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Government, Household and Corporate Debt - The Effect on Growth

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Abstract

According to Reinhart and Rogoff (2009), credit booms have been associated with financial instability and crisis for as long as 800 years. Notwithstanding, the debate on the sustainability of increased indebtedness in the world economy has regained importance, as trends for both public and private debt show rapid rises in the last three decades. To understand the effect of debt accumulation on growth, there is a need to look comprehensively at all forms of non-financial debt – household, corporate and government debt. Using panel data on 20 advanced economies between the years 1980-2014, this essay investigates the relationship between public (government) and private (household and corporate) debt growth and economic growth. This is done through a dynamic panel data model that is estimated using both a system GMM estimator and a bias corrected OLS estimator. Both short- and long-term effects are considered in the model. Potential non-linear effects are studied as well. In addition to GDP growth, the effect of debt on capital growth, TFP growth and private consumption growth is modeled in an effort to examine potential channels through which debt is likely to affect growth. The results show that there is a relationship between both public and private debt and growth. However, the relationship differs in the short- and long-term and is more complex for private debt. The main finding is that public debt growth seems to pose a larger problem for economic growth in the short-term, while there should be a greater concern regarding household debt growth in the longer run. Furthermore, this thesis finds nonlinear relationships between growth of public and private debt and GDP growth, both in the short-term and long-term analysis. Hence, reductions of debt are associated with higher GDP growth, while debt accumulation is associated with lower GDP growth. However, the results are only significant on the short-term basis. The negative effect on GDP growth from both public and private debt primarily operates through lower capital and TFP growth. In regards to private consumption, some evidence is provided to the notion that both public and private debt growth crowds out private investments, reducing capital accumulation and long run growth.

Keywords: Public debt, private debt, corporate debt, household debt, credit booms, economic growth, capital stock, TFP, household consumption, financial crisis

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1 Introduction

Credit booms have been associated with financial instability and financial crises for as long as 800 years according to Reinhart and Rogoff (2009). Historically, only a minority of these booms have ended in crashes. However, some of these crashes have been significant, contributing to the belief that credit booms are at worst a recipe for disaster and at best dangerous (IMF, 2012). Despite this, the global financial crisis in 2007, preceded by a private credit boom, marked the beginning of an intense policy debate on the need to monitor the role of indebtedness in the world economy (Schularick and Taylor, 2012). The main reason is the rapid increase of private and public borrowing in many advanced countries, raising questions of the long-term sustainability of credit expansions. There is also a growing recognition that the interplay between public and private debt carries weight for macroeconomic outcomes and financial stability (Reinhart et al., 2012). Hence, there is a need to look comprehensively at all forms of non-financial debt – household, corporate and government debt – to understand its effect on growth (Cecchetti et al., 2011).

Average total debt for advanced economies, including both public and private debt, has increased substantially from 130 percent of GDP in the 1980s to approximately 270 percent of GDP in 2014 (BIS, 2015). Financial liberalization and higher private sector debt are the main drivers behind this increasing trend (Taylor, 2012). Debt accumulation can affect economic growth in either a positive or a negative direction. A positive effect may arise as debt facilitates consumption smoothing and investments, in turn raising capital and technology (Cecchetti et al., 2011). This effect is more likely on the short-term as debt boosts aggregate demand. On the longer run however, debt can affect growth negatively by crowding out private investments, inducing financial instability and crisis as well as draining productive sectors of the economy of workers as the financial sector grows (Elmendorf and Mankiw, 1999; Rajan, 2005; and Kneer, 2013). The way in which debt affects growth should also depend on whether lending feeds speculative bubbles or finance investment in productive assets (Arcand et. al., 2015).

There is a broad collection of empirical research examining the relationship between debt and economic growth. Appendix 1 includes a list of selected papers, covering descriptions of studies, samples, methods and main findings. Previous research findings show an impact from debt on growth, but the relationship appears complex. Focus is largely put on nonlinear relationships and threshold estimations, where the majority of studies find a positive effect on growth from low levels of debt, while high[1] levels of debt is associated with lower growth (see e.g. Reinhart and Rogoff, 2010; Checherita-Westphal and Rother, 2012; Arcand et al., 2015). Arguably the most influential and controversial contribution is the one put forward by Reinhart and Rogoff (2010), showing that public debt/GDP levels above 90 percent are associated with significantly lower growth. However, in a famous replication and critique, Herndon et al. (2013) concludes that debt does not dramatically

[1] The definition of *high* debt levels differs but the conventional view from previous research is that debt/GDP ratios above 80-100 percent starts to become harmful for the economy (see e.g. Reinhart and Rogoff, 2010; Cecchetti et. al., 2011; and Reinhart et. al., 2012).

lower growth when correcting for coding errors. Along the same lines, several studies find no evidence of systematic nonlinearities (see e.g. Eberhart and Presbiter, 2015). Instead, as pointed out by Pescatori et al. (2014), the *debt trajectory* is important, as countries with high but declining debt seem to grow at an equally fast rate as countries with lower debt. There is also the question of causality when studying debt and growth, as most studies highlight the issue of endogeneity (Easterly, 2001; Panizza and Presbitero, 2014; and Reinhart et al., 2012). Easterly (2001) claims that the causality runs from slow growth to high debt, while Panizza and Presbitero (2014) find no causal relationship between public debt and growth.

Up until recently the literature has mainly focused on public debt[2] (see e.g. Égert, 2015; and Pescatori et al., 2014), while fewer have included private sector debt[3] (see e.g. Cecchetti et al., 2011). In research made, private debt is found to have a drag on growth above threshold levels of 80-100 percent of GDP (Arcand et al., 2015), similar to threshold levels found for public debt. Incorporating private (household and corporate) and public (government) debt is important in terms of policy insight, especially when analyzing debt dynamics around episodes of financial stress and crisis. Prior to the 2007 financial crisis, private sector debt rose fast in advanced countries, while there was a quick expansion of public debt in arrears (Dembiermont et al., 2015; Reinhart et al., 2012 and 2015). In addition, private sector credit booms are regarded good predictors of financial crises and should therefore be included in the analysis (Taylor, 2012; and Gourinchas and Obstfeld, 2012). Finally, a number of studies focus on the channels through which debt influences growth, where the negative relationship between debt and growth seems to originate from reduced investments, affecting both the capital stock and TFP negatively (Kumar and Woo, 2010; Pattillo et al., 2004; and Checherita-Westphal and Rother, 2012).

This essay attempts to provide additional evidence of the relationship between debt, both public and private, and economic growth by giving insights to the following questions: (i) if there is an impact from government, household and corporate debt on economic growth; (ii) if the impact differs on the short-term and long-term; (iii) if the impact is nonlinear[4]; as well as (iv) if the channels through which the impact is likely to occur are capital stock, TFP[5], and private consumption. The main contribution of this study is the extent of the analysis by including both public (government) and private (household and corporate) debt. In addition, research connecting both sectors and potential growth channels in terms of capital stock, TFP and private consumption has not been found. Both public and private debt should affect growth through the channels of capital and TFP as debt can

[2] Public debt is debt accumulated by central (federal) governments, state governments and municipalities. It can take different forms such as government bonds and sovereign debt (governments borrowing from each other) (Bloch and Fall, 2015; and Reinhart and Rogoff, 2011).

[3] Private debt is the debt accumulated by individuals and corporations and can take many forms such as personal loans, bank loans, credit card debt, corporate bonds and business loans (Dembiermont et. al., 2013; and Meakin, 2015).

[4] Where a concave (inverted U-shape) relationship is expected according to previous research (see Checherita-Westphal and Rother, 2012).

[5] Total factor productivity (TFP) is a measure of labor productivity and how productively the economy uses all factors of production (Aghion and Howitt, 2009:106).

boost consumption and investments in the shorter run (raising capital and technology), but crowd out private savings and investments in the log-run through higher private consumption (Kumar and Woo, 2010, and Pattillo et al., 2004). Hence, by including both a short-term and long-term analysis, it is possible to capture the dynamics of the growth-debt nexus.

In order to estimate the causal relationship between debt and growth, this thesis uses an empirical approach. The examination includes a panel of 20 advanced economies between the years 1980-2014. The estimation method is based on a dynamic panel data model that is estimated using both a system GMM estimator and a bias corrected OLS estimator. In addition to GDP growth, the effect of debt on capital growth, TFP growth and private consumption growth is modeled. The baseline model includes annual growth rates to capture short-term impacts of debt on growth. In addition, a long-term analysis is added by supplementing yearly data with five-year (non-overlapping) growth periods. Lastly, the model explores nonlinear relationships by including squared debt variables.

The results point to a relationship between both public and private debt and growth. However, the relationship differs in the short- and long-term and is more complex for private debt. Overall, few robust results are found for household and corporate debt. The main finding is that public debt growth seems to pose a larger issue for economic growth in the short-term, while there should be a greater concern regarding household debt growth in the long-term. Both in the short-term and long-term analysis, negative nonlinear relationships between growth of public and private debt and GDP growth are present. For that reason, reductions of debt are associated with higher GDP growth, while debt accumulation is associated with lower GDP growth. However, the results are only significant on the short-term basis. The negative effect on GDP growth from both public and private debt operates primarily through lower capital and TFP growth. Regarding private consumption, some evidence is provided to the notion that both public and private debt growth crowds out private investments, reducing capital accumulation and long run growth.

