering the recovery (Bloom, 2014).

Large gaps in the financial crisis literature before 2008 were fulfilled with a new perspective from modern behavioural economics. Studies started to pay closer attention to the overconfidence in terms of underestimating the variability of future shocks, which often leads agents to hold not enough buffer stocks of assets, or equivalently, to hold too much debt (Reinhart and Rogoff, 2011). As a stable macroeconomic environment may favour growth, especially through reduction of uncertainty, many macroeconomic factors with impact on growth have been identified by the literature, with close attention been placed on inflation, fiscal policy, budget deficits and tax burdens (Matiti, 2013). As documented by Blavy (2006) using cross-country analysis, evidence shows that high public debt and its debt service had been associated, respectively, with heightened macroeconomic uncertainty and crowding out of public investment, thereby distorting productivity growth.

According to Checherita-Westphal et al. (2014), the nonlinear relationships identified between debt burden and rate of growth implicitly entails an optimal – or growth-maximising – level of debt, which is not easily derived in the face of unexpected shocks and political uncertainty. While the rule of forward-looking budget reactions is supposed to fit into a debt targeting framework, the corresponding safe zone for fiscal policy is not able to guarantee more certain outcomes since it only tells where the economy should not go, rather than the debt level that should be pursued. Similarly, Fukač and Kirkby (2017) emphasized the relevance of a clear public understanding of uncertainty and its sources for the overall credibility of fiscal anchors, as measurement errors could have severe implications for the communication of debt targets. Therefore, uncertainty may jeopardise the fiscal policy’s ability to carry out macroeconomic stabilization and welfare-improvement.

Nguyen et al. (2003) also examined how debt overhang, especially high level of external debt, depresses investment and growth by increasing uncertainty. As the stock of public sector debt increases, the growing uncertainty regarding government's reactions to meet its debt servicing raises expectations that such obligations will be financed by distortionary measures. In this context, potential private investors prefer instead to exercise their option of waiting while the rapid accumulation of debt is likely to trigger an increasing capital flight if the private sector fears imminent devaluation. Still talking about external debt, findings from Pattillo et al. (2002) suggested its non-linear negative impact on growth in highly uncertain environments mainly by lowering the efficiency of investments rather than its volume. As recurrent borrowing and poor export performance of some countries led to very high accumulated debt stocks, and thus created uncertainty and debt overhang effects, the consequent misallocation of investments returned lower efficiency of overall capital accumulation.

Likewise, by focusing on highly indebted poor countries (HIPCs), Dijkstra and Hermes (2001) found supportive evidence of uncertainty with respect to debt service payments hurting economic growth. As a consequence, debt relief might be needed in order to stimulate growth by reducing instability and uncertainty, which in turn may enhance the effectiveness of government policies and, finally, provide the private sector with positive signals and incentives about the future profitability. Liu and Rosenberg (2013), in the same line, advocated that removing uncertainty and providing debt relief could have positive externalities for the economy as a whole, although its benefits should be weighed against the fiscal and political cost associated with reforms. Elmeskov and Sutherland (2012), who were also interested in the implications for growth of reducing debt levels, found the pace of consolidation in the dynamics of adjustment to be determined by factors which are typically surrounded by significant uncertainties, such as the need to signal a credible commitment to fiscal consolidation and the ability of monetary policy to mitigate the demand effects of fiscal tightening.

From the lenses of the long-run approach or the intertemporal analysis, Mendoza and Oviedo (2009) studied how the measures of fiscal sustainability are likely to be inaccurate for those governments holding large stocks of debt and dealing with volatility in their revenues and expenditures. The key question would be, then, whether the debt-output ratio is sustainable given the domestic and international economics environment and future prospects, which are much less clear in times of uncertainty. Nevertheless, taking this higher uncertainty as a propagation channel from debt to growth in a general way is not plausible. Especially for the Heavily Indebted Poor Countries (HIPC), uncertainty and volatility are key issues for potential economic growth since the macroeconomic environment is less stabilized, and unbalanced fiscal policies increase the cost of financing and hinder the development of a deep domestic bond market (Arnone and Presbitero, 2007). Hence, country-specific economic conditions determine the exposure to uncertainty at different degrees, with these effects tending to be larger in weaker economies, which face more creditworthiness constraints on debt issue and a bigger challenge to finance its deficits. This is the case since the public debt uncertainty and the likelihood of default from heavily indebted countries is expected to differ from countries holding smaller or moderate amounts of debt (Apergis and Cooray, 2016).

3.3 Private Debt

Further investigation of the potentially non-uniform transmission mechanisms of public debt towards economic growth requires a deeper understanding of what have determined in the past debt turning points such that threshold effects could be observed. As noted by Schularick (2014), although private and public debt cycles have been tightly linked since the 1970s, the recent literature has not looked at both jointly. On the relevance of the private debt channel, there is a substantial research gap in the existing literature in terms of evaluating the effects of private firms' debt position to the aggregate economic performance of a country, rather than only focusing on its effects to firms' own growth.

However, as early mentioned by Bernanke et al. (1988), concerns of high levels of corporate debt should move beyond company walls and be of interest to economists, forecasters, and policymakers. Considering not only the microeconomic but also the macroeconomic significance of firms holding high debt burdens, they conclude that the financial condition of firms contributes to some sort of spillover effects and aggregate externalities, as it plays a substantial role in the persistence and even the origin of business cycles. On this matter, we can identify two sets of theories differing on the sign of the association between private debt and economic growth. While some studies point that this relationship is positive, others suggest these variables are actually negatively related.

The theoretical part of the first set builds on models that relate higher private debt to improved corporate governance, which return beneficial ramifications on economic growth. This literature advocate that debt instruments may reduce the amount of free cash available to firms, therefore, reducing managerial slack and accelerating the rate at which managers chase new technologies (Aghion et al., 1999; Levine, 2005). Empirically, it dominates the idea that a better functioning financial system contributes to higher GDP growth, even if the increased volatility leads to an economic downturn afterwards. In line with private debt booms being also periods of accelerating credit deepening, evidence shows that countries that are more economically developed hold higher private debt-to-GDP ratios (Verner, 2019).

Greater access to credit and the following higher indebtedness in the private sector can boost output through several channels, with all of them ultimately increasing the productive capacity of the economy. The lower cost of capital and a more efficient distribution of savings to investments are some of the direct effects of credit deepening on GDP growth due to more open financial markets (Levine, 2005). As an example, Varela (2018) emphasize how expanding credit can facilitate firm entry and increase market competition, leading firms to expand investments in technology. Still according to this author, some previously credit-constrained firms respond to reductions in financial distortions by also increasing their investments – a reallocation effect.

Instead of studying how private debt anticipates higher growth, Randveer et al. (2011) measured the impact of private debt on growth by looking at the economic recovery episodes and relating the growth performance of countries with their debt levels before the beginning of the recession. If debt instruments can open room for improved allocation opportunities in terms of higher productivity, firms that are able to sustain high debt levels tend to be more capable of surviving and reestablishing once the crisis is over. They found that credit booms and larger private debt stocks before a recession are associated with higher GDP growth after the crisis, even though they make economic slowdowns steeper.

In this line, Jordà et al. (2011) found that credit-intensive booms tend to be followed by deeper recessions and slower recoveries, both in normal and financial crisis recessions. Also, their findings show that private credit booms during economic expansion episodes raises the likelihood of a subsequent financial crisis. Furthermore, while business leverage is at record levels, Jordà et al. (2020) found that the economic costs of private debt booms rise when inefficient debt restructuring, and liquidation prevents the resolution of corporate financial distress. As a result, corporate debt overhang becomes an important macroeconomic force with notable negative effects on business cycles. Considering the government debt as well, Jordà et al. (2014) concluded that countries may hold high levels of debt for the same reasons that define their inability to respond to financial crises. In this case, a recession could be worse because the private sector is accumulating too much debt rather than because of the build-up of public debt per se. As the government is often required to assume the losses of the banking system, if public debt is high at the start of some crisis, the government may be unable to play its lender-of-last-resort function, thereby slowing the recovery.

Mian et al. (2017) tested the basic prediction of standard macroeconomic models where growth in debt is driven by expected future productivity shocks, thereby implying that we should observe a positive correlation between debt growth and subsequent output growth in the data. However, this common feature across most representative agent models was not empirically observed by these authors: growth in private debt over a three to four year period predicts subsequently lower output growth and an increase in unemployment. Their findings highlight the importance of the debt-driven "consumption" channel for business cycle dynamics, rather than the "investment" channel contribution usually claimed by the literature in macro-finance.

This is in line with the other set of studies (the one stating that the private debt-growth link is negative), larger and mainly focused on how an increase in the stock of private debt creates real costs for firms in the following years and constitutes a threat to the financial system stability, affecting the economy-wide performance in an adverse way. More than ten years after the financial crisis, the private sector debt still shows to be growing fast in major economies, placing an increased risk of a new bout of financial stress.

Therefore, one can argue that the magnitude of the overall debt overhang channel until reach a country's growth performance might vary accordingly to its private debt accumulation, since this type of debt often sets large systematic risks and plays a relevant role in determining posterior financial crisis (Reinhart and Rogoff, 2009). Likewise, Reinhart et al. (2012b) highlighted that many advanced economies hold multiple debt overhangs, and thus, public and private debt issues should not be considered in insolation. By saying that, they advocate in favor of evaluating debt burdens as a whole in order to assess the extent of an economy's vulnerability to crisis, which in turn may be not easy as the lines between public and private debt are become blurred during periods of crisis.

Lo and Rogoff (2015) also reviewed some data that are suggestive of the potential worries of debt in an integrative manner across advanced countries based on the striking growth of public, private and external debt burdens from – at least – 1970 to 2010. According to this view, both the economy's overall debt level and composition matter, not only because private defaults may create contingent liabilities for the government, but also due to amplification mechanisms across sectors that could worsen the negative impact of private debt on economic growth. If, for example, private sector defaults lead to weaker growth, the sustainability of government debt is compromised. Besides that, governments are in theory even more vulnerable as they internalise the possible costs of later bailing out the private sector to mitigate risks of systematic crisis from heavily indebted firms.

For Liu and Rosenberg (2013), who identified in the years following the 2008 global financial crisis a sharp increase especially in the private non-financial debt-to-GDP levels across Europe, this trend could be seen as both the cause and the effect of the Great Recession. After relaxing credit conditions, the following rapid accumulation of private sector debt enhanced the economy vulnerability to the sudden stop of capital inflows, determining the severity of the crisis. They highlight that, when left unresolved, high levels of private sector debt are likely to deter the recovery due to a number of channels. These include reduced investment as companies focus on deleveraging and repairing their balance sheet as well as complex banks' lending as rising non-performing loans erode banks' capital buffers, absorb management time and create uncertainties. The authors, furthermore, conclude that public sector debt sustainability may also be affected since excessive private sector liabilities often end up being transferred to the public sector's balance sheet.

Such migration of debt from the private to the public sector was also examined in Bornhorst and Ruiz-Arranz (2014) by pointing its important role as a buffer in the euro area. Figure 7 captures the precrisis (from 2000 to 2007) and postcrisis (from 2008 to 2012) variation in domestic debt shares relatively to total debt. The vertical axis shows the percentage change of each sector's share through bars of different colours: general government (light blue), households (grey), financial corporates (yellow), and nonfinancial corporates (dark blue). As we can see from it, during the boom phase, the private sector – in particular financial firms – increased their indebtedness level while governments were able to reduce debt. However, as the corporate and financial sector entered the deleveraging cycle following the financial crisis, debt has migrated to the public sector through different channels – such as bank recapitalization, automatic stabilizers, or debt-financed fiscal demand support – dampening further the medium-term growth outlook.