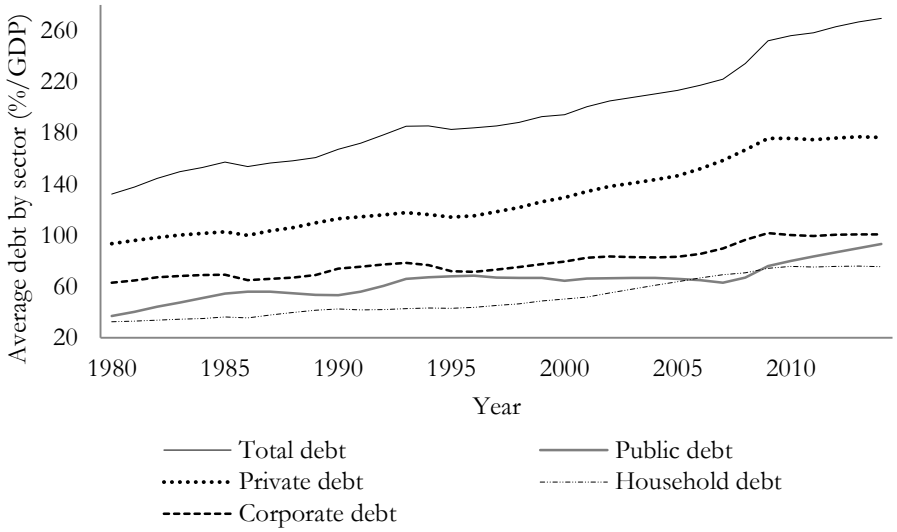
This thesis is organized as follows. Chapter two provides background information on trends of private and public debt, as well as potential explanations to the developments. Chapter three presents the theoretical framework and outlines the potential channels of impact from debt to growth. Chapter four presents the data and research method used. Chapter five presents the empirical results, divided into descriptive evidence and both a short-term and long-term analysis. Ultimately, chapter six outlines concluding remarks.

2 Trends of public and private debt

Advanced countries have witnessed a rise of indebtedness for the last three decades. Even though it is difficult to point to a specific cause, this increased borrowing has coincided with deeper financial market liberalization (Reinhart et al., 2012). Figure 1 shows average aggregate non-financial sector debt, and its composition, as a percentage of GDP between the years 1980-2014. Each year shows an average of the twenty advanced economies[6] used in the sample. *Total debt* is combined debt for government, household and (non-financial) corporations, while total *private debt* incorporates both household and (non-financial) corporate debt[7]. For simplicity, I will refer to government and public debt interchangeably throughout this thesis.

As shown in Figure 1, total debt as a percentage of GDP has increased substantially. Starting from approximately 130 percent of GDP in 1980, average total debt is now at levels of 270 percent of GDP. Mainly higher private debt drives this increase. More specifically, corporate debt accounts for 100 percentage points, household debt for 75 percentage points and public debt for the remaining 90 percentage points in 2014. Average annual growth rate of public debt is 1.7 percent between 1980 and 2014, while it is 2.6 percent for private debt. Hence, there is an increasing trend of debt to GDP ratios.

Figure 1. Average aggregate debt over the sample countries by sector, 1980-2014.



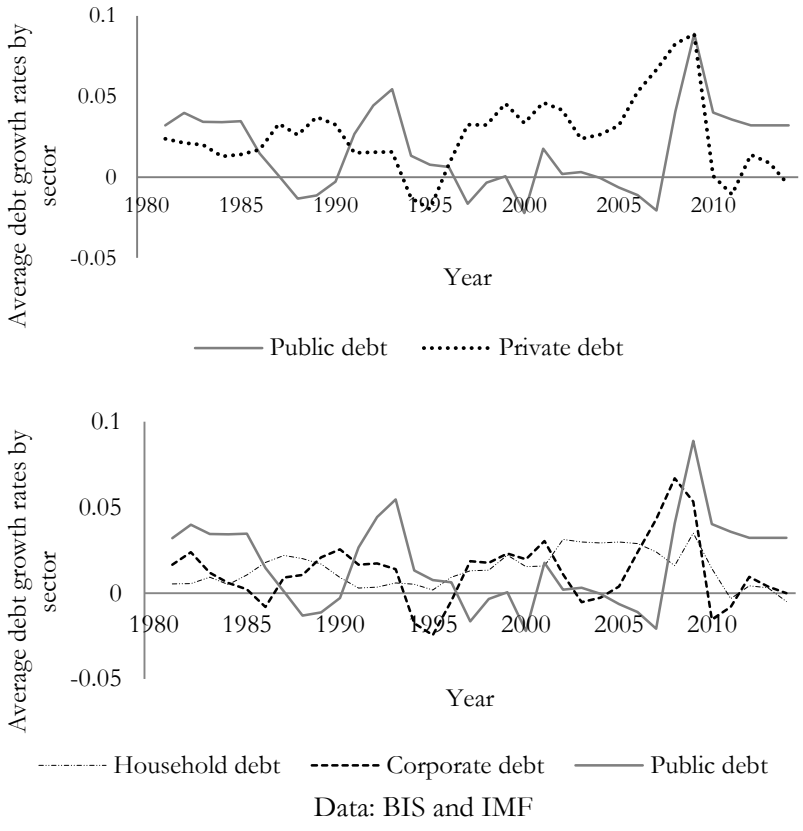
Data: BIS and IMF

[6] Countries included are: Australia, Belgium, Canada, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Italy, Japan, South Korea, Netherlands, Norway, Portugal, Sweden, Singapore, Turkey and United States.

[7] Government debt refers to the "general government" sector including central government debt (plus social security funds and extra budgetary-units), state and local government debt. Household debt also includes debt of non-profit institutions serving households and (non-financial) corporate debt includes the debt of public (non-financial corporations) (Bloch and Fall, 2015; and Dembiermont et al., 2013).

Incorporating both the public and private sector when studying debt sustainability is important, especially when analyzing developments of debt in connection to financial stress and crises (see e.g. Reinhart and Rogoff, 2009; and Reinhart et al., 2012). As seen in Figure 1, public debt levels is relatively stable compared to private debt levels between 1995 and 2005. Private debt on the other hand illustrates an upward trend, with an annual average growth rate of 2.7 percent during the same period. However, when the financial crisis hits in 2007, there is a sharp increase in public debt, while, private debt halts, stabilizing at approximately 175% of GDP (which must originate in a nominal decrease since GDP fell after the crisis). Illustrating average annual growth rates of debt/GDP ratios for the sample countries in Figure 2 further confirms this pattern.

Figure 2. Average growth rates in debt/GDP ratios over the sample countries by sector, 1980-2014.



Data: BIS and IMF

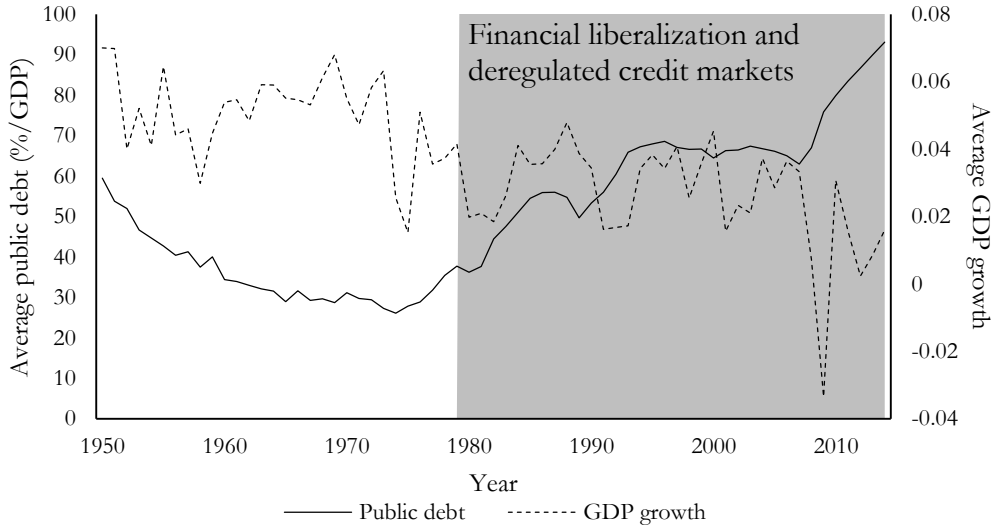
As seen in the top panel of Figure 2, the growth rate of public debt increases dramatically in connection to the financial crisis, while the decline in public debt after 2010 is less sharp than the decline in private debt. Notable is that there seems to be a negative covariation between public and private debt over time. In periods of low public debt growth there seems to be a period of high private debt growth and vice versa. This may reflect a countercyclical response of debt accumulation in periods of income movements (Barro, 1979). As highlighted previously, financial crisis (often preceded by a private sector boom) constrains government budgets and may trigger public debt increases to unsustainable levels. In addition, there are theories stating that the public perceives public debt as private debt, since public debt accumulation equals higher tax payments in the future. Hence, when public debt increases, households and corporations should reduce their share of private

debt in order to be able to meet future tax increases (see e.g. Friedman, 1987; and Barba and Pivetti, 2009).

As pointed out in Pescatori et al. (2014), it is important to study the debt trajectory of countries, as some countries experience increasing growth rates of debt while others have decreasing growth rates, potentially affecting economic growth differently. As is seen in the bottom panel of Figure 2, average growth rates of household debt are fairly stable within the time period, except between 1995-2007 where a clear upward trend is shown. Average growth rate of corporate debt fluctuates somewhat more and there is a stronger credit boom and bust pattern in connection to the crisis. Growth rates of public debt are more volatile throughout the period also showing more distinct boom and bust patterns. This also relates to mitigating business cycles and/or periods of financial instability, often by meeting economic downturns with increased spending financed by higher indebtedness (see e.g. Abbas et al., 2013).