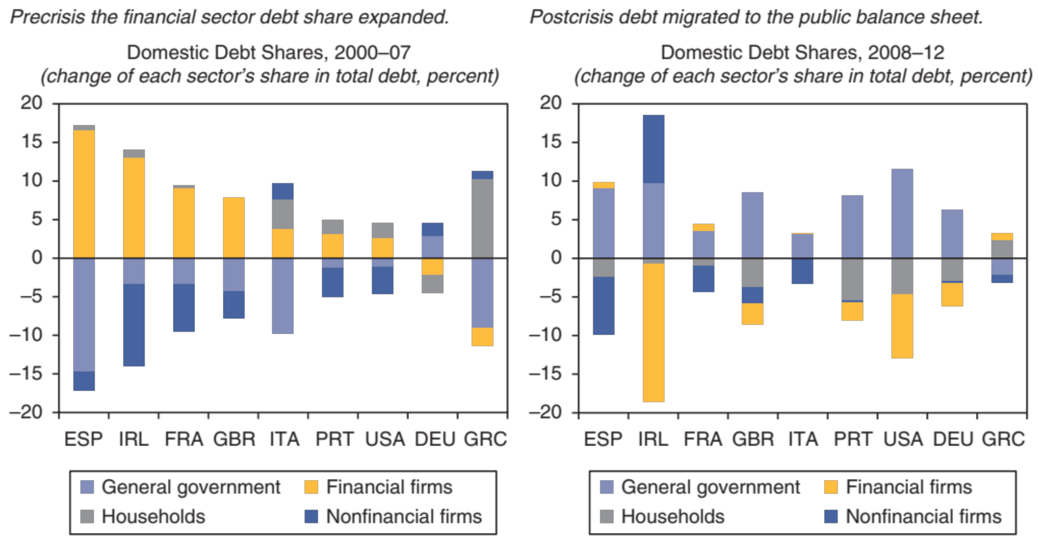

Figure 7. Debt migration 2000-07 vs 2008-12

Source: Bornhorst and Ruiz-Arranz (2014).

One of the few studies and notable contributions to the quantification of the subsequent negative effect of private indebtedness on economic activity was conducted by Cecchetti et al. (2011), who addressed this question using data for 18 OECD countries from 1980 to 2010. Their findings suggested that, when corporate debt goes above 90 percent of GDP, it becomes a drag on growth – a 1 percentage point increase in corporate debt is associated with an approximately 2 basis point reduction in per capital GDP growth. This effect was also shown to be stronger if controlling for government debt, which in turn means that high levels of private debt, while in the present of large government debts, contribute to make the economy more susceptible to shocks.

Regarding the strategy of deleveraging and renegotiating private debt once indebtedness has reached levels that impede overall macroeconomic performance, there is reason to believe that such private debt threshold effects might differ widely from one country to another as the composition and relevance of the private sector is also very likely to differ. Reinhart and Rogoff (2010b), for example, found evidence for emerging markets facing lower thresholds in both public and private external debts. Similarly, Liu and Rosenberg (2013) noted that the urgency of tackling the private sector debt depends on a number of country-specific factors.

As reforms to facilitate private sector debt restructuring are not costless – they require not only budget resources but also political capital – non-uniform economic conditions across countries may imply different effort levels needed to create the conditions for a sustained recovery. Following this perspective, the link between private debt levels and economic performance depends, then, on country circumstances – like the elasticity between corporate liabilities and investment – deserving, thus, to be also included in the analysis of the heterogeneous impact of debt under investigation here.

Chapter 4 – Data and Research Methodology

This Chapter starts by describing the data and sources used in the following analysis. It also provides an overview of the sample with some descriptive statistics. Then, the Chapter turns to the research strategy applied to empirically investigate the public debt and growth dynamics, by discussing the econometric methods as well as the empirical specifications.

4.1 The Data

To analyse the heterogeneous effects of public debt on growth, Eberhardt and Presbitero (2015) use annual data on the total public debt stock, the capital stock and GDP over the sample 1960-2012. In this thesis, I extend their dataset in two ways for a panel of 95 low, middle and high-income countries. First, I extend their sample to 2015[2]. Second, I include two new time series of cross section variables: i) the private debt stock; and ii) a proxy for the economic and political uncertainty. Some descriptive statistics for the sample are presented in Table 1.

[2] The period1960-2015 represents the longest sample covering a balanced panel dataset that I managed to obtain.

Variables	Obs	Mean	Std. Dev.	Min	Max
GDP					
level	4,571	4.27E+11	1.28E+12	2.05E+08	1.67E+13
growth	4,476	3.75	4.99	-69.81	40.18
per capita level	4,571	11,558	15,369	132	91,566
per capita growth	4,476	2.11	4.91	-64.44	36.03
Capital stock					
level	4,000	1.28E+12	3.59E+12	1.32E+08	4.40E+13
growth	3,905	4.60	3.88	-4.87	71.50
per capita level	4,000	35,214	48,453	53	266,667
per capita growth	3,905	3.05	3.74	-7.57	68.21
Public debt					
level	3,990	3.01E+11	1.20E+12	2.06E+07	1.76E+13
growth	3,840	5.15	17.93	-300.85	135.81
per capita level	3,990	6,917	11,597	4.67	116,803
per capita growth	3,840	3.59	17.93	-301.29	134.43
Private debt					
level	4,061	5.47E+11	1.97E+12	3.23E+06	2.53E+13
growth	3,962	0.07	0.16	-1.91	2.62
per capita level	4,061	14,989	28,629	1.02	224,817
per capita growth	3,962	0.05	0.16	-1.93	2.61
Uncertainty					
level	3,927	0.155	0.124	0.006	0.914
growth	3,423	0.003	0.129	0.873	0.715

Table 1. Descriptive statistics – Raw variables and standard transformations

Note: Level variables are reported in US$2010 values, except for the uncertainty index which is normalized to be in the range of 0 to 1.

The main data sources used have been chosen according to data availability and comparability in order to preserve the definition of the core variables under analysis. These sources are: the World Development Indicators (WDI), from the World Bank; the IMF Historical Public Debt Database (HPDD), an updated version of the remarkable dataset provided by Abbas et al. (2010); the IMF Global Debt Database (GDD), following the methodology in Mbaye et al. (2018); the IMF World Uncertainty Index (WUI), based on the new measure of uncertainty developed by Ahir et al. (2018); and the Aggregate Capital Stock Estimations, according to the Perpetual Inventory Method originally proposed in Berlemann and Wesselhöft (2014).

From the World Bank database, I could take the following series from 1960 to 2019: real GDP and GDP per capita series (both in constant 2010 U$$), total population and gross fixed capital formation (as a share of GDP), formerly gross domestic fixed investment. From the HPDD, I obtained the gross government debt-to-GDP ratios over the period 1960 to 2015, which is the first compilation of other government debt databases from individual researchers, institutional bodies and official government publications reaching far back in time. Despite the effort on collecting data public debt before this database, the most widely used sources were often confined to a limited set of countries, not spanning a long period or not continuously updated. The robust and comprehensive compilation provided by the HPDD represents, then, a useful and trustable source, facilitating a range of notable comparisons, both across time and country groups.

From the GDD, the total stock of private debt, loans and debt securities issued by households and nonfinancial corporations as a share of GDP was obtained over the period 1960 to 2018. This database is the result of a multiyear investigative process that started with the October 2016 Fiscal Monitor, also from the IMF. From the WUI database, I obtained the index that captures the uncertainty level per country related to economic and political events. This is available for 143 countries from the mid-1950s onward. This index is a novel measure for tracking uncertainty across the globe by text mining and counting the percent of word "uncertain" (or its variant) in the country reports of the Economist Intelligence Unit. A higher number means higher uncertainty and vice versa.

Lastly, an extended version of Berlemann and Wesselhöft's (2014) data with consistent estimates of aggregate capital stocks was kindly provided by its authors. Considering that the lack of reliable and internationally comparable capital stock data is a major obstacle to empirical studies analysing the contribution of the capital stock to economic growth, this dataset overcomes the issue of employing different proxies of capital accumulation. Using a unified approach of the Perpetual Inventory Method, this measure refrains completely from merging data from different databases to increase the sample size to, instead, rely completely on official data taken from the World Bank. Covering the years from 1960 to 2016, this method is based on investment data from the World Bank's World

Development Indicators database, which is, as mentioned above, also the source of most variables in this study.

To provide a first look at the main variables of the dataset, Figure 8 shows a scatter plot of initial public debt level against subsequent growth (in terms of real per capita GDP) over five-year periods. Covering the full sample (with the exception of outliers and missing points), initial debts stand for the government debt to GDP ratio in the first year of each five-year sub-period (i.e., 1960, 1965, 1970 etc), while subsequent growth reports the average growth rates (annual percentage) over each five-year sub-period (i.e., 1960-64, 1965-69, 1970-74 etc). Using the initial level of government debt to examine the impact on subsequent growth is a strategy suggested by Kumar and Woo (2010) to avoid the reverse causality issue. This may not be trivial as slower economic growth could instead lead to high debt build-up, rather than high debt lowering growth. I get back to this issue in Section 5.3.1.

The graph suggests an inverse long-run relationship (given the five year time-span) between initial debt and subsequent growth, still not controlling for other determinants of growth. According to the fitted line, the coefficient of initial debt is -0.018, which indicates that a 10-percentage point increase in initial debt-to-GDP ratio is associated with a subsequent slowdown in per capita GDP growth of 0.18 percentage points. Again, this approach does not include controls, which means it is likely ignoring the potential endogeneity problem – growth and government debt might be jointly determined by other variable(s).

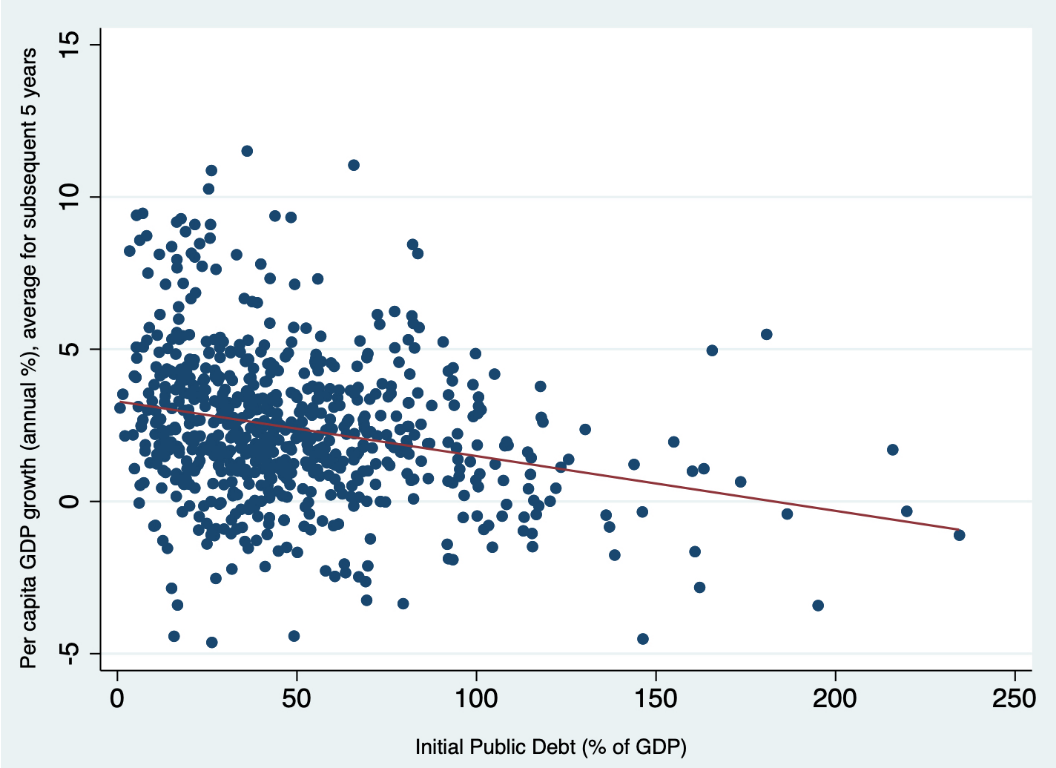

Figure 8. Initial government debt-to-GDP and subsequent growth of real per capital GDP

In Figure 9 and Figure 10, I plot the same long-run relationship between uncertainty or private debt, respectively, and subsequent growth (still in terms of real per capita GDP) over five-year periods. In both cases, I am unable to see any relationship between the considered variables used in isolation from other possible explanatory variables. The fitted lines are, therefore, almost flat. Again, it is worthy to emphasize that the choice of using subsequent growth to avoid the reverse causality problem allows us to only check for possible equilibrium relationships – the potential long-run link between the variables we are looking at. In other words, these plots cannot capture any potential short-run relationship and are simply suggestive, as they do not control for any other factor. To properly address the debt-growth dynamics both in the short-run and long-run taking into account all these variables together I turn to a more structured econometric analysis in Section 4.2.1.

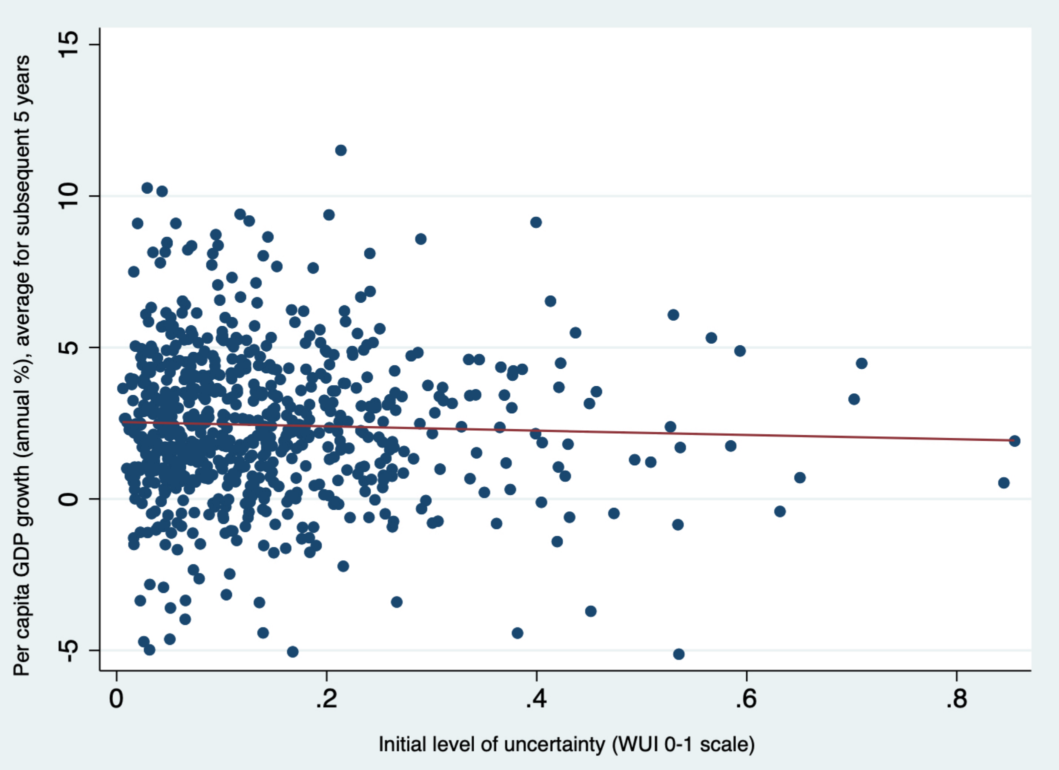

Figure 9. Initial level of uncertainty (WUI) and subsequent growth of real per capital GDP

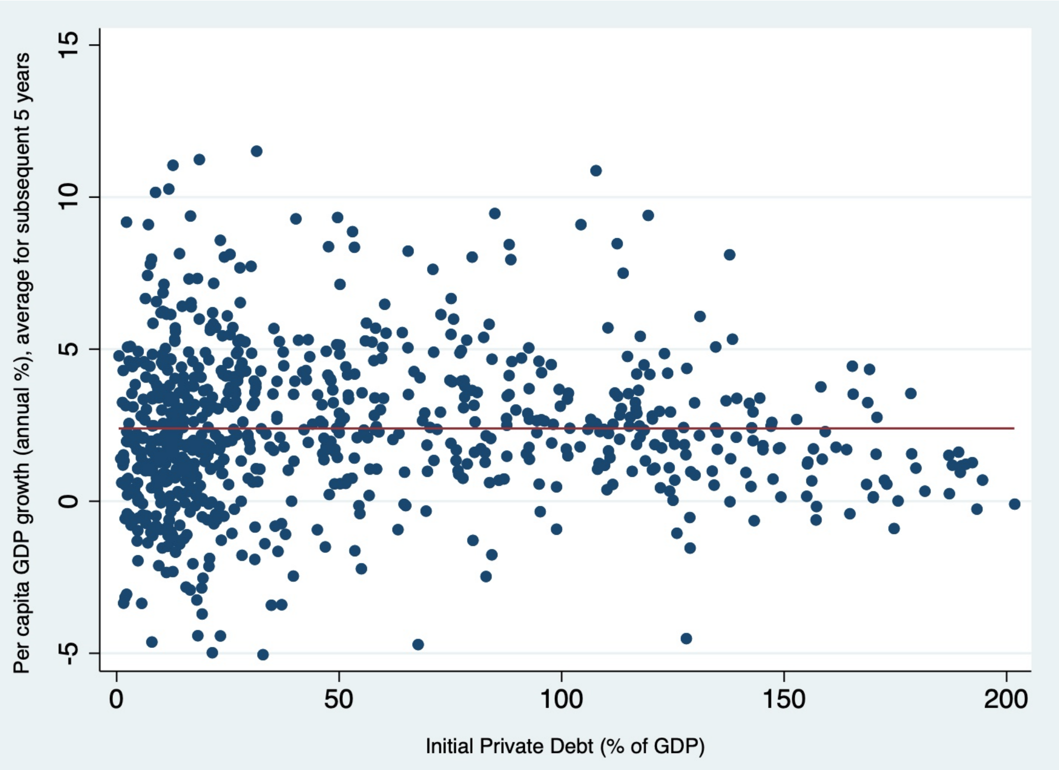

Figure 10. Initial private debt-to-GDP and subsequent growth of real per capital GDP

4.2 Empirical Strategy

Linking public debt with economic activity is not just a matter of finding if the two are correlated in some way, as this relationship might also carry a lot of other important related coincident effects. Hence, understanding the sources of variation in the output performance in times of high government debt-to-GDP ratios rely on an analysis including some coherent potential factors that could, otherwise, generate misleading inferences. What is the effect of public debt on GDP growth rates – and how strong is the propagation of other variables also related to the same conditions that entailed such fiscal deterioration – are largely empirical questions from a macroeconomic perspective.

To overcome these problems, I estimate the heterogeneous effect of public debt overhand on economic growth in the literature in two steps. First, I estimate a public debt-growth model based on the standard empirical literature specification – e.g., Eberhardt and Presbitero (2015). Then, as a second step, I add the two potential omitted variables – uncertainty and private debt – to verify whether their prevailing levels have also a significant impact on output growth over other determinants. That is, I check if the impact of outstanding levels of public debt on economic growth is likely to differ once I also take into account high levels of uncertainty and private debt. I shall note that, as for public debt, these two new variables might also have a heterogenous effect on growth due to the unique set of economic conditions that each country faces.

The analysis quantifies the short-run and long-run relationships between government debt stock and output growth using a panel of 95 countries spanning 55 years from 1960 to 2015, while exploiting both cross-sectional and time-series dimensions of the data. I return to the detailed identification strategy in the discussion of the empirical implementation below. The analysis is based on standard linear regression models and, to consider the importance of time series properties and dynamics while using a panel approach, I employ an Error Correction Model (ECM). To address the problem of the omitted-variable bias by controlling for both observed and unobserved heterogeneity across the cross-sectional dimension (and also across periods), I employ the Common Correlated

Effects (CCE) estimator. Alternative extensions are tested in the robustness exercises presented in Section 5.3.

4.2.1 The Model Specifications

Now I present the main part of this empirical analysis, defined in the two steps through which I expect to uncover the relationship between public debt and economic growth: the baseline and the extended model specifications. First, I follow Eberhardt and Presbitero (2015) and estimate its original empirical specification of the public debt-growth nexus within a linear dynamic model of a log-linearised production function based on capital and augmented with a debt stock term. In this step, I consider the following baseline equation of interest:

$$y_{it} = \beta_i^K cap_{it} + \beta_i^D debt_{it} + u_{it} \quad (1)$$

$$u_{it} = \alpha_i + \lambda_i \boldsymbol{f}_t + \varepsilon_{it} \quad (2)$$

where y is the aggregate GDP, cap is the capital stock and $debt$ is the total debt stock. The variables in Equation (1) constitute the observable part of their model and are used in logarithms of per capita terms. Note that the capital and debt parameter coefficients β_i^j (for j = K, D, respectively) are allowed to differ across countries, setting the central feature of their empirical setup, that is, the heterogeneity. This means that the magnitudes of such parameter coefficients matter and do not differ randomly across countries.

In Equation (2), the country-specific intercepts (α_i) are also included, as well as a set of unobserved common factors ($\boldsymbol{f}_t$) together with country-specific 'factor loadings' (λ_i) to account, respectively, for the levels and evolution of unobserved Total Factor Productivity (TFP). As noted by Eberhardt and Presbitero (2015), employing a variable in per capita terms imposes constant returns to scale on the production process. However, the specification of an endogenous TFP in the form of common factors allows for externalities such as knowledge spillovers at the local and global level. Such common factors can combine 'strong' factors, representing global shocks (such as the global financial crisis), and 'weak' factors, capturing local spillover effects along channels determined by the limits of shared culture heritage, geographic proximity, economic or social interaction. The authors also mention that common factors should not be regarded as merely omitted variables, but a set of latent drivers of the macroeconomy.

To quantify the importance of time series properties and dynamics while using a panel approach, Eberhardt and Presbitero (2015) employ an error correction model (ECM). The implied ECM representation of (1) and (2) combined is given as:

$$\Delta y_{it} = \alpha_i + \rho_i\left(y_{i,t-1} - \beta_i^K cap_{i,t-1} - \beta_i^D debt_{i,t-1} - \lambda_i \boldsymbol{f}_{t-1}\right) + \gamma_i^K \Delta cap_{it} + \gamma_i^D \Delta debt_{it} + \gamma_i^{F\prime} \Delta \boldsymbol{f}_t + \varepsilon_{it} \quad (3)$$

Where the β_i^j (for $j = K, D$) represents the long-run equilibrium relationship between GDP and the measures for capital and debt, respectively, and the γ_i^j (for $j = k, d$) represents its short-run relations version. The ρ_i indicates, as described previously, the speed of convergence of the economy to its long-run equilibrium path. The terms in round brackets represent the candidate cointegrating relationship they seek to identify in their panel time series approach. Note that the set of unobserved common factors is also included in the long-run equation, implying that they were investigating an equilibrium relationship between output, capital, debt and TFP as well.