Even though it is difficult to point to any specific cause of the increasing trend of indebtedness, it coincides with some important economic developments during the investigated period. To start, financial market activity and lending became less restricted and liberalized from the 1980s and forward. Together with technological developments and improvements, an innovative financial sector progressively developed. This led to a more efficient allocation of risk and a stable credit supply. Hence, increased indebtedness of the world has moved in tandem with financial reform (Cecchetti et al., 2011; Taylor, 2012; and Dynan et al., 2005). Figure 3 provides evidence to this notion by plotting historical data on public debt (solid line) between the years 1950-2014. There is a clear increasing trend of indebtedness beginning in the 1980s, as indicated in the shaded area. Taylor (2012) calls this era the "Age of Credit". Interestingly, there is no increasing trend of annual average GDP growth in the sample countries (dashed line) during this "financiation" of the world economy.

Figure 3. Average public debt and GDP growth over the sample countries, 1950-2014.



Data: IMF

Additional explanations to the increased trend of borrowing relates to the decline of worldwide real interest rates in the 1990s. *The global savings glut hypothesis* by Ben Bernanke tries to explain this new low interest rate era as a consequence of excess saving compared to investments in emerging markets, a preference that arose due to poor social safety nets and an ageing population (see e.g. Bernanke 2005; Bernanke et al., 2011; and Eichengreen, 2014)[8]. Last, tax policies might play an important role. Deductions of interest rates payments and tax reliefs for mortgage interest payments, along with subsidies, can explain the increased borrowing within both the corporate sector (which rather issue debt than equity) and the household sector (Cecchetti et al., 2011). Additional explanations to increased household debt relates to demographic changes in advanced countries, where demand for housing rises with baby booms (see e.g. Akerlof and Shiller, 2010). Research by Azzimonti et al. (2014) also points to a relationship between income inequality and increased borrowing, where higher income inequality leads to higher indebtedness. Whatever cause, the consequences prove clear. Governments, households and corporations have accumulated debt during a time of less financial regulations and there seems to be a strong interplay between public and private debt.

[8] See also *the secular stagnation hypothesis* by Larry Summers. However, this theory calls for even lower real interest rates, by lowering nominal rates below zero, to depart from stagnation (see e.g. Summers, 2015).

3 Debt and economic growth

A variety of theoretical and empirical research models that links debt and growth exist. The conventional view is that debt (reflecting deficit financing) can stimulate aggregate demand and output in the short run, but crowds out capital and reduces output in the long run (Kumar and Woo, 2010). This paper focuses on both the short and long run effects of debt on growth. It is important to note that there is a clear interaction between public and private debt. For instance, the public sector's ability to sustain a given level of debt depends on its fiscal capacity[9], which can be compromised if the private sector is highly indebted (Cecchetti et al., 2011, and Eggertson and Krugman, 2012).

Previous theoretical and empirical studies indicate several channels through which public and private debt can affect growth. This paper focuses on five main channels of impact relating to consumption smoothing, capital and technology, crowding out effects, crises, and brain drain. The first two channels have a positive effect on growth, while the last three channels have a negative effect on growth.

First, borrowing can help individuals, firms and governments to *smooth consumption* over time when incomes, sales and expenditures are variable. Public debt, in particular, can help smooth consumption across generations and hence reduce macroeconomic volatility[10]. To the extent that future generations will be richer than current ones, through a combination of more human capital and productive technology, society's intertemporal welfare increases when consumption is transferred from future to current generations (Cecchetti et al., 2011). By increasing the current disposable income of households, and in turn their lifetime wealth, aggregate demand is boosted (Elmendorf and Mankiw, 1999). Even with rising public debt levels, there is a positive effect on growth since the tax rise needed to fund higher consumption is postponed. Hence, debt through deficit financing can boost aggregate demand and output, at least in the short run (Cecchetti et al., 2011; Kumar and Woo, 2010; and Traum and Yang, 2010).

Second, debt facilitates investments that in turn boost growth by increasing *capital and technology* (Pattillo et al., 2004). As debt ease credit constraints faced by governments, households, and firms, there is a weaker dependency on domestic and private savings (Lane and Pels, 2012; Cecchetti et al., 2011). In addition, risk diversification increases as the financial system develops, improving capital allocation throughout the economy (Klein and Olivei, 2008; and Panizza, 2013). Hence, increased funds raise capital and facilitate the introduction and replacement of existing technology, boosting both the capital stock and TFP, which in turn affects growth positively.

Conversely, the effect on growth from debt can be negative. According to the third channel of impact, debt might *crowd out* private investments, mainly through increased consumption (Reinhart et

[9] The possibility to raise taxes to service the debt (Cecchetti et al., 2011).
[10] For instance, by financing lower taxes with increased indebtedness in economic downturns.

al., 2012). The argument is easiest explained in a closed economy set-up, but holds for open economies as well[11] (Bricongne and Mordonu, 2015). If a government increases debt, i.e. reduces tax revenues and holds spending constant, then the budget deficit will increase and public savings decrease. If private savings and/or capital inflows do not increase enough[12] to offset government borrowing, national savings decline and so forth total investment. Reduced investments affect the capital stock and labor productivity negatively, which in turn implies lower output and income (Elmendorf and Mankiw, 1999; Traum and Yang, 2010). The same reasoning holds for the private sector, where increased private consumption from higher private debt should reduce private savings and investments (Claessens et al., 2011; Borio, 2012; and Barba and Pivetti, 2009). Similarly, high debt burdens at the corporate level restrains turnover and investment growth, as profits planned for new investments are used to service existing liabilities (Randveer et. al., 2011).

The reasoning above also relates to *debt overhang theories* giving support to the crowding out channel (see e.g. Koeda, 2006). If there is a likelihood that future debt levels will be larger than the repayment ability, investors lower their expectations of returns as future taxes will be higher and progressively more distortionary to repay the debt. Thus, domestic and foreign investment is discouraged (Pattillo et al., 2002 and 2004). In addition, higher debt levels are more likely to be associated with higher long-term interest rates[13], higher inflation[14], and greater uncertainty and macroeconomic volatility affecting capital accumulation negatively (Kumar and Woo, 2010). This suggests that the nonlinear effects of debt on growth are likely to occur through lower capital accumulation (Pattillo et al., 2004, see also Krugman, 1988; and Sachs 1989). The crowding out of both public and private investments should also constrain growth by lowering TFP. For instance, investment strategies and productivity may be less efficient as additional government spending does not need to match additional tax revenue when increasing debt. In addition, when uncertainty increases, investment can be misallocated to activities with quick returns, neglecting a longer run focus (Pattillo et al., 2004; and Elmendorf and Mankiw, 1999). The way in which finance impact economic growth may also depend on whether lending finance investment in productive assets or feed speculative bubbles (Arcand et. al., 2015).

Forth, increased debt can induce *financial instability and crises* through higher risk-taking and macroeconomic volatility (Arcand et al., 2015, Schularick and Taylor, 2012; and Rajan, 2005)[15]. Borrower's ability to repay becomes progressively more sensitive to changes in income, sales and interest rates as debt levels increase. In addition, creditworthiness may decrease as debt accumulates

[11] With perfectly integrated financial markets, there should not be any correlation between national savings and national investment. However, Feldstein and Horioka finds in their famous paper from 1979 that such a correlation does exists, though it is weaker with deepening of financial globalization.
[12] There are theories stating that the increase in private savings will perfectly match the fall in public savings, commonly referred to as the Ricardian equivalence (Elmendorf and Mankiw, 1999).
[13] Baldacci and Kumar (2010) find that higher deficits and public debt lead to a significant increase in long-term interest rates.
[14] See also Cochrane (2011) for an analysis of government debt and fiscal and monetary policy.
[15] See Easterly et al. (2000) for the relationship between financial depth and output growth volatility.

to unsustainable levels (Cecchetti et al., 2011). In the case of a credit crunch, the probability of defaulting increases with higher debt burdens, which might trigger debt, banking and/or currency crises (Cecchetti et al., 2011; Kumar and Woo, 2010; Gourinchas and Obstfeld, 2012; and Reinhart and Rogoff, 2011). In the case of a crisis, there will be a cycle of decreased consumption and investment and the drop in aggregate demand will be larger the higher the level of debt (Cecchetti et al., 2011). As aggregate demand and sales drop, companies are forced to respond, affecting unemployment rates (Randveer et. al., 2011). Hence, high indebtedness may increase financial fragility and raise volatility in the real economy. What might be seen is a credit-fuelled boom and a default-driven bust, similarly to the 2007 financial crisis (Cecchetti et al., 2011).

The last channel identified relates to the problem of a *brain drain* as the financial sector increases. A growing financial sector may lead to a suboptimal allocation of talents, as a bigger financial sector attracts talents from the productive sector of the economy and therefore becomes inefficient from society's point of view (Kneer, 2013). Manufacturing sectors that are either R&D-intensive or dependent on external finance suffer disproportionate reductions in productivity growth when finance booms (Cecchetti and Kharroubi, 2015). In addition, because finance is a traded sector, countries may specialize in providing financial services to the rest of the world (Arcand et al., 2015). That is, when rents increase, including economic benefits from branches such as legal and accounting services that cluster around financial centers, the financial sector develops more quickly at the expense of the real economy[16] (Kneer, 2013). This in turn increases financial volatility without benefitting long run growth through reduced TFP (Arcand et al., 2015; Beck et al., 2014; and Cecchetti and Kharroubi, 2015).

In conclusion, public and private debt can affect growth either in a positive or a negative direction. A positive effect can operate through higher consumption and investments. A negative effect can operate through a crowding out effect on private investments, increased financial volatility and crisis as well as reduced productivity as the financial sector grows bigger. In addition, we may see different effects on the short- and long-term. Generally, positive effects on growth are more likely in the short run, while negative effects should be seen on the longer run due to the distortionary effects on both capital and TFP (Elmendorf and Mankiw, 1999). Also, these effects are likely to be amplified as debt accumulation increases, hence, nonlinear effects should be present (Pattillo et al., 2004).

[16] Philippon and Reshef (2013) show that the size of the financial sector is positively correlated with the presence of rents associated with working in the sector.