To estimate the long-run parameters it is useful to rewrite Equation (3) as:

$$\Delta y_{it} = \pi_{0i} + \pi_i^{EC} y_{i,t-1} + \pi_i^K cap_{i,t-1} + \pi_i^D debt_{i,t-1} + \pi_i^{F\prime} \boldsymbol{f}_{t-1} + \pi_i^k \Delta cap_{it} + \pi_i^d \Delta debt_{it} + \pi_i^{f\prime} \Delta \boldsymbol{f}_t + \varepsilon_{it} \quad (4)$$

where, from the coefficients in 'levels' terms π_i^j j (for $j = K, D$), they could back out the long-run parameters, $\beta_i^K = -\pi_i^K/\pi_i^{EC}$ and $\beta_i^D = -\pi_i^D/\pi_i^{EC}$; whereas from the coefficient on the terms in first difference π_i^j (for $j = k, d$, lowercase to distinguish from the long-run coefficients), they could read off the short-run parameters directly. By construction, the π_i^{EC} relates to the speed at which the economy returns to the long-run equilibrium, providing insights into the presence of a long-run relationship. Note that, if $\pi_i^{EC} = 0$, then, $\rho_i = 0$ and there is no cointegration. The model, therefore, reduces to a regression with only first differentiated variables. Otherwise, if there is cointegration between the variables in levels, both π_i^{EC} and ρ_i are different from zero and reflect the adjustment of the economy following a shock, or the 'error correction'.

Finally, the second step follows the CCE estimator strategy described in Section 4.2.2. Eberhardt and Presbitero (2015) adjusted the model in Equation (4) using the simple algebraic mechanics of accounting for the unobservable factors and omitted elements of cointegration with cross-section averages of all variables. The estimation equation assumes, then, the following terms:

$$\begin{aligned}\Delta y_{it} = \pi_{0i} + \pi_i^{EC} y_{i,t-1} + \pi_i^{K} cap_{i,t-1} + \pi_i^{D} debt_{i,t-1} + \pi_i^{k} \Delta cap_{it} + \pi_i^{d} \Delta debt_{it} \\ + \pi_{1i}^{CA} \overline{\Delta y_t} + \pi_{2i}^{CA} \overline{y_{t-1}} + \pi_{3i}^{CA} \overline{cap_{t-1}} + \pi_{4i}^{CA} \overline{debt_{t-1}} + \pi_{5i}^{CA} \overline{\Delta cap_{t-1}} \\ + \pi_{6i}^{CA} \overline{\Delta debt_{t-1}} + \varepsilon_{it} \qquad (5)\end{aligned}$$

While the first line of Equation (5) represents the specification for a standard Mean Group (MG) estimator, the addition of the terms with cross-section averages yields the standard Common Correlated Effects (CCE) Mean Group estimator, as in Pesaran (2006).

In line with Pesaran (2006) and Chudik and Pesaran (2015), their final empirical specification for a linear dynamic model also includes further lags of the cross-section averages (besides the cross-section averages of all model variables). This is taken as a remedy to the issue of small sample bias, in particular when dealing with moderate time series dimensions, and to the problem of consistency arising from allowing for feedback between the observables when relaxing the assumption of strict exogeneity. This dynamic CCE Mean Group estimator (CCEMG) is said to perform well even in a dynamic model with weakly exogenous regressors once augmented with a sufficient number of lagged cross-section averages[3].

To the extended model specification, I now incorporate two new economic variables, while keeping the whole structure from Eberhardt and Presbitero (2015) presented above. By doing this, I expect to measure whether and to what extent the

---

[3] The authors suggest p =int ($T^{1/3}$) as a rule of thumb, which equates in their ECM to adding up to two lagged differences.

prevailing levels of both variables do matter to the output growth, which may affect the magnitude of propagation of public debt effects towards economic fluctuations. These two candidate growth determinants are the uncertainty level and the private debt stock – further details on the dataset were presented in section 4.1.

With the embodied variables, I rely on a new extended estimation equation to uncover the heterogenous dynamic relationship between public debt and output growth in the following way:

$$\begin{aligned}\Delta y_{it} &= \pi_{0i} + \pi_i^{EC} y_{i,t-1} + \pi_i^{K} cap_{i,t-1} + \pi_i^{G} gdebt_{i,t-1} + \pi_i^{P} pdebt_{i,t-1} + \pi_i^{U} wui_{i,t-1} \\ &+ \pi_i^{k} \Delta cap_{it} + \pi_i^{g} \Delta gdebt_{it} + \pi_i^{p} \Delta pdebt_{it} + \pi_i^{u} \Delta wui_{it} \\ &+ \pi_{1i}^{CA} \overline{\Delta y_t} + \pi_{2i}^{CA} \overline{y_{t-1}} + \pi_{3i}^{CA} \overline{cap_{t-1}} + \pi_{4i}^{CA} \overline{gdebt_{t-1}} + \pi_{5i}^{CA} \overline{pdebt_{t-1}} + \\ &+ \pi_{6i}^{CA} \overline{wui_{t-1}} + \pi_{7i}^{CA} \overline{\Delta cap_t} + \pi_{8i}^{CA} \overline{\Delta gdebt_t} + \pi_{9i}^{CA} \overline{\Delta pdebt_t} + \pi_{10i}^{CA} \overline{\Delta wui_t} \\ &+ \varepsilon_{it} \qquad (6)\end{aligned}$$

where aggregate GDP is denoted by *y*, capital stock denoted by *cap*, and *gdebt*, *pdebt* represents the total public and total private debt stock, respectively. All these variables are denominated in logarithms of per capita terms. The equation of interest also includes the World Uncertainty Index represented by *wui.* As before, to account for the heterogeneity under analysis, the empirical setup allows the corresponding parameter coefficients for both on short- and long-run to differ across countries with π_i^z (for $z = K, G, P,\ U,\ k, g, p, u$). Again, I account for the presence of unobserved time-varying heterogeneity by augmenting the country regressions with cross-section averages of all model variables (i.e., the dependent and independent variables).

The idea behind this specification is that to properly measure the heterogeneity behind the public debt impact on output fluctuations, I should avoid in my identification the potential omitted variables, which may also carry heterogeneities. Otherwise, by disregarding that, I am subject to the risk of getting a biased estimate of the public debt coefficient, and not capturing its own heterogenous effect on economic growth. To avoid misleading inferences, I run the extended specification above, along with the baseline model, both considering the cointegration relationship between growth and the explanatory variables. Results are compared in the next Chapter.

4.2.2 The Common Correlated Effects Estimator

Finally, I turn to the choice of the estimator motivated by both the data properties and the literature, which has made progress on proposing new econometric approaches to circumvent potential issues when dealing with heterogenous dynamic panels. Within the recent effort to design procedures able to properly estimate economic long-run relationships using macro-panel data techniques, a significant development could be observed when dealing with the assumption of cross section independence among the units of the panel data.

Such a strong assumption was rarely found in empirical economic analyses since, as pointed by Banerjee and Carrion-i-Silvestre (2017), cross-sectional dependence appears naturally when studying economic data due to market integration processes, globalization of economic activity, or because of the presence of common shocks. Cross-sectional dependence in panel data arises not only from spillover effects contaminating units in the same cross-section, but mainly from unobserved common factors which tend to affect all units, although probably in a different way.

Here, the common correlated effects (CCE) estimation procedure offers the best available option, as the focus here is exactly to investigate the potential heterogeneity both in the short- and long-run. As already mentioned, the main objective of this work is to empirically measure how specific growth determinants weigh on output performance to reveal some part of the debt-growth bivariate narrative, which is often unclear and put aside in the error term. By doing this, I expect to be able to get more accurate estimates for the debt effect on growth *per se* and uncover the effect of a couple of candidate drivers: the level of uncertainty and private debt prevailing in the economy.

The CCE-type estimators account for the presence of unobserved heterogeneity through a simple augmentation of the regression equation: the general idea is to extend the original regression by cross-sectional averages of the dependent variable and all the explanatory variables as well. As it is often likely that nonzero error covariances appear due to omitted common effects that impact all countries – a sign of misspecification rather than error correlation – this strategy can reduce the bias caused by omitting unobserved common components of the error term. This is possible because the inclusion of cross-sectional means of the observables as additional regressors works as an estimator of the common factors, dealing explicitly with the effects of between-country nonzero error covariance (Pesaran et al., 1999).

Pesaran (2006) proposed this new approach to estimation and inference in panel data models with a general multifactor error structure as a procedure that yields consistent and asymptotically normal parameter estimates even in the presence of correlated unobserved common effects. Such specification allows the common effects to have differential impacts on individual units, while at the same time permits them to carry an arbitrary degree of correlation among themselves and with the individual-specific regressors. It additionally allows for individual-specific errors to be serially correlated and heteroscedastic and does not require the individual-specific regressors to be identically and/or independently distributed over the cross-section units, which is particularly important to the analysis of cross-country panels.

Finally, to formally introduce the CCEMG estimator, I start by setting out a multifactor residual model and its assumptions (for more details, see Pesaran, 2006). Let y_{it} be the observation on the *i*th cross-section unit at time t for *i* = 1,2,….,*N* and *t* = 1,2,…,*T*. We suppose this is a series generated according to the linear heterogeneous panel data model as follows:

$$y_{it} = \boldsymbol{\alpha}_i' \boldsymbol{d_t} + \boldsymbol{\beta}_i' \boldsymbol{x_{it}} + e_{it} \qquad\qquad e_{it} = \boldsymbol{\gamma}_i' \boldsymbol{f_t} + \varepsilon_{it}$$

where $\boldsymbol{d_t}$ represents a (*n* x 1) vector of observed common effects (including deterministic components such as intercepts or seasonal dummies), $\boldsymbol{x_{it}}$ is a (*k* × 1) vector of observed individual-specific regressors on the *i*th cross-section unit at time t, and the errors have the multifactor structure in which $\boldsymbol{f_t}$ is a vector of (*m* × 1) unobserved common effects and ε_{it} accounts for the individual-specific (idiosyncratic) errors. These errors are assumed to be independently distributed of

$(\boldsymbol{d_t}, \boldsymbol{x_{it}})$. However, it is reasonable to assume, in general, that the unobserved factors $\mathbf{f_t}$ might be somehow correlated with $(\boldsymbol{d_t}, \boldsymbol{x_{it}})$, and to allow for such a possibility, we consider the general model for the individual specific regressors:

$$\boldsymbol{x_{it}} = \boldsymbol{A_i'}\boldsymbol{d_t} + \boldsymbol{\Gamma_i'}\boldsymbol{f_t} + \boldsymbol{v_{it}}$$

where $\boldsymbol{A_i'}$ and $\boldsymbol{\Gamma_i'}$ are ($n \times k$) and ($m \times k$) factor loading matrices with fixed components, while v_{it} are the specific components of $\boldsymbol{x_{it}}$ distributed independently of the common effects and across the *i*-units but assumed to follow general covariance stationary processes. However, unit roots and deterministic trends could still be considered in $\boldsymbol{x_{it}}$ and y_{it} by allowing one or more of the common effects in $\boldsymbol{d_t}$ or $\boldsymbol{f_t}$ to have unit roots and/or deterministic trends.