4 Data and method

4.1 Data

With the aim to reflect the theoretical channels of impact in Chapter 3, the empirical approach in this thesis combines growth regressions with regressions on potential sources of growth. Such growth accounting exercises have been commonly used in previous research (see e.g. Fisher, 1993). As previously discussed, debt can affect growth both in a positive and a negative direction. Both effects likely runs through the channels of capital and TFP as debt can boost (private) consumption and investments in the shorter run (raising capital and technology) but crowd out private savings and investments in the log-run through higher private consumption. Hence, in order to capture the full impact of debt on growth, four dependent variables are considered; *GDP growth*, *capital stock growth*, *TFP growth* and *private consumption growth*. To estimate the effect of debt on growth, observations from 20 advanced economies[17] between the years 1980-2014 is included. The data for the variables is mainly collected from the Bank of International Settlements (BIS), the International Monetary Fund (IMF), the Organization for Economic Cooperation and Development (OECD) and the World Bank (WB). Capital stock is constructed with data on gross fixed capital formation using the standard perpetual inventory method (assuming a common and constant depreciation rate of five percent). TFP is constructed with data on share of gross capital formation and persons employed using a residual method, see Appendix 2 for derivations.

The main explanatory variables of interest are public and private debt measured as *total debt* (both public and private debt), *credit to private non-financial sector* (total private debt), *gross general government debt* (total public debt), *credit to households* and *credit to non-financial corporations*. Hence total debt includes government, household and corporate debt, while credit to the private (non-financial) sector includes credit to both the household and corporate sector. The original series are presented as percentage of nominal GDP and have been applied in previous research (see e.g. Cecchetti et al., 2011; and Buttiglione et al., 2014). Data on credit to the private sector is collected from BIS[18], while data on government debt is collected from the IMF. In terms of lenders, the credit series includes lenders from all sectors of the economy, domestic banks and non-residents. In terms of financial instruments, credit consists of core debt defined as: (i) loans; (ii) debt securities; and (iii) currency and deposits. Further, liabilities are reported on a gross basis (Dembiermont et al., 2015). The series are presented on a consolidated basis for public debt, i.e. claims and liabilities between government entities such as state and local level are netted out (Bloch and Fall, 2015; and Dembiermont et al., 2015). On the other hand, private sector debt is reported on a non-consolidated basis. If not, the

[17] The availability of data on primarily private and public debt dictates the sample size and most importantly the choice of countries: Australia, Belgium, Canada, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Italy, Japan, South Korea, Netherlands, Norway, Portugal, Sweden, Singapore, Turkey and United States.

[18] The credit series from BIS are on a quarterly basis, hence averages were calculated in order to receive annual data.

measured level of credit would be understated as private sector lending to a large extent involves lending relationships within the same (private non-financial) sector (Dembiermont et al., 2013).

Additional explanatory variables included in the empirical model are chosen in line with previous research (see e.g. Cecchetti et al., 2011; Kumar and Woo, 2010; and Checherita-Westphal and Rother, 2012). This thesis takes into account the "core set" of growth determinants including *inflation* measured by CPI inflation, *general government consumption expenditure* as a proxy for government size, *population* as a proxy of country size, *trade openness* (sum of exports and imports as a percent of GDP) as a proxy for economic integration, *average years of schooling* as a proxy for human capital and *gross national savings* (see also Sala-i-Martin et al., 2004). In reflection to the finding that debt accumulation relates to crises[19], which in turn relates to lower growth, this thesis controls for *economic crises* by including an index consisting of data on banking, currency, debt (domestic and external), and inflation crises developed by Reinhart and Rogoff (2009). In addition, as the population structure changes with higher ageing dependencies, there should be an upward pressure on savings, in turn affecting debt levels and growth. Therefore, an *age dependency ratio* is included in line with Cecchetti et al. (2011) and Kumar and Woo (2010). Last, the *long-term interest rate* capturing the effect of monetary policy and the *current account balance* is included in line with Checherita-Westphal and Rother (2012).

For a complete list of variables included, description and sources, see Appendix 2. To be able to interpret estimates in terms of elasticities, all variables (except those expressed as percentage shares) are logged. Due to lack of data, some variables (capital share and schooling) are linearly interpolated[20].

4.2 Models and research method

In order to measure the effect of debt on growth, a dynamic panel data model with both fixed country and time effects[21] is included. Accounting for dynamic processes, i.e. that the dependent variable rely on its past realizations, is suitable in growth models since the economic performance in a specific year should rely on the performance in previous year. The baseline model measures annual growth rates, capturing the short-term effect of debt on growth. As outlined in the theoretical part, the effect on growth can differ in the short- and long-term. Therefore, a long-term analysis is added by supplementing yearly data with seven non-overlapping five-year periods[22], in line with previous research (Checherita-Westphal and Rother, 2012). To include five-year non-overlapping growth rates is common in growth regressions and reduces potential effects of cyclical movements (Cecchetti et al., 2011). As discussed in section 4.1, four models are estimated. The first model estimates the direct impact of debt on GDP (Y) growth:

[19] Reinhart and Rogoff (2009) find for instance that public debt increases in connection to banking crises.
[20] This is not expected to affect the results to any large extent since variables such as capital share and schooling do not vary significantly over time.
[21] By using fixed effects, it is possible to control for unobserved heterogeneity between countries and measure the impact on growth within a given country (Cecchetti et al., 2011).
[22] Periods are 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2010, 2010-2014.

$$\Delta\, ln(Y_{it}) = \rho_Y \Delta\, ln(Y_{it-1}) + \beta_Y \Delta D_{it-1} + \tau_Y \Delta D_{it-1}^2 + \theta_Y \Delta X_{it} + \lambda_i + \delta_t + \varepsilon_{it} \quad (1)$$

where D_{it-1} is a vector with five one-period lagged debt variables including credit to households, (non-financial) corporations, governments, total private sector, and total debt (both public and private); D_{it-1}^2 is the same vector squared to capture nonlinear effects in line with previous research and the theoretical framework; X_{it} is a vector including the controls (i.e. population, trade openness, age dependency, government consumption, inflation, national savings, current account balance, crisis index, schooling and the long-term interest rate), λ_i is the country-specific fixed effects allowing the countries to have individual intercepts; δ_t measures the time dependent fixed effects; and last v_{it} is the error term. The same set-up holds for the following models.

The second model analyzes the effect of public and private debt on capital accumulation (K) growth,

$$\Delta\, ln(K_{it}) = \rho_K \Delta\, ln(K_{it-1}) + \beta_K \Delta D_{it-1} + \tau_K \Delta D_{it-1}^2 + \theta_K \Delta X_{it} + \lambda_i + \delta_t + \varepsilon_{it} \quad (2)$$

The third model analyzes the effect of public and private debt on total factor productivity (A) growth,

$$\Delta\, ln(A_{it}) = \rho_A \Delta\, ln(A_{it-1}) + \beta_A \Delta D_{it-1} + \tau_A \Delta D_{it-1}^2 + \theta_A \Delta X_{it} + \lambda_i + \delta_t + \varepsilon_{it} \quad (3)$$

Last, the fourth model analyzes the effect of public and private debt on household consumption (C) growth:

$$\Delta C_{it} = \rho_C \Delta C_{it-1} + \beta_C \Delta D_{it-1} + \tau_C \Delta D_{it-1}^2 + \theta_C \Delta X_{it} + \lambda_i + \delta_t + \varepsilon_{it} \quad (4)$$

To estimate the causal effect on growth, two estimation methodologies are considered: a system GMM estimator (henceforth SGMM) and a bias corrected OLS estimator (henceforth BOLS)[23]. The estimators are chosen with the aim of controlling for biases associated with both the panel data model setting and the regressors included in the model. As pointed out in previous research, a problem of endogeneity is likely to exist when estimating the effect of debt on growth. There are three main sources of endogeneity; measurement errors, omitted variable bias and reverse causality (Verbeek, 2012: 141-146). Previous literature has especially highlighted the problem of reverse causality when studying debt and growth, as slower growth (possibly due to a recession) can lead to higher debt buildup, rather than high debt lowering growth (Easterly, 2001). In addition, a dynamic panel bias is present in dynamic estimations since the lagged dependent variable is correlated with the fixed effects in the error term, leading to inconsistent estimates of OLS[24]. Both estimators address the issue of endogeneity, though in different ways. The BOLS estimator handles endogeneity caused

[23] The GMM estimator is widely used in previous research (see e.g. Pattillo et al., 2004; and Cecchetti et al., 2011).

[24] If a country is hit by a negative supply chock, which for some reason is not modeled in a given year, the shock appears in the full disturbance term $v_{it} = \lambda_i + \varepsilon_{it}$. Everything else equal, the fixed effect for that country will appear to be lower. The year after, lagged GDP growth and the fixed effect will both be lower. Hence, there is a positive correlation between a regressor and the error, which violates an important assumption for consistency of OLS (Roodman, 2009).

by the model, i.e. the dynamic panel bias when including a lagged dependent variable. The SGMM estimator on the other hand handles both endogeneity caused by the lagged dependent variable and other regressors included, hence the SGMM estimator is more general compared to the BOLS estimator (see Roodman, 2009 and Bruno, 2005a).

The SGMM estimator is based on the Arellano and Bond (1991) estimator, also known as difference GMM (DGMM). The DGMM estimator transforms the models in first differences and includes lagged levels of the dependent and endogenous variables as instruments. Hence, both unobserved heterogeneity in the fixed effects[25] (from including y_{it-1}) and endogeneity among other regressors is controlled for. The general moment condition is $E(\mathbf{Z_i}\Delta\varepsilon_i) = 0$, where $\mathbf{Z_i}$ is a matrix of instruments. To increase efficiency, Arellano and Bover (1995) and Blundell and Bond (1998) developed a system GMM by adding an assumption that first differences of instruments are uncorrelated with the fixed effects[26]. This allows the usage of first differenced instruments in the level baseline model to instrument y_{it-1} and other endogenous variables. Hence, by adding the moment condition, $E(\Delta\mathbf{Z_{it-1}}\varepsilon_i) = 0$, more instruments are allowed. Thus, suitable lagged differences of both the dependent variables and endogenous regressors can be used to instrument the equation in levels, in addition to the instruments for the first-differenced equation (Roodman, 2009; Verbeek, 2012:402-403).

The GMM estimator is consistent, but like other instrumental variable approaches it generally suffers from poor small sample properties as it is difficult to find truly exogenous instruments in finite samples. In addition, the endogenous variables may be overfitted as the instruments easily become numerous. The consequence is that specifications tests, such as the Hansen J-test for over-identifying restrictions tends to become misleading[27] (Verbeek, 2012:403; and Roodman, 2009). To reduce this problem, the lagged dependent variables and all five debt variables are instrumented with only two lags. In addition, the GMM estimator is found using a positive weighting matrix. This matrix can either be specified in a one-step procedure were homoscedasticity is assumed, or in a two-step procedure where no such assumption is made (Roodman, 2009). The problem of too many instruments is more distinct in the two-step estimator because it relies on a high dimensional optimal weighting matrix (Verbeek, 2012:403). Consequently, a one-step SGMM estimation is chosen for this thesis.

The GMM approach generally works best with large N and small T, which is not typical for

[25] Defining the full disturbance term as $v_{it} = \lambda_i + \varepsilon_{it}$, the fixed effects λ_i is removed when transforming the model into first differences $\Delta y_{it} = \alpha\Delta y_{it-1} + \Delta X_{it}\beta + \Delta v_{it}$.

[26] This assumption is not trivial and may not hold in the case of growth models since it would imply that lagged growth levels are not correlated with country fixed effects. That is, when controlling for covariates, faster-growing countries should not systematically be closer or farther away from their steady states than slower-growing ones (Verbeek, 2012: 403; Roodman, 2009). However, as this thesis only includes advanced economies, the importance of this assumption may decrease since most of the countries included should be close to their steady state level.

[27] For instance, the Hansen J-test can generate exceptionally good p-values of one, i.e. meaning that the overall validity of the instruments is perfect (Roodman, 2009).

macroeconomic panel data (Cecchetti et al., 2011). Therefore, the analysis is complemented with a BOLS estimator to be able to draw any robust conclusions. It computes bias corrected least-squares dummy variables (LSDV) estimates and their bootstrap variance-covariance matrix for dynamic panel data models (Bruno, 2005a). The main difference from the SGMM estimator is that the BOLS estimator assumes strictly exogenous regressors, and hence only correct for dynamic panel bias from including lagged dependent variables. However, the BOLS estimator works better with small samples and often outperforms the GMM estimators in terms of root mean squared error and bias (Bruno, 2005a; Judson and Owen, 1996; and Kiviet, 1995). The BOLS is estimated in two main steps. First, the initial estimates of the lagged dependent variables and the explanatory variables are obtained using the Blundell Bond (BB)-estimator, which is the one-step SGMM described above including internal instruments to correct for endogeneity arising from including a lagged dependent variable. Second, the estimates obtained are used to calculate the bias approximations and thus receive the bias corrected LSDV estimates (Bruno, 2005a and 2005b).

Cross-section data often suffers from problem of heteroskedasticity, while non-stationarity and autocorrelation is common in time-series data (Verbeek, 2012: 97, 112, 338). Robust standard errors are included in all regressions to account for heteroskedasticity. Since the purpose is to estimate the effect on economic growth, all variables are transformed into growth rates by differentiating. This further facilitates the correction for non-stationarity. Results from stationary tests are presented in Appendix 3. The full disturbance term, $v_{it} = \lambda_i + \varepsilon_{it}$, is presumed to be autocorrelated since it contains fixed effects. The estimators are designed to eliminate this source of trouble as described above. Yet, if the errors ε_{it} are serial correlated it would render some lags invalid as instruments. The Arellano/Bond test for autocorrelation is thus included in the regressions, which is valid for any GMM regression on panel data, including OLS (Roodman, 2009). The results are presented in Appendix 6 and 7 with the short-term and long-term results for the control variables and further discussed in section 5.2.1 and 5.2.2. In line with previous research, only the AR(2) test results is presented since second order correlation in differences indicates first-order serial autocorrelation in levels[28].

[28] Negative first-order serial correlation is expected in differences since Δv_{it} is related to Δv_{it-1} via the shared v_{it-1} term (Roodman, 2009).

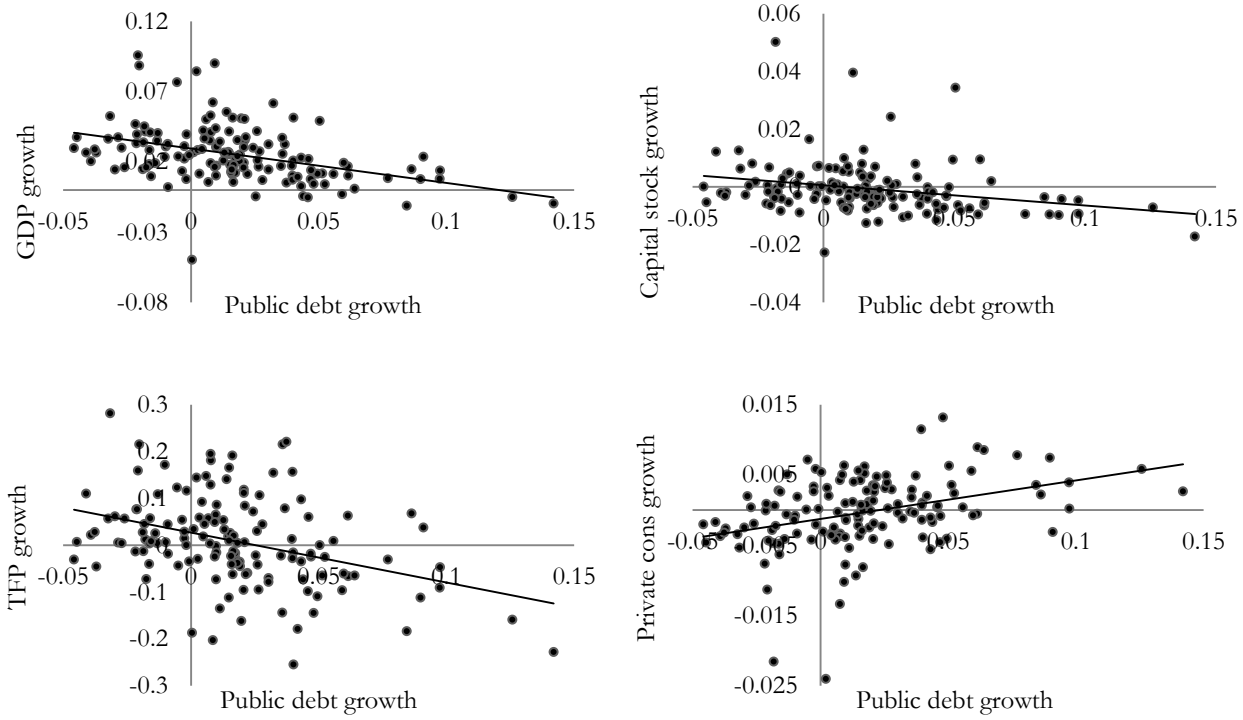
5 Empirical results

5.1 Descriptive evidence

Descriptive statistics of the variables included in the regression analysis are presented in Appendix 4. Analyzing the debt variables, the summary statistics show that the average annual growth rate of public debt to GDP is 1.7 percent and for private debt it is 2.6 percent. Disaggregating private debt into household and corporate, average household debt grows at a faster annual rate of 1.4 percent, while corporate debt grows at 1.2 percent. As preliminary evidence, scatter plots of the relationship between public and private debt growth and the four dependent variables are presented. For a more thorough analysis of the relationship between these variables, a full correlations matrix is provided in Appendix 5.

To start, Figure 4 illustrates scatter plots of the relationship between growth of public debt and GDP, capital, TFP and private consumption growth using data on 5-year periods, hence the preliminary analysis is made on the longer run.

Figure 4. Preliminary examination of public debt.