This setup is sufficiently general and provides a variety of panel data models as special cases:

i. The familiar fixed or random effects models corresponding to the case where $\boldsymbol{d_t}$ = 1, $\boldsymbol{\beta_i} = \boldsymbol{\beta}$, and $\boldsymbol{\gamma_i}$ = 0, for all *i*-units.

ii. The time-varying effects that allows for error cross-section dependence through a single unobserved factor, but in addition to assuming that $\boldsymbol{d_t}$ = 1, $\boldsymbol{\beta_i} = \boldsymbol{\beta}$, also require the individual-specific regressors to be cross-sectionally independent, namely $\boldsymbol{A_i}$ = 0 and $\boldsymbol{\Gamma_i}$ = 0.

iii. The random coefficient model that allows for slope heterogeneity but assumes $\boldsymbol{\gamma_i}$ = 0, for all *i*-units.

iv. In the special case where $\boldsymbol{\gamma_i} = \boldsymbol{\gamma}$, the multifactor structure reduces to $\boldsymbol{\gamma_t}$ = $\boldsymbol{\gamma' f_t}$, and the regressions become the familiar panel data model with time dummies. In this case, we can estimate $\boldsymbol{\beta}$ by using standard panel data estimators based on cross-sectionally demeaned observations.

v. Some recent large *N* and *T* factor models focus on consistent estimation of $\boldsymbol{f_t}$ (including its dimension *m*) and the factor loadings $\boldsymbol{\gamma_i}$, and are not concerned with the estimation of the "structural" parameters $\boldsymbol{\beta_i}$.

The latter case is not aligned with the purpose here. The primary parameters of interest here are the means of the individual-specific slope coefficients $\boldsymbol{\beta_i}$, and to this end some assumptions are needed to ensure that such coefficients can be consistently estimated and tested. These assumptions are presented in the Appendix.

A variety of sources of cross section dependence can exert different degrees of dependence intensity. "On the one hand, we may have pervasive cross section dependence due to the presence of a dominant unit in the panel data set-up, a situation that can be interpreted as if there were common factors affecting all the time series in the panel. On the other hand, cross section dependence may be important only among some neighbours. The notion of 'neighbour' does not of course necessarily need to be defined in terms of physical contiguity, such as neighbouring regions or cities but may also be defined *inter alia* in terms of economic distance, usually, trade partnerships" (Banerjee and Carrion-i-Silvestre, 2017, p.1).

This should be particularly considered once standard methods often used for multi-country estimation – as the Dynamic Fixed Effect (DFE) estimator, the Mean Group (MG) estimator or the Pooled Mean Group (PMG) estimator – are not reliable in the presence of cross-sectional dependence. While such estimators allow for some parameter heterogeneity across countries, they still impose restrictions either on slope coefficients, regression intercepts or error variances, which are assumed to be equal in the long-run for all countries. Choosing one of these estimators would imply a trade-off between consistency and efficiency, with restricted estimators being likely to be downward biased under an invalid constraint of parameter homogeneity in such a dynamic model (Pesaran and Smith, 1995; Loayza and Rancière, 2004).

For instance, even though the Pooled Mean Group (PMG) estimator is quite often applied in the empirical growth literature, this estimator fits better when there are reasons to believe that the long-run equilibrium relationship is given by conditions expected to be homogeneous across countries. As this might be not the case for my dataset, since the sample includes very different countries and during a period which is long enough to present structural changes in some economic conditions (such as the natural interest rate), assuming that is likely to lead to misleading estimates. Also, addressing the heterogeneity proved to be central to understand the growth process in particular, such that failing to fulfil this issue can risk producing inconsistent estimation in a PMG model (Eberhardt and Teal, 2011).

The basic mechanism behind the common correlated effects (CCE) estimator is to filter the individual-specific regressors by means of cross-section aggregates such that the differential effects of unobserved common factors are eliminated. This estimation approach has the advantage of using OLS as an auxiliary regression, where the observed regressors are augmented by cross-section and weighted averages of the dependent variable as well as of the individual specific regressors. The standard CCE estimator in the Mean Group version (referred to as CCEMG) is also asymptotically unbiased as $N \rightarrow \infty$ for both T fixed and $T \rightarrow \infty$ and continues to hold even under slope homogeneity. Still according to Pesaran (2006), such results are remarkable as they hold for any fixed number of unobserved factors, which is an important consideration in practice, where unobserved common effects are in general unknown. Hence, an estimator of the CCE-type comes close to replicating the properties of infeasible estimators when there is no clear knowledge of the residual factor structure and/or the realizations of the unobserved effects.

To conclude this section, there are some important remarks from Pesaran (2006) that shall also be highlighted here. First, the residual factor model specified in the first equations above allows the unobserved common factors to be correlated with the individual-specific regressors and permits a general degree of error cross section dependence by considering a multifactor structure with differential factor loadings over the cross-section units. Secondly, besides the intercepts, the seasonal dummies, and the observed stationary variables, it is also possible to include deterministic trends by suitable scaling of the trend variables. The advantage of this method is that the main results still hold if there are unit root processes among the elements of the vectors of both observed and unobserved common effects, which in turn would introduce unit roots in the observed individual-specific regressors.

In third place, the weights are not unique and, as it turns out, do not affect the asymptotic distribution of the estimators. Also, the number of observed factors and the number of individual-specific regressors are assumed fixed and known, but the number of unobserved factors is not required to be known, only assumed to be fixed.

Lastly, it is worth noting that the common feature dynamics across the *i*-units are captured through the serial correlation structure of the common effects, while the individual-specific dynamics are allowed through the serial correlation in the individual-specific errors.

Chapter 5 – Results

This Chapter starts by presenting a preliminary examination using the basic pooled fixed effects (2FE) estimator, with and without additional controls. Then, I turn to my main empirical regressions using the heterogeneous parameter CCE model. Robustness checks and potential weaknesses are also discussed. All the computations were obtained using the statistical software Stata 16.

5.1 Preliminary Evidence

High levels of public debt have been observed to produce harmful effects on GDP growth in many cases, as summarized in the literature review (Chapter 3). Here, I estimate the same relationship but with the candidate controls in order to answer: are the same forces that push public debt up driving uncertainty and private debt? Also, are these controls relevant for economic growth? If both are true, explicitly specifying these variables now may change the results reported previously in the literature.

For a full sample of 95 countries over the period 1960 to 2015, the quantitative investigation of this thesis is based on error correction models which use the first difference of log real GDP per capita as the dependent variable. Both public and private debt variables refer to the real per capita value of the respective debt stocks[4]. To address these questions, results from linear dynamic models using the fixed-effects (FE) estimator with and without additional controls are presented in Table 2. The first column reports the regression coefficients between the mentioned

[4] It is worth emphasizing that these variables are never used as a debt-to-GDP ratio, since this proportion is, by construction, automatically affected by any change in the growth rate of real GDP. Instead, I take both debt stocks in constant 2010 US$ values.

measures of public debt and output growth, using only the per capita capital stock variable as a control, as in the original work – Equation (4) from last section.

The following three columns of Table 2 report the regression coefficients obtained when including, respectively, uncertainty and private debt stock as additional controls individually and together, as Equation (4') shows. The idea is to verify whether the sign and/or significance of the public debt coefficients (both in the long-run and short-run) change once I add such controls.

$$\Delta y_{it} = \pi_{0i} + \pi_i^{EC} y_{i,t-1} + \pi_i^{K} cap_{i,t-1} + \pi_i^{G} gdebt_{i,t-1} + \pi_i^{P} pdebt_{i,t-1} + \pi_i^{U} wui_{i,t-1} + \pi_i^{F\prime} \boldsymbol{f}_{t-1} + \pi_i^{k} \Delta cap_{it} + \pi_i^{g} \Delta gdebt_{it} + \pi_i^{p} \Delta dpebt_{it} + \pi_i^{u} \Delta wui_{it} + \pi_i^{f\prime} \Delta \boldsymbol{f}_t + \varepsilon_{it} \quad (4')$$

Country and time-fixed effects were included in the panel regressions to eliminate bias from unobservable variables that change over time but are constant across countries, as well as from factors that differ across countries but are constant over time. By including dummy variables in both dimensions for missing and/or unknown factors that could affect such correlation measure, this means that the two-way linear fixed effects regression (2FE) is able to remove the likely omitted variable bias in such simple regressions. As it captures the heterogeneity (variation within each dimension), this model is supposed to provide better correlation estimates in comparison to classical OLS models, avoiding misleading inferences.

2FE	Δ ln(gdp) [1]	Δ ln(gdp) [2]	Δ ln(gdp) [3]	Δ ln(gdp) [4]
Public debt coefficients				
LR	-0.086 (-1.37)	-0.081 (-1.26)	-0.0004 (-0.01)	-0.02 (-0.44)
SR	-0.019 (2.41)*	-0.022 (2.72)**	-0.022 (3.06)**	-0.027 (3.50)**
Capital coefficients				
LR	0.524 (4.75)**	0.506 (3.52)**	0.325 (2.81)**	0.359 (2.74)**
SR	0.144 (-1.83)	0.193 (2.10)*	0.063 (-0.93)	0.109 (-1.64)
Uncertainty coefficients				
LR		-0.488 (2.44)*		-0.315 (2.28)*
SR		-0.024 (4.63)**		-0.02 (4.12)**
Private debt coefficients				
LR			0.173 (2.80)**	0.144 (2.37)*
SR			0.085 (8.25)**	0.085 (7.86)**
EC coefficient $y_{i,t-1}$	-0.042 (4.34)**	-0.048 (4.20)**	-0.051 (5.90)**	-0.056 (5.83)**
Observations	3545	2846	3363	2745
Countries	95	95	95	95
R-squared	0.15	0.18	0.23	0.28

Table 2. Linear dynamic models with and without additional controls – 2FE estimator
Robust t-statistics in parentheses. * significant at 5%; ** significant at 1%.
Source: Author's calculations.

Table 2 shows the long-run (LR) and short-run (SR) coefficients for both public and private debt as well as for capital and uncertainty. It also provides us with the error correction (EC) coefficient that represents the speed of adjustment for the economy to the long-run equilibrium and could be used to test for cointegration. As we can observe from Table 2, the statistical significance of this error correction term is confirmed at the conventional level of 1% for all models tested. This means that there is cointegration between the dependent variable and the explanatory variables in levels regardless of the specification. Also, it means that the economy returns to its long-run equilibrium path following a shock.

On the results obtained for public debt without controlling for uncertainty and private debt – column [1] or baseline model – and controlling for each and for both – columns [2-4] – the estimated coefficients for all different specifications show that only in the short-run is the public debt impact on GDP per capita growth statistically different from zero. In the first model this is true at the 5% significance level, while in the following models this effect is even stronger at 1% significance level. On the other hand, the capital stock coefficient showed to be positively related to per capita output growth rate and statistically significant at 1% in the long-run, with no significant effects on the short-run, except when only controlling for uncertainty – as column [2] shows. By adding the uncertainty index as a control, variations in the capital stock becomes statistically important also in the short-run, although in lower magnitude than in the long-run.

Still in column [2], both long-run and short-run coefficients estimated for the uncertainty level showed a negative significant effect on per capita GDP growth, stronger in the long-run. This means that higher levels of uncertainty are related to lower GDP per capita growth. column [3], based on the regression controlling for per capita private debt stock, reports positive private debt coefficients statistically significant both at the long-run and short-run at 1%. This mean that an increase in the private debt stock is related to higher GDP per capita growth. As before, both columns [2-3] still present public debt coefficients only significant in the short-run, although statistically more significant – at 1% now.