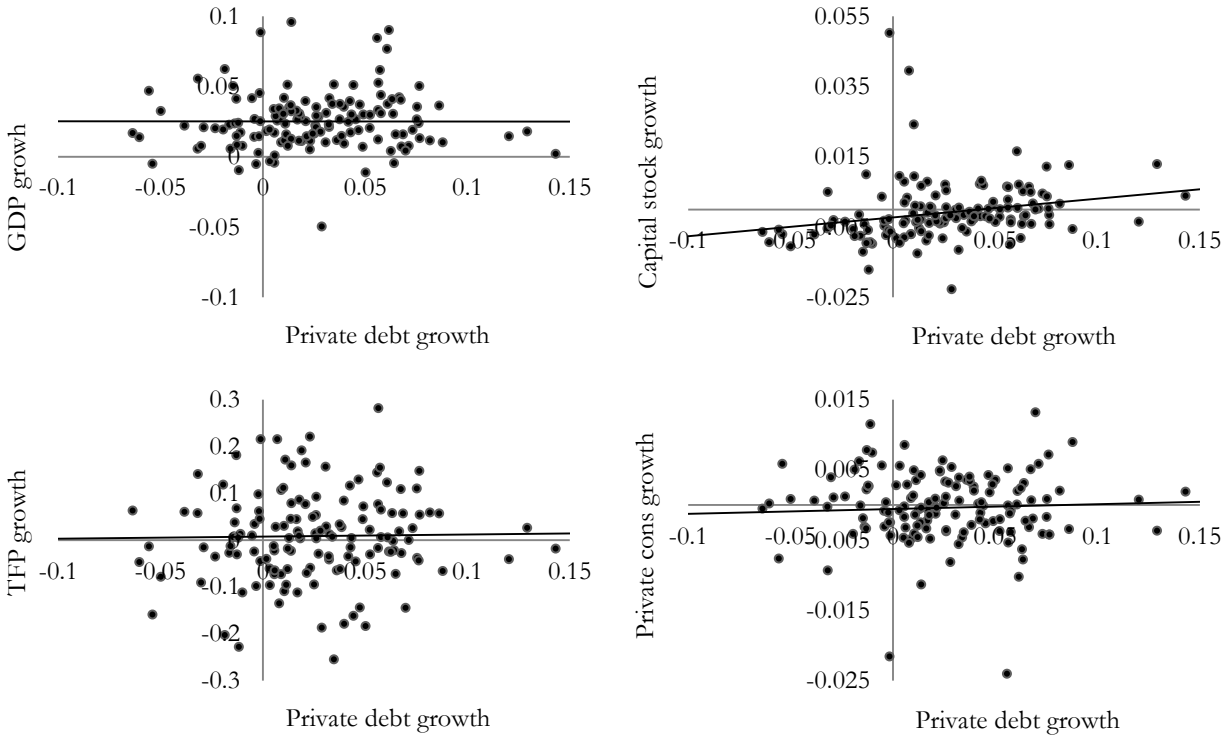


As can be seen in Figure 4 there is a negative correlation between public debt and GDP growth, as expected according to previous research (see e.g. Kumar and Woo, 2010). Hence, higher rates of public debt growth relate to lower GDP growth. Further, there is a negative relationship between public debt and capital stock growth and TFP growth. The scatter plots (and the correlations coefficients in Appendix 5) indicate that the correlation is weaker for capital stock growth (the

correlations coefficient is -0.26 for capital growth, compared to -0.37 for TFP growth). Last, public debt and private consumption correlates positively. This provides some preliminary evidence of the third channel of impact discussed in the theoretical part, that higher public debt boosts consumption but crowds out private savings and investments. As illustrated, public debt seems to have a negative effect on GDP growth by lowering both capital and TFP growth.

Figure 5 investigates the relationship between growth of private debt and GDP, capital, TFP and private consumption growth.

Figure 5. Preliminary examination of private debt.



Analyzing private debt, a different pattern arise and the relationships are less clear. Compared to public debt, private debt growth is nearly uncorrelated with GDP growth in the longer run (the coefficient is -0.0030). However, there is a positive correlation between private sector debt growth and capital stock growth. Similarly, there is a positive but weak relationship between private debt growth and TFP growth (the correlation coefficient is 0.02) as well as private consumption growth (the correlation coefficient is 0.05). Having a quick look at the correlation matrix for 5-year averages in Appendix 5, household debt growth seems to be positively correlated with GDP growth, while corporate debt growth is negatively correlated with GDP growth. This seems to originate from a negative correlation between corporate debt and TFP. However, no significant correlations are found for either household or corporate debt and hence a more sophisticated anlysis is needed.

5.2 Regression results

Below follows the empirical regression analysis of the effect of private and public debt on economic growth. The regression results are divided into two sub-sections representing short- and long-term effects. Short-term effects are measured using annual growth rates, while long-term effects are measured using five-year, non-overlapping, average growth periods. Each sub-section includes results of all four models: the effects on GDP growth, capital stock growth, TFP growth and private consumption growth. Estimates from both the SGMM estimator, presented in the left column, and the bias corrected OLS (BOLS) estimator, presented in the right column, are provided. The inclusion of two estimation methods checks the robustness of the results. In all models and specifications, non-linear effects are estimated using squared debt variables.

Since the main focus of this thesis is to provide insights to the relationship between debt and growth, a thorough analysis of the control variables is left to the interested reader. The short-term estimates of the control variables are presented in Appendix 6, while the long-run estimates are presented in Appendix 7. In addition, test-specifications relating to the estimators – the Arellano/Bond test for autocorrelation as well as the Hansen J-test of over-identifying restrictions – are presented in Appendix 6 and 7 as well together with the controls. Hence, the regression output below will only consists of relevant debt variables. However, each sub-section ends with a discussion on the overall fit of the model and the performance of the estimators.

5.2.1 Short-term effects

Table 1 presents the main results of the short-term effects on economic growth from government, household and corporate debt growth. To illustrate the dynamics between government and total private debt on the one hand, and government, household and corporate debt on the other hand, three main specifications are presented. In order to get a general understanding of debt's effect on growth, specification (1) presents the results for total debt growth. Specification (2) includes both public and private debt growth. Last, total private debt is divided into household and corporate debt, and hence specification (3) includes government, household and corporate debt growth. The same setup holds for specifications (4) - (6) when using the BOLS estimator. Each model is discussed separately and a short summary will end the short-term analysis.

Table 1. Baseline results for the short-term analysis.

	SGMM[1/]			**BOLS[2/]**		
Dependent variable: GDP Growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	0.02			0.03**		
	(0.01)			(0.01)		
Total debt squared	-0.30***			-0.51***		
	(0.10)			(0.07)		
Public debt		0.05*	0.03		0.01	0.01
		(0.03)	(0.02)		(0.02)	(0.02)
Public debt squared		-0.91***	-0.85***		-1.16***	-1.16***
		(0.18)	(0.17)		(0.14)	(0.14)
Private debt		0.02			0.01	
		(0.02)			(0.02)	
Private debt squared		-0.08			-0.17	
		(0.14)			(0.13)	
Household debt			0.03			0.04
			(0.04)			(0.04)
Household debt squared			0.95			1.10
			(0.85)			(0.78)
Corporate debt			-0.04*			-0.00
			(0.02)			(0.03)
Corporate debt squared			-0.01			-0.26
			(0.22)			(0.23)
Dependent variable: Capital stock growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	-0.00***			-0.01***		
	(0.00)			(0.00)		
Total debt squared	-0.02**			-0.02**		
	(0.01)			(0.01)		
Public debt		-0.00*	-0.00**		-0.01***	-0.01***
		(0.00)	(0.00)		(0.00)	(0.00)
Public debt squared		-0.06***	-0.06***		-0.06***	-0.05***
		(0.02)	(0.02)		(0.02)	(0.01)
Private debt		-0.00**			-0.01***	
		(0.00)			(0.00)	
Private debt squared		0.04*			0.04**	
		(0.02)			(0.01)	
Household debt			0.00			0.01
			(0.00)			(0.01)
Household debt squared			0.01			0.01
			(0.09)			(0.8)
Corporate debt			-0.01***			-0.01***
			(0.00)			(0.00)
Corporate debt squared			0.05**			0.04*
			(0.02)			(0.02)

	SGMM[1/]			BOLS[2/]		
Dependent variable: TFP growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	-0.14			-0.05		
	(0.11)			(0.09)		
Total debt squared	-0.71			-0.74		
	(0.50)			(0.60)		
Public debt		-0.45***	-0.40***		-0.00	0.06
		(0.16)	(0.15)		(0.14)	(0.13)
Public debt squared		-4.74***	-4.76***		-3.16***	-3.09***
		(1.32)	(1.28)		(1.18)	(1.10)
Private debt		-0.07			-0.18**	
		(0.16)			(0.13)	
Private debt squared		-0.06			0.32	
		(0.99)			(1.09)	
Household debt			0.61***			0.50
			(0.21)			(0.35)
Household debt squared			-5.05			0.72
			(5.86)			(6.22)
Corporate debt			-0.26			-0.45**
			(0.16)			(0.20)
Corporate debt squared			1.59			1.37
			(0.99)			(1.84)
Dependent variable: HH Cons growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	-0.01			-0.00		
	(0.01)			(0.00)		
Total debt squared	-0.00			-0.00		
	(0.03)			(0.03)		
Public debt		0.00	0.00		0.01**	0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Public debt squared		-0.04	-0.06		-0.03	-0.04
		(0.08)	(0.07)		(0.06)	(0.05)
Private debt		-0.02***			-0.02**	
		(0.01)			(0.01)	
Private debt squared		0.08*			0.03	
		(0.05)			(0.05)	
Household debt			-0.08***			-0.08***
			(0.02)			(0.02)
Household debt squared			0.89***			0.84***
			(0.24)			(0.31)
Corporate debt			0.01			0.01
			(0.01)			(0.01)
Corporate debt squared			-0.09			-0.11
			(0.06)			(0.09)

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

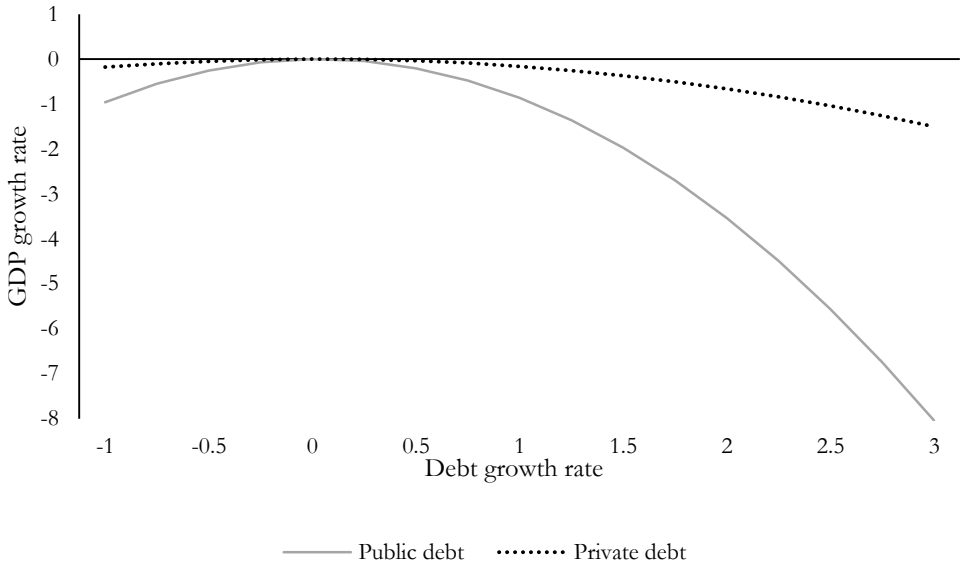
1/ For SGMM estimations: all debt variables lagged one period

2/ For BOLS estimations: all debt variables lagged one period; estimator chosen is the Blundell and Bond (BB) with no intercept; bias of order 1 included which forces an approximation up to O(1/T); number of bootstraps equal 1000. For more information, see Bruno (2005a)

Generally, the results of the effect on GDP growth are largely consistent considering both types of estimators. Few differences in size, sign and significance levels of the coefficients are shown and hence the majority of the results can be viewed robust considering both types of estimators. The general impression is that there are strong negative nonlinear effects from debt on GDP growth. Total debt growth shows a significant negative nonlinear effect, where higher growth of total debt is associated with lower annual GDP growth. The same holds for public debt growth, which is in line with previous research (see e.g Eberhart and Prosbiter, 2015; and Checherita-Westphal and Rother, 2012). This result is robust considering both estimators. Regarding private debt, a negative nonlinear effect on GDP growth is found as well. Hence, some evidence of previous empirical findings showing that lower levels of public debt have a positive effect on growth, while higher levels are hurtful are provided for both public and total private debt[29], even though the positive linear effects are less significant. In addition, the negative nonlinear effects are larger than the positive linear effects.

In order to illustrate these nonlinear relationships, Figure 6 plots the development of GDP growth as growth of both public and total private debt increases. No such relationship is found for either household or corporate debt and therefore only the development of total private debt is plotted. Analyzing the data set, average annual repayments of public and private debt rarely exceeds one percent. Hence, Figure 6 plots the development of GDP growth as both public and private debt growth increases from repayments of one percent to accumulation of three percent.

Figure 6. Developments of GDP growth rates from higher debt growth in the short-term.



As seen above, there is a strong nonlinear relationship between public debt growth and GDP growth. As public debt is repaid/decreases, there is a positive effect on growth. On the other hand, as public debt accumulates through higher growth rates, there is a sharp negative effect on growth.

[29] Assuming that lower growth rates are associated with lower levels of debt, which must not be the case.

This provides some evidence of the findings of Pescatori et al. (2014) that highlight the importance of the debt trajectory. The same pattern holds for private debt, even though the relationship is less distinct and non-significant - reductions are associated with higher GDP growth and accumulation is associated with lower GDP growth. Disaggregating total private debt into household and corporate debt, the picture is more complex and there is only one significant result found for corporate debt. Corporate debt growth is always associated with lower GDP growth, which is in line with the results found in Cecchetti et al. (2011). On the other hand, household debt growth is associated with higher GDP growth. This stands in contrast to Cecchetti et al. (2011) that found a negative linear effect (however, they estimate a long run effect). Hence, the results show a negative effect on GDP growth from both private and public debt in the shorter run. Moving on to investigate the effect on capital growth, TFP growth and consumption growth, should facilitate the interpretation of these results.

Regarding the effect on capital growth, the results are once again robust over the estimators. There is a negative nonlinear effect from total debt growth. The same holds for public debt growth. Unlike the results for model 1, there is also a negative linear effect – hence, total and public debt growth is always associated with lower capital stock growth. Once again, the nonlinear effects are larger. The short run negative relationship between public debt and capital growth is in line with previous research (see e.g. Pattillo et al., 2004). Hence, as suggested by Pattillo et al. (2004), the negative effect from public debt growth on GDP growth partly seems to operate through lower capital accumulation. That is, even in the short run, investments seem to be crowded out and/or discouraged as public debt accumulates.

Regarding private debt, the relationship is almost the opposite. Higher growth of total private debt is robustly associated with higher capital growth, as expected from the second channel of impact stating that increased debt should increase investments, boosting the capital stock. Interestingly, there are linear significant negative effects on capital growth from private debt. Hence, the relationship seems to be U-shaped. The same holds for corporate debt. This relationship is intuitive in the short run. At lower growth rates of private debt accumulation or even repayments of debt, the capital accumulation is slower and as results shows even negative. However, as private debt increases, there should be a positive effect on investments, as in this case on corporate investments, boosting the capital stock. Household debt growth seems to be associated with higher capital growth, however no significant results are found.

Regarding the effect on TFP growth, similar patterns as with model 1 and 2 arise. Growth of total debt is associated with lower TFP growth (however non-significantly). Public debt growth on the other hand significantly lowers TFP growth, which is in line with previous research (see Checherita-Westphal and Rother, 2012). Before proceeding, some notes need to be made. For some specifications in model 3, coefficients and standard errors are large and point to problems of misspecifications. An effort to mitigate these problems were made by introducing longer (or no) lag lengths on debt variables and longer (or no) dynamic effects, no sign of improvement was shown though. Running the Arellano-Bond test for autocorrelation for the specifications, some indication of serial correlation is provided (the null hypothesis of no second-order serial correlation is rejected

on a five percentage level). In addition, the Hansen J-test for over-identifying restrictions provides "perfect" p-values of one, indicating that we cannot reject the null of instruments being exogenous. However, this implies that the instruments overfit the endogenous variables according to Roodman (2009). Hence, instruments included in this mode are weak, which should be taken into consideration. Therefore, the results for model 3 should be interpreted with some caution.

The negative nonlinear effect from public debt growth on TFP growth provides some evidence of the theoretical channels of impact, even on the short-term. As discussed previously, investment strategies and productivity may be less efficient as additional government spending does not need to be matched by instant higher tax revenue when increasing debt (Elmendorf and Mankiw, 1999). Further, as uncertainties increase, investments are misallocated to activities with quick returns (Arcand et. al., 2015). Similarly, there is a negative relationship between total private debt growth and TFP growth, no robust results are found though. The last theoretical channel stating that TFP may decrease due to a reduction of skilled labor in the productive sectors of the economy, as the financial sector and rents associated with it grows (Cecchetti and Kharroubi, 2015), could explain this. Regarding household and corporate debt, no real conclusions can be drawn as few significant and no robust results are found. Corporate debt seems to affect TFP growth negatively, while household debt seems to be associated with higher TFP growth.

Effect on household consumption

Last, the effect on private consumption is analyzed. Incorporating private consumption contributes to a broader understanding of the debt-growth nexus, since analyzing this effect may capture the crowding out effect of private savings and investments from both higher public and private debt. Literature on the subject has established a relationship between debt and consumption but the direction of the effect is debated. Mian et al. (2015) finds a positive relationship between household debt and consumption, while Berben and Brosens (2005) find a negative relationship between public debt and private consumption (the level of debt is analyzed though).

Overall, the output provides few significant results compared to earlier models. Growth of total debt is associated with lower private consumption. Similar results are found for public debt growth, having a negative nonlinear effect on private consumption, non-significant though. However, there is a positive significant linear effect on consumption growth from public debt (although not robust). Hence, there is some indication that public debt growth increases consumption in the short run. The opposite holds for total private debt. There are negative linear significant effects, while nonlinear effects are positive and significant from total private debt growth. Hence, higher growth of private debt leads to higher household consumption. The same results are found for household debt, which is in line with previous research (Mian et al., 2015). No significant results for corporate debt are found, but growth of corporate debt seems to be associated with lower household consumption growth.

Summary

In conclusion, short-term effects found are in line with previous research but seems to partly go against theory. Generally, there are negative nonlinear effects on GDP growth from both public and private debt (though non-significant for private debt). Hence, there is no support to the first two theoretical channels of impact pointing to positive effects on growth in the shorter run. Rather results points to positive linear effects on GDP growth from public and private debt. Hence instead of finding different effects on the short- and long-term, the results indicate that the difference of the effect lies in the amount of debt accumulation, at least when analyzing the effect on GDP growth. Regarding *public debt*, there are negative and robust nonlinear effects in all four models. Hence, the negative effect on GDP growth from public debt operates through lower capital growth, lower TFP growth and lower private consumption growth. Regarding *private* debt, fewer significant results are found and the effect on growth is complex. Nonlinear effects on GDP growth from private debt growth is less distinct compared to public debt. In accordance with theory, private debt growth boosts capital growth in the short-term, but lowers TFP. Hence, the negative effect on GDP growth from private debt mainly operates through lower TFP growth. This might be an indication of the last channel of impact, that a greater financial sector drains the economy of productive workers, lowering TFP (Arcand et. al., 2015).

Regarding *household* and *corporate* debt, few robust results are found, but household debt seems to affect GDP growth positively in the short run through both the capital and consumption channel, while corporate debt affects GDP growth negatively in the short run mainly through the capital and TFP channel. That is, corporate debt growth seems to drive the negative nonlinear effect on short-term growth from total private debt. This might be because corporate debt affects the capital stock and TFP to a larger extent than household debt, that according to previous research rather affects growth through a consumption channel (see Mian et al., 2015 and Barba and Pivetti, 2009). Regarding the fewer significant results for household and corporate debt, the obvious explanation lies in the shortage of data for some countries included in the analysis. For a handful of countries, data is partly missing, making it more difficult to determine the relationship. This, of course, also relates to the less significant results for total private debt.