Finally, focusing on the results obtained from Equation (4') in the last column of Table 2, that is, taking into account both uncertainty and private debt as controls in the same regression, the mentioned significant effect of public debt in the short-run increases. This means that a 10-percentage point increase in the per capita public debt stock is, on average, associated with an approximately 0.3 basis point reduction in GDP per capita growth rate in the short-run. In the baseline model, this reduction effect was approximately 0.2. Overall, uncertainty and private debt as additional controls simultaneously showed to be statistically significant in the long-run and short-run, with higher effects on the long-run.

As in model [3], the results from model [4] using private debt stock variable as a control also imply a significant reduction on the positive effect of capital stock on output growth rate in the long-run, when compared to the first two models without such control. However, such effects remain significant at 1%. This indicates some covariance between capital stock and private debt, which resulted in upward biased estimates for capital stock coefficients in the absence of this control. This overestimated value should, therefore, be solved by including the private debt as an explanatory variable in the regression model, such that I avoid leaving out relevant information about the output growth performance due to misspecification.

With such preliminary results, we can say that not only uncertainty but also private debt seem to be associated with output growth in the short-run and long-run, even though we could not see it from the descriptive plots before (Figures 9 an 10). Furthermore, adding both as controls allows us to observe a slightly more detrimental effect of government debt on output fluctuations. This means that the baseline results on the effect of public debt (without any of the two candidate controls) is potentially downward biased. This might be attributed to uncertainty and private debt as direct drivers of economic growth or, in a more complicated case, as they both closely proxying some of the actual drivers of economic growth. That is, they could be possibly correlated with some other unobserved factors causing economic growth. If, for instance, uncertainty is a good representation for a crisis of confidence, as it is highly correlated with increased volatility (see Section 3.2), this covariate might be in fact capturing the effect of another related source of economic growth, namely confidence.

With that being said, it is time to finally turn to an analysis based on somewhat more sophisticated regressions. In the next Section, I present the results based on similar empirical equations of interest using, however, a different estimator known by its ability of allowing for observed and unobserved heterogeneity across countries.

5.2 CCE Model Results

To address my main concern over cross-sectional dependence arising from unobserved common factors that tend to affect all units in a different way (e.g., global shocks that differ in their impact across countries), I use the common correlated effects (CCE) estimator. The idea here is to check whether this estimator, refereed to more appropriated for non-homogenous relationships, modifies the previous results. As described in the last Chapter, the simple augmentation of the regression equation is capable of considerably reducing the cross-section dependence, avoiding the potential heterogeneity misspecification in the debt–growth relationship.

This is important because spurious estimates for my parameters of interest may appear in this investigation if heterogeneous relationships are erroneously modelled as common across countries. Therefore, I now move from a pooled specification to a heterogenous parameter model by augmenting the country regressions with the cross-section averages of the dependent and independent variables without the new controls – as in Equation (5) – and with the new controls (uncertainty and private debt) – as in Equation (6). The results from the empirical models allowing for i) cross-country heterogeneity in all long-run and short-run parameters; and ii) unobserved time-varying heterogeneity are reported in Table 3.

CCE	Δ ln(gdp) [1]	Δ ln(gdp) [2]	Δ ln(gdp) [3]	Δ ln(gdp) [4]
Public debt coefficients				
LR	-0.027 (-1.58)	-0.024 (-1.17)	-0.015 (-0.58)	-0.051 (2.14)*
SR	-0.014 (-1.86)	-0.014 (-1.43)	-0.029 (3.09)**	-0.029 (2.49)*
Capital coefficients				
LR	-0.213 (2.44)*	-0.425 (3.04)**	0.254 (2.26)*	-0.192 (-1.39)
SR	0.295 (3.62)**	0.157 (-1.14)	-0.006 (-0.06)	0.093 (-0.65)
Uncertainty coefficients				
LR		-0.039 (-1.12)		-0.018 (-0.72)
SR		-0.016 (-1.91)		-0.007 (-1.12)
Private debt coefficients				
LR			0.126 (3.27)**	0.033 -0.94
SR			0.103 (7.91)**	0.11 (5.79)**
EC coefficient $y_{i,t-1}$	-0.389 (9.87)**	-0.38 (7.14)**	-0.285 (7.84)**	-0.448 (7.82)**
Observations	3545	2648	3333	2142
Countries	95	81	93	60

Table 3. Linear dynamic models with and without additional controls – CCE estimator
Robust t-statistics in parentheses. * significant at 5%; ** significant at 1%.
Source: Author's calculations.

Although computed with a different methodology, estimates for the same parameters in short-run and long-run from the previous Table 2 are reported now in Table 3. The coefficient estimates for the cross-section averages added are not reported since they are only meant to purge the effect of unobservable and omitted elements of the cointegration relationship. As before, the error correction term is still significative at 1%, indicating cointegration and justifying the use of the ECM representation. The baseline specification in column [1] already indicates some important changes, once the debt coefficients this time seem to not be statistically relevant at all, both in the short-run and long-run.

However, when looking at the results in columns [3] and [4], it is possible to see that once I control for private debt, public debt turns to be significant and has much higher effect on growth, compared to columns [1] and [2]. A possible reason is that public and private debt are positively correlated and have opposite effects on growth, thereby when controlling for private debt the estimated effect of public debt becomes bigger (in absolute terms). In column [4], the public debt coefficient is relevant at the 5% level in both time horizons. In the short-run, a 10 percentage point increase in the per capita public debt stock is, on average, associated with an approximately 0.3 basis point reduction in GDP per capita growth rate in the short-run, exactly as with the 2FE estimator. In the long-run, though, the effect now is significantly stronger: a 10 percentage point increase in the per capita public debt stock is, on average, associated with an approximately 0.5 basis point reduction in GDP per capita growth rate.

Still considering the model from column [4], capital and uncertainty coefficients are not significant, assuming no role as drivers of output performance. Private debt, however, still seems to be statistically important in the short-run, carrying a positive effect on growth: a 10 percentage point increase in the per capita private debt stock increases, on average, the GDP per capita growth rate by approximately 1.1 basis point. Back to the literature presented in Section 3.3, this positive coefficient estimate could be attributed to better functioning credit markets meaning greater access to credit such that firms holding productive projects can easier get the financing needed and achieve a better allocation of capital towards higher output.

Once I control for capital, the effect of private debt cannot be purely attributed to investments increasing the capital stock and thus output. Instead, this could be explained by private debt allowing improvements on overall productivity by better allocation of capital across projects. As part of the literature mentioned in see Section 3.3 (Levine, 2004; Varela, 2018; Verner, 2019), an economic reason for this fact may be that better conditions in the credit markets facilitate better allocation towards the purchase of more productive resources and thus higher growth.

The absence of long-run relationships between output growth and the candidate controls – uncertainty and private debt – is in line with the flat fitted lines in Figures 9 and 10 from Section 4.1. Nevertheless, it should be noted that this time the different models (columns) report results which are not anymore based on the same number of observations and countries. Once I add cross-section averages, the limited data with World Uncertainty Index (WUI) as a proxy to measure uncertainty reduces the panel since some countries are missing values at the first years of the sample. Using a restricted amount of data is likely to affect results, once I am likely missing sources of variation that are relevant for the overall estimates.

Based on these findings and considering the heterogeneous dynamic regression models with the CCE estimator as more appropriate to deal with likely endogeneity issues, I can after all infer that: i) the government debt is negatively associated with economic growth both in the short-run and long-run, with the latter effect being larger; ii) the contribution of capital stock and uncertainty to economic performance does not seem to be driving growth; and iii) the private debt accumulation indeed matter for GDP growth in the short-run, and in a positive way – in line with private debt booms episodes following credit deepening moments.

This could explain why private debt seems to be associated with economic growth in the opposite direction found for government debt in the short-run. However, interpreting this positive association between private debt and output growth requires attention, since we saw in the literature that this could be expected both before and after recessions episodes, but not during it. In fact, evidence usually shows that private debt burden makes future recessions deeper and longer. And, in some cases, the private debt even triggers the economic collapse afterwards, such that higher growth in times of debt booms turns to be followed by high volatility, growth slowdowns and severe financial crises, as in the Great Recession. The results are thereby in line with the idea that private debt can benefit growth on average, even though it increases the likelihood and the depth of economic crises, as the literature on crises typically finds – see Jordà et al. (2011) in Section 3.3. Therefore, the relevance of private debt confirms the need of considering debt burdens as whole, especially because many advanced economies hold multiple debt overhangs, as pointed by Reinhart et al. (2012b), see Section 3.3.

Nevertheless, the results from this section might be considered as more consistent than those found using the 2FE model since the heterogeneity issue in the CCE model specification is also extended to the unobservable determinants of growth. By controlling for other drivers of economic activity which are likely to be disregarded now, I can obtain more accurate estimates for the coefficients of the variables I indeed specified in my model. However, I shall mention again that, as before, the latter conclusions might reflect the case of significant variables as actually proxies of other determinants of economic growth, rather than its purely own effect. For instance, I found private debt to be significant for growth in the short-run, but it might be the case that this variable is instead approaching the effect of some driver of economic growth, which is closely related to private debt. In other words, private debt could be correlated with some other important variable which is not specified in the model and be capturing its effect.

5.3 Robustness Checks

In order to address some potential issues arising from sources of weakness in the main exercise above, I consider two robustness checks: the reverse causality and the non-linear relationship.

5.3.1 Reverse Causality

I start by testing an alternative specification to deal with the potential simultaneous relationship between public debt and economic growth. If this is the case, the measured debt-growth link cannot be entirely seen as from high debt towards lower growth and the consistency of the parameter estimates is likely to be distorted. The slower economic growth would, then, be driving the high debt build-up, not only the opposite. Besides the omitted variable bias which I tried to fix using additional controls and the CCE estimator, another source of endogeneity is the reverse causality. Therefore, to avoid the simultaneity bias producing inconsistent parameter estimates, I can either choose an ad hoc approach or an instrumental variable estimation.

As highlighted by Eberhardt and Presbitero (2015), standard instrumentation in a pooled empirical framework is not appropriate considering this setup. Not only it is difficult to find instruments which are both valid and informative, but I shall also consider the underlying equilibrium relationship differing across countries. An ad hoc solution seems, therefore, more feasible, which includes the common approach of lagging the suspected variables by one or more periods.

In this line, as mention in section 4.1, I follow Kumar and Woo (2010) strategy to handle it by using the initial level of government debt to estimate its impact on subsequent economic growth, rather than using the contemporaneous values of both series. By using the future output growth rates as the dependent variable, I am similarly using the lagged values of public debt (and all the variables) as regressors. The idea is that, although current growth might be affecting current debt accumulation (as well as capital stock, uncertainty, and private debt), it is unlikely that the past values of such variables are subject to the same concern.

The specifications are thus the same as in Equations (4) and (4') with the difference of using as the dependent variable the subsequent GDP per capita growth, that is, the GDP per capita growth five years ahead of the considered level of public debt. I still rely on a linear dynamic model, but back to the 2FE estimator since the cross-section averages from the CCE estimator structure would imply a mismatched control for heterogeneity. That is, I would purge the non-homogenous features but in different periods depending on the variable (lagged and non-lagged). Because of this, the 2FE model seemed more appropriate in this case. The corresponding results are reported in Table 4.

2FE	Δ ln(gdp_t+5) [1]	Δ ln(gdp_t+5) [2]	Δ ln(gdp_t+5) [3]	Δ ln(gdp_t+5) [4]
Public debt coefficients				
LR	-0.395 (-1.01)	-0.301 (-0.87)	-0.143 (-1.65)	-0.148 (-1.4)
SR	-0.008 (-1.26)	-0.003 (-0.4)	-0.009 (-1.32)	(-0.005) (-0.73)
Capital coefficients				
LR	1.464 (2.80)**	1.33 (2.95)**	0.291 (-1.72)	0.152 (-0.69)
SR	0.333 (4.14)**	0.346 (4.01)**	0.273 (3.73)**	0.23 (2.86)**
Uncertainty coefficients				
LR		0.361 (-0.4)		-0.169 (-0.42)
SR		0.003 -0.43		0.003 (-0.41)
Private debt coefficients				
LR			0.578 (3.88)**	0.669 (3.23)**
SR			0.004 (-0.57)	0.004 (-0.52)
EC coefficient $y_{i,t-1}$	-0.01 (-1.37)	-0.013 (-1.24)	-0.025 (3.54)**	-0.029 (2.61)**
Observations	3353	2719	3206	2640
Countries	95	95	95	95

Table 4. Linear dynamic models, subsequent growth as dependent variable – 2FE estimator
Robust t-statistics in parentheses. * significant at 5%; ** significant at 1%.
Source: Author's calculations.

By looking at the public debt and uncertainty coefficients on subsequent growth for all the four different specifications, we cannot observe any statistically significant effect both on short and long-run. For the uncertainty control variable, this is the same as what I found before. However, for public debt, this is different from what I have estimated in the last Section. By losing its significance once we consider an alternative dependent variable, which is meant to be appropriate to avoid the reverse causality problem, this suggests that the significant public debt effect estimated before was capturing some simultaneous relationship between GDP growth and public debt stock.

I shall mention that these findings are not in line with the results from Kumar and Woo (2010). They have found a negative and significant effect for the coefficients of initial debt on subsequent growth, ranging from -0.019 to -0.029 across their different estimation techniques. However, these results were obtained by controlling for other determinants of growth not included here, such as the initial levels of inflation, government size, trade openness, financial depth, among others. As my results in this exercise were obtained based on the 2FE estimator, I have lost the advantage of the CCE specification of controlling for the unobservable determinants of growth, which is likely to affect the estimates.

Also differing from before, the capital coefficients now turned to be significant at 1% for the specifications of columns [1-2], carrying a positive impact on subsequent growth. These estimated effects, however, are not anymore significant in the long-run and decline in the short-run once we include the private debt control. As the short-run coefficient for capital on forward growth becomes relevant in this alternative specification, we can say that the simultaneous estimation procedure (both variable in period t) used in our main regressions before was not appropriate. That is, the regression of GDP growth on the same period level of capital was not able to capture in the correct way the role of capital stock as a driver of economic growth. If we consider that capital accumulation takes time to build productive capacity, which is a determinant for output performance, the result from this robustness exercise makes more sense than the one previously obtained.

Finally, the private debt coefficients have also changed. While in the short-run the initial private debt stock turned to not be significant anymore, in the long-run its effect has significantly increased in magnitude. Based on this exercise, a 1 percentage point increase in the initial private debt-to-GDP ratio is associated with an impulse of around 0.67 in subsequent growth in real GDP per capita. This positive effect is still in line with the better capital allocation hypothesis that links corporate debt booms to higher economy growth, although some caution is needed when interpreting it given the phase of the economic cycle.

5.3.2 Non-linear Relationship

The second robustness exercise addresses the possibility of a misspecification in case the debt-growth relationship turns to be, in practice, non-linear. The related literature, as in Reinhart and Rogoff (2010a), report some evidence of common or country-specific thresholds (or high vulnerability regions), beyond which the relationship between public debt and economic growth changes in magnitude. The most common practice to add non-linearity to a model is by including the quadratic version of a specific continuous variable. For this exercise, I employ a polynomial in public debt, that is, I consider both the linear and the squared per capita public debt stock variable in the regression. This approach was also conducted by Eberhardt and Presbitero (2015) with the same purpose.

So far, I have employed dynamic linear models. Now, I turn to a static non-linear regression model. This simple specification was employed by the study I build on since reconciling non-linearities with cross-sectional dependence, parameter heterogeneity and a dynamic specification within a panel of moderate time series dimension represents a problem of high complexity. This is the reason why I employ again the pooled two-way fixed effects (2FE) estimator. However, by allowing country-specific non-linearities through the squared term, I can measure if the marginal effect of higher public debt depends on its prevailing level. The benchmark estimation equation is thus:

$$y_{it} = \alpha_i + \beta_i^K cap_{it} + \beta_i^{DL} debt_{it} + \beta_i^{DS} debt_{it}^2 + \lambda_i \boldsymbol{f}_t + \varepsilon_{it} \quad (7)$$

Other than that, I also run the corresponding model now including the candidate controls – uncertainty and private debt – as before, both individually and simultaneously, as in Equation (8). Table 5 reports the results.

$$y_{it} = \alpha_i + \beta_i^K cap_{it} + \beta_i^{DL} debt_{it} + \beta_i^{DS} debt_{it}^2 + \beta_i^P pdebt_{it} + \beta_i^U wui_{it} + \lambda_i \boldsymbol{f}_t + \varepsilon_{it} \quad (8)$$

2FE	ln(gdp) [1]	ln(gdp) [2]	ln(gdp) [3]	ln(gdp) [4]
Public debt coefficients				
Linear	-0.221	-0.197	-0.155	-0.127
	(2.39)*	(2.13)*	(-1.95)	(-1.62)
Squared	0.019	0.016	0.013	0.011
	(3.38)**	(3.06)**	(2.81)**	(2.48)*
Capital coefficient	0.623	0.64	0.303	0.31
	(16.41)**	(18.13)**	(5.63)**	(6.36)**
Uncertainty coefficient		0.016		-0.007
		(-0.45)		(-0.18)
Private debt coefficient			0.231	0.228
			(10.01)**	(10.41)**
Observations	3592	3134	3409	3005
Countries	95	95	95	95

Table 5. Static non-linear models – 2FE estimator

Robust t-statistics in parentheses. * significant at 5%; ** significant at 1%.

Source: Author's calculations.

The estimates reported in column [1] based on the benchmark model, that is, only controlling for the capital stock, show that both linear and squared public debt coefficients are statistically significant at 5% and 1%, respectively. Based on this result, I can say that, by not including the quadratic version of the government debt into the regression, the main results from Section 5.2 are less robust given the misspecification of the non-linear debt-growth relationship. The positive sign of the coefficient estimated for the squared public debt as a predictor indicates that the curve is convex, meaning that the marginal negative effect of more public debt on growth decreases in debt.

In other words, the effect of public debt on growth is on average smaller, the more debt countries hold from before. It is worthy to emphasize that this average effect could be driven by: i) major strong economies being more able to sustain higher levels of debt over time than others; and ii) lower cost of debt in the low-interest-rate environment set by eased monetary conditions after the Global Financial Crisis. This smooth curve does not support the existence of the debt threshold effects from Reinhart et al. (2003), Cordella et al. (2005), Reinhart and Rogoff (2010a), see Section 3.1, even though these authors themselves claim that it is difficult to identify a common debt threshold across countries.

The uncertainty coefficient, by its turn, remains insignificant as previously. The results reported in column [2] are, therefore, close to the baseline model. However, once I add the private debt stock as a control variable in the model adopting the polynomial specification for public debt, columns [3-4], the parameter estimate for the linear public debt term is not statistically significant anymore. The squared term remains significant at 1% when only adding the private debt as a control, and at 5% when adding both uncertainty and private debt as controls. The positive explanatory power of private debt for economic growth is, as the results obtained from previous exercises, highly significant. Again, this finding is in line with part of the literature indicating that more options on debt tools arising from credit deepening allow firms to improve their capital allocation such that gains in productivity lead to higher growth.

Here, I emphasize some important caveats. First, while some economic models stablish that private debt booms anticipate stronger economic growth, such episodes of debt accumulation are not exogenous events and likely coincide with other expansionary forces. For instance, periods of higher credit supply facilitate not only the economy's productive capacity, but also the expansion in demand. Dealing with other effects of credit cycles driving output, else than productive investments financed with private debt, represents a central task for future research. Secondly, another point that could be addressed deeper by next studies is the extent to which the positive effect observed for private debt on growth binds. Instead of boosting output, debt booms may become too excessive, increase the financial vulnerability, and sow the seeds of future economic slowdowns. Therefore, some turning points for private debt also deserve to be investigated further. Finally, another interesting investigation could address the trade-off between crises and long-run growth implied by private debt here. As private debt can increase both growth and the probability of crisis, it could be that private debt still be well worth it.

Chapter 6 – Conclusion

This thesis investigated the effect of public debt on economic growth by controlling for two potential sources of heterogeneity behind the growth determinants: uncertainty and private debt. The inclusion of both additional controls represented an extension of the analysis provided by Eberhardt and Presbitero (2015). First, the struggle with record debt levels after the Great Recession, and more recently, with the COVID-19 pandemic, has been surrounded by unprecedented levels of macroeconomic uncertainty. Second, most of the advanced economies hold multiple debt overhangs. Thereby it is not reasonable to consider public and private debt separately. To consider the variety of time and country-specific characteristics, I conducted an empirical research for a panel of 95 countries from 1960 to 2015, employing the Common Correlated Effects (CCE) estimator. This estimator can address the problem of the omitted-variable bias by controlling for both observed and unobserved heterogeneity across time and cross-sectional dimensions. The strategy of this thesis to approach the growth dynamics focused on a core set of explanatory variables that are consistently related to growth performance - capital and private debt stocks as well as uncertainty - rather than considering an array of potential determinants.

The main results (CCE estimates) suggested a significant negative effect of government debt on economic growth (-0.029) in the short-run once I control for private debt. Capital stock, by its turn, has not shown to be statistically relevant. In contrast, private debt seems to be associated with economic growth in the short-run in the opposite direction found for government debt. While also controlling for capital stock, such a positive impact is in line with the theory that private debt can benefit growth on average – through better capital allocation opportunities – even though it increases the likelihood and the depth of economic crises. I did not find strong evidence that uncertainty explains growth both in the long-run and short-run or affects the role estimated for public debt.

Robustness checks suggested that the negative relationship between public debt and economic growth is sensitive to the reverse causality problem and the non-linear specification between these variables. The latter indicated a convex curve, meaning that the marginal negative effect of more public debt on growth decreases in debt. This finding is likely to be biased by large stable economies being more able to tolerate higher debt levels than others or by the historically low-interest rates observed in the last years across many economies, meaning less costly debt. Including time and country-specific threshold effects for public debt represents a big challenge for future research, as these are either unobserved or difficult to capture in an empirical setup. Turning points for private debt and its resulting trade-off between economic crises and long-run growth is another topic that could be investigated further.

References

Aghion, P., Dewatripont, M., & Rey, P. (1999). Competition, financial discipline and growth. *The Review of Economic Studies*, *66*(4), 825-852.

Ahir, H., Bloom, N., & Furceri, D. (2018). The world uncertainty index. *Available at SSRN 3275033*.

Apergis, N., & Cooray, A. (2016). Debt uncertainty and economic growth: evidence from five highly indebted Eurozone countries. *Applied Economics Letters*, *23*(3), 171-174.

Arnone, M., & Presbitero, A. F. (2007). External debt sustainability and domestic debt in heavily indebted poor countries. *Rivista Internazionale di Scienze Sociali*, 187-213.

Banerjee, A., & Carrion-i-Silvestre, J. L. (2017). Testing for panel cointegration using common correlated effects estimators. *Journal of Time Series Analysis*, *38*(4), 610-636.

Berlemann, M., & Wesselhöft, J. E. (2014). Estimating aggregate capital stocks using the perpetual inventory method. *Review of economics*, *65*(1), 1-34.

Bernanke, B. S., Campbell, J. Y., Friedman, B. M., & Summers, L. H. (1988). Is there a corporate debt crisis? *Brookings Papers on Economic Activity*, *1988*(1), 83-139.

Bivens, J. (2016). Why is Recovery Taking So Long – and Who's to Blame? *Economic Policy Institute.*

Blavy, R. (2006). *Public Debt and Productivity; The Difficult Quest for Growth in Jamaica* (No. 06/235). International Monetary Fund.

Bloom, N. (2007). *The Impact of Uncertainty Shocks* (No. w13385). National Bureau of Economic Research.

Bloom, N. (2014). Fluctuations in uncertainty. *Journal of Economic Perspectives*, *28*(2), 153-76.

Bornhorst, F., & Arranz, M. R. (2014). Growth and the Importance of Sequencing Debt Reductions across Sectors. In *Jobs and Growth: Supporting the European Recovery*. International Monetary Fund.

Cecchetti, S., Mohanty, M., & Zampolli, F. (2011). *The real effects of debt* (No. 352). Bank for International Settlements.

Checherita-Westphal, C., Hughes Hallett, A., & Rother, P. (2014). Fiscal sustainability using growth-maximizing debt targets. *Applied Economics*, *46*(6), 638-647.

Chen, W., Mrkaic, M., Nabar, M. S., & Celasun, O. (2019). The Global Economic Recovery 10 Years After the 2008 Financial Crisis, *IMF Working Papers*, *2019*(083), A001.

Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, *188*(2), 393-420.

Cordella, T., Ricci, L. A., & Ruiz-Arranz, M. (2005). *Debt Overhang or Debt Irrelevance? Revisiting the Debt-Growth Link* (No. 2005/223). International Monetary Fund.

Dell'Erba, S., Hausmann, R., & Panizza, U. (2013). Debt levels, debt composition, and sovereign spreads in emerging and advanced economies. *Oxford Review of Economic Policy*, *29*(3), 518-547.

Dijkstra, G., & Hermes, N. (2001). *The Uncertainty of Debt Service Payments and Economic Growth of HIPCs: Is There a Case for Debt Relief?* (No. 2001/122). WIDER Discussion Paper.

Eberhardt, M., & Presbitero, A. F. (2015). Public debt and growth: Heterogeneity and non-linearity. *Journal of international Economics*, *97*(1), 45-58.

Eberhardt, M., & Teal, F. (2011). Aggregation versus heterogeneity in cross-country growth empirics. *CREDIT Research Paper*, (11/08).

Elmeskov, J., & Sutherland, D. (2012). Post-crisis debt overhang: growth implications across countries. *Available at SSRN 1997093*.

Fukač, M., & Kirkby, R. (2017). Accounting for uncertainty in public debt targets. *Australian Economic Review*, *50*(1), 89-102.

IMF. (2018). *World Economic Outlook 2018: Challenges to Steady Growth*. International Monetary Fund.

Jordà, Ò., Kornejew, M., Schularick, M., & Taylor, A. M. (2020). *Zombies at large? Corporate debt overhang and the macroeconomy* (No. w28197). National Bureau of Economic Research.

Jordà, Ò., Schularick, M. H., & Taylor, A. M. (2011). *When credit bites back: leverage, business cycles, and crises* (No. w17621). National Bureau of Economic Research.

Jordà, Ò., Schularick, M., & Taylor, A. M. (2014). Private credit and public debt in financial crises. *FRBSF Economic Letter*, *7*.

Jovanovic, B., & Ma, S. (2020). *Uncertainty and Growth Disasters* (No. w28024). National Bureau of Economic Research.

Koh, W. C., Kose, A., Nagle, P. S. O., Ohnsorge, F. L., & Sugawara, N. (2020). *Debt and Financial Crises* (No. 9116). The World Bank.

Krugman, P. (1988). Financing vs. forgiving a debt overhang. *Journal of development Economics*, *29*(3), 253-268.

Kumar, M. S., & Woo, J. (2013). Public Debt and Growth. *Fiscal Policy and Growth*, 173.

Levine, R. (2005). Finance and Growth: Theory and Evidence. *Handbook of Economic Growth*, *1*, 865-934.

Liu, Y., & Rosenberg, C. Dealing with Private Debt Distress in the Wake of the European Financial Crisis A Review of the Economics and Legal Toolbox. *Journal Issue*, *2013*, 44.

Lo, S., & Rogoff, K. (2015). Secular stagnation, debt overhang and other rationales for sluggish growth, six years on. *BIS Working Papers*, (482).

Loayza, N., & Ranciere, R. (2004). *Financial development, financial fragility, and growth*. The World Bank.

Mann, C. L. (2016). Deploy effective fiscal initiatives and promote inclusive trade policies to escape from the low-growth trap. *ECOSCOPE, November*, *28*.

Matiti, C. (2013). The relationship between public debt and economic growth in Kenya. *International Academic Journal of Information Sciences and Project Management*, *1*(1), 65-86.

Mbaye, S., Badia, M. M., & Chae, K. (2018). *Global Debt Database: Methodology and Sources* (No. 2018/111). International Monetary Fund.

Mendoza, E. G., & Oviedo, P. M. (2009). Public debt, fiscal solvency and macroeconomic uncertainty in Latin America: the cases of Brazil, Colombia, Costa Rica and Mexico. *Economía mexicana. Nueva época*, *18*(2), 133-173.

Mian, A., Sufi, A., & Verner, E. (2017). Household debt and business cycles worldwide. *Quarterly Journal of Economics*, *132*(4), 1755-1817.

Nguyen, T. Q., Clements, B. J., & Bhattacharya, R. (2003). *External Debt, Public Investment, and Growth in Low-Income Countries* (No. 2003/249). International Monetary Fund.

OECD. (2016). *OECD Economic Outlook, Volume 2016 Issue 2*. Organization for Economic Co-operation and Development.

Padoan, P. C. (2014). Editorial Avoiding the low-growth trap. *Economic Policy Reforms*, 4.

Pattillo, C., Poirson, H., & Ricci, L. (2002). External debt and growth. *Finance & Development*, *39*(2), 32-32.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, *74*(4), 967-1012.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of econometrics*, *68*(1), 79-113.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American statistical Association*, *94*(446), 621-634.

Randveer, M., Kulu, L., & Uusküla, L. (2011). *The impact of private debt on economic growth*. Eesti Pank.

Reinhart, C. M., & Rogoff, K. S. (2009). The aftermath of financial crises. *American Economic Review*, *99*(2), 466-72.

Reinhart, C. M., & Rogoff, K. S. (2010a). *Debt and Growth Revisited* (No. 24376). University Library of Munich, Germany.

Reinhart, C. M., & Rogoff, K. S. (2010b). Growth in a Time of Debt. *American economic review*, *100*(2), 573-78.

Reinhart, C. M., & Rogoff, K. S. (2011). From Financial Crash to Debt Crisis. *American Economic Review*, *101*, 1676-1706.

Reinhart, C. M., Reinhart, V. R., & Rogoff, K. S. (2012a). Public debt overhangs: advanced-economy episodes since 1800. *Journal of Economic Perspectives*, *26*(3), 69-86.

Reinhart, C. M., Reinhart, V. R., & Rogoff, K. S. (2012b). *Debt overhangs: Past and present* (No. w18015). National Bureau of Economic Research.

Reinhart, C. M., Rogoff, K. S., & Savastano, M. A. (2003). *Debt intolerance* (No. w9908). National Bureau of Economic Research.

Reza, A., & Sarker, S. (2015). Is Slower Growth the New Normal in Advanced Economies? *Bank of Canada Review*, *2015*(Autumn), 1-13.

Rogoff, K. (2016). Debt supercycle, not secular stagnation. *Progress and confusion: the state of macroeconomic policy*, 19-28.

Schularick, M. (2014). Public and private debt: the historical record (1870–2010). *German Economic Review*, *15*(1), 191-207.

Summers, L. H. (2014a). US economic prospects: Secular stagnation, hysteresis, and the zero lower bound. *Business economics*, *49*(2), 65-73.

Summers, L. H. (2014b). Reflections on the 'new secular stagnation hypothesis'. *Secular stagnation: Facts, causes and cures*, (27-38).

Varela, L. (2018). Reallocation, competition, and productivity: Evidence from a financial liberalization episode. *The Review of Economic Studies*, *85*(2), 1279-1313.

Verner, E. (2019). Private Debt Booms and the Real Economy: Do the Benefits Outweigh the Costs? *Available at SSRN 3441608*.

Appendix

Appendix Section 4.2.2 - The Common Correlated Effects Estimator's assumptions:

ASSUMPTION 1 — Common Effects: The $(n + m) \times 1$ vector of common effects is covariance stationary with absolute summable autocovariances, distributed independently of the individual-specific errors ε_{it} and $\boldsymbol{v}_{it}$ for all *i*, *t*, and *t'*.

ASSUMPTION 2 — Individual-Specific Errors: The individual-specific errors ε_{it} and $\boldsymbol{v}_{it}$ are distributed independently *i*, *j*, *t*, and *t'*.

ASSUMPTION 3 — Factor Loadings: The unobserved factor loadings $\boldsymbol{\gamma}_i$ and $\boldsymbol{\Gamma}_i$ are independently and identically distributed across the *i*-units, the individual specific errors, and the common factors, with fixed means $\boldsymbol{\gamma}$ and $\boldsymbol{\Gamma}$, respectively, and finite variances.

ASSUMPTION 4 — Random Slope Coefficients: The slope coefficients $\boldsymbol{\beta}_i$ follow the random coefficient model:

$$\boldsymbol{\beta_i} = \boldsymbol{\beta} + \mathrm{v}_i \qquad \mathrm{v}_i \sim IID(0, \Omega_{\mathrm{v}})$$

where the random deviations v_i are independently distributed and Ω_{v} is a (k x k) symmetric nonnegative definite matrix.

ASSUMPTION 5 — Identification of $\boldsymbol{\beta_i}$ and $\boldsymbol{\beta}$: Consider the cross-section averages of the individual-specific variables $\boldsymbol{z_{it}} = \begin{pmatrix} y_{it} \\ \boldsymbol{x_{it}} \end{pmatrix}$, defined by $\boldsymbol{\bar{z}_{wt}} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{N}} w_j \boldsymbol{z_{jt}}$, with the weights $\{w_j\}$ that satisfy the following conditions:

i. $w_i = O\left(\frac{1}{N}\right)$, that is, the deterministic sequence w_i is at most of order (1/N).

ii. $\sum_{i=1}^{N} w_i = 1$

iii. $\sum_{i=1}^{N} |w_i| < K$

Although the consistent estimation of $\boldsymbol{f_t}$ (the vector of unobserved common effects) still requires knowledge of the underlying parameters, the individual slope coefficients of interest, $\boldsymbol{\beta_i}$ and their means $\boldsymbol{\beta}$, can be consistently estimated by augmenting the OLS or pooled regressions of y_{it} on $\boldsymbol{x_{it}}$ with $\boldsymbol{d_t}$ (the vector of observed common effects) and the cross-section averages above described $\boldsymbol{\bar{z}_{wt}}$. We, then, refer to such estimators as the common correlated effect estimator (CCE). Finally, the common correlated effects mean group (CCEMG) estimator is, then, the simple average of the individual CCE estimators.