Appendix 6 reports R-squared values[30] together with the result on the control variables. Computation of goodness-of-fit measures is fairly uncommon when using panel data since usual and adjusted R-squared are appropriate only when estimating OLS (Verbeek, 2012: 386). In addition, the R-squared takes into account the fixed effects, which to a large extent perfectly fit the variation (or at least capture it). Hence, R-squared values tend to be high and somewhat misleading (Verbeek, 2012: 387). In addition, few reports on the R-squared are made in previous research when using the SGMM estimator (see e.g. Kumar and Woo, 2010). High R-squared values are confirmed when using annual growth rates. The independent variables explain between 50-70 percent of the variation in GDP, capital, TFP and consumption growth for both estimators. Pattillo et al. (2004) uses a comparable

[30] Calculated as the squared correlation coefficient between actual and fitted values (Verbeek, 2011: 386).

model and gets similar results[31]. However, the R-sqaured should not be used to evaluate the model, rather than cautiously facilitate the choice of specifications (Verbeek, 2012: 387).

Importantly, some points need to be made regarding the discussion on the validity of the instruments in section 4.2. The specification tests – including the Arellano/Bond test for autocorrelation and the Hansen J-test for over-identifying restrictions – provide some inconclusive results on the short-run. Even though the number of instruments are reduced to include only two lags, the Hansen J-test for over-identifying restrictions provides p-values of one for the majority of the specifications when including annual data, hence the instruments seem to overfit the endogenous variables (Roodman, 2009). Even though several efforts to mitigate this problem were made by modifying the model, by including higher dynamic lags and/or reduce the number of lags and instruments as a sensitivity check, no improvements were shown. As stated in Roodman (2009), the Hansen test should not be relied upon too faithfully, as such specification tests tend to become misleading as the number of instruments increase. However, the implication is that the validity of the instruments cannot properly be assessed, which should be taken into consideration. On the other hand, there is not any major difference between the estimators with regards to the estimates, which indicates that endogeneity may not be a large problem in the shorter run.[32]

Furthermore, there is little indication of serial correlation in the errors. The Arellano/Bond test for autocorrelation cannot reject the null of no second-order serial correlation in the first-differenced error terms in the majority of cases. P-values range between 0.12-0.55 for the specifications analyzing the effect on GDP, capital and consumption growth, for both estimators. As already discussed, there are signs of serial correlation in the model on TFP growth, where the AR(2) p-values ranges between 0.02-0.06 for both estimators. That is, the null hypothesis of no second-order serial correlation is rejected on a ten-percentage level and hence the instruments included in the regressions in model 3 are weak. Hence, in general there are no major signs of misspecifications but the validity of the instruments can be questioned, which is common when using internal instruments.

5.2.2 Long-term effects

Table 2 presents the main results for the long-term effects of private and public debt on growth. The set-up is identical to the one in section 5.2.1. Appendix 7 presents the results for the control variables and the specification tests. Similar to the setup in the previous section, this section discusses each model separately with a short summary in the end.

[31] Their measure of the R-squared value is 1-RSS/TSS.

[32] Since the BOLS estimator only handles endogeneity caused by the model structure, including a lagged dependent model, there should be differences in the results from both estimators if the explanatory variables are strongly endogenous.

Table 2. Baseline results for the long-term analysis.

	SGMM[1/]			**BOLS[2/]**		
Dependent variable: GDP Growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	0.01			-0.10		
	(0.04)			(0.04)		
Total debt squared	-0.13			-0.16		
	(0.42)			(0.36)		
Public debt		0.09	0.08		-0.04	-0.00
		(0.09)	(0.07)		(0.08)	(0.08)
Public debt squared		-0.31	-0.47		-0.17	-0.40
		(0.61)	(0.54)		(0.74)	(0.79)
Private debt		0.03			-0.01	
		(0.04)			(0.04)	
Private debt squared		-0.23			-0.05	
		(0.33)			(0.40)	
Household debt			-0.14*			-0.24**
			(0.08)			(0.12)
Household debt squared			1.67			2.93
			(1.33)			(2.31)
Corporate debt			0.07			0.08
			(0.06)			(0.06)
Corporate debt squared			-0.95			-0.40
			(0.60)			(0.89)
Dependent variable: Capital stock growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	0.04			0.06**		
	(0.02)			(0.02)		
Total debt squared	-0.14			-0.18		
	(0.13)			(0.19)		
Public debt		-0.04**	-0.05**		-0.02	-0.03*
		(0.02)	(0.02)		(0.02)	(0.02)
Public debt squared		-0.38	-0.41**		-0.36**	-0.39**
		(0.26)	(0.20)		(0.17)	(0.17)
Private debt		-0.04***			-0.04***	
		(0.01)			(0.01)	
Private debt squared		0.44***			0.36***	
		(0.11)			(0.12)	
Household debt			-0.06***			-0.03
			(0.02)			(0.04)
Household debt squared			0.73			0.93
			(0.47)			(0.72)
Corporate debt			-0.04***			-0.04**
			(0.01)			(0.02)
Corporate debt squared			0.60**			0.44
			(0.25)			(0.28)

	SGMM[1/]			BOLS[2/]		
Dependent variable: TFP growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	-0.19			0.06		
	(0.25)			(0.36)		
Total debt squared	-0.88			-1.71		
	(2.31)			(3.04)		
Public debt		-0.83**	-0.34		-0.40	-0.18
		(0.40)	(0.27)		(0.49)	(0.55)
Public debt squared		-6.06**	-7.24***		-10.32**	-10.34**
		(2.96)	(2.54)		(4.26)	(4.63)
Private debt		-0.21			-0.02	
		(0.25)			(0.34)	
Private debt squared		-0.86			-0.39	
		(1.79)			(3.06)	
Household debt			-0.86*			-1.09
			(0.50)			(0.95)
Household debt squared			-0.17			7.88
			(6.77)			(19.41)
Corporate debt			0.10			0.71
			(0.24)			(0.50)
Corporate debt squared			-0.61			0.16
			(3.69)			(7.46)
Dependent variable: HH Cons growth	(1)	(2)	(3)	(4)	(5)	(6)
Total debt	-0.02			-0.00		
	(0.01)			(0.01)		
Total debt squared	0.00			-0.03		
	(0.09)			(0.09)		
Public debt		-0.01	-0.01		0.01	0.00
		(0.02)	(0.01)		(0.02)	(0.02)
Public debt squared		0.19*	0.17		0.19	0.22
		(0.12)	(0.11)		(0.14)	(0.14)
Private debt		-0.01			0.01	
		(0.01)			(0.01)	
Private debt squared		0.03			-0.08	
		(0.10)			(0.10)	
Household debt			-0.02			0.00
			(0.02)			(0.03)
Household debt squared			0.03			0.16
			(0.39)			(0.61)
Corporate debt			-0.01			-0.01
			(0.01)			(0.02)
Corporate debt squared			0.01			-0.29
			(0.26)			(0.23)

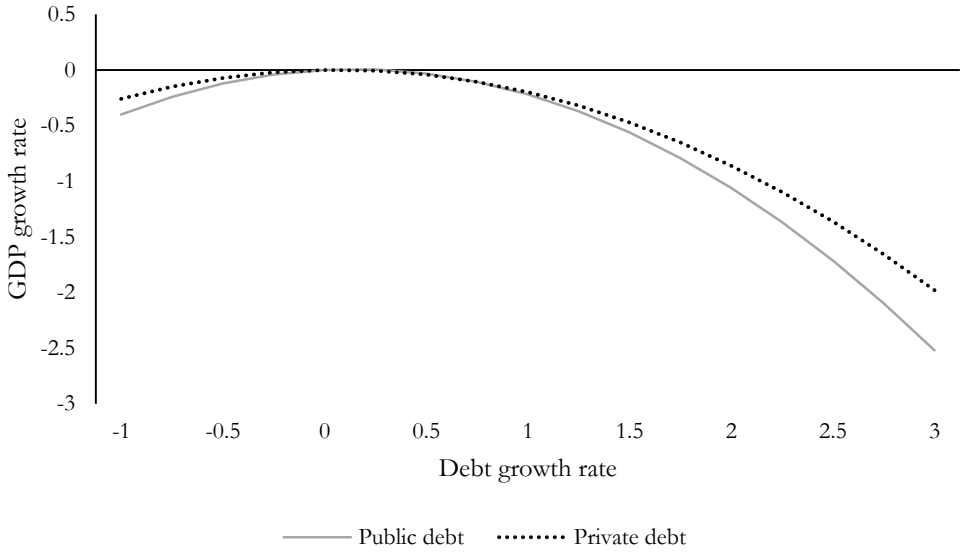
*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

1/ For SGMM estimations: all debt variables lagged one period

2/ For BOLS estimations: all debt variables lagged one period; estimator chosen is the Blundell and Bond (BB) with no intercept; bias of order 1 included which forces an approximation up to O(1/T); number of bootstraps equal 1000. For more information, see Bruno (2005a)

In the long-term analysis, there seems to be a greater discrepancy between the two estimators compared to the short-term analysis. The largest differences relate to significances of coefficients, rather than size and sign. However, it is important to note that there are fewer significant and robust results on the longer run. This is further discussed in the summary. Higher growth of total debt relates to lower GDP growth, the results are non-significant though. Non-linear effects are smaller on the longer run compared to the short-term analysis. There are no significant nonlinear effects on GDP growth from public debt growth on the longer run. Pescatori et. al. (2014) found similar results. The same holds for private debt, where no significant results are found on GDP growth from private debt growth in the long run (which was indicated in the preliminary analysis where a small but negative correlation was shown). The nonlinear relationship between public and private debt and GDP growth is plotted in Figure 7 using the coefficients for the SGMM estimator, in order to illustrate the relationship as in the short-term analysis. Important to note is that the nonlinear relationships are not robust over the estimators.

Figure 7. Developments of GDP growth rates from higher debt growth in the long-term.



As seen above, the nonlinear effects of public and private debt moves much closer, compared to the short-term analysis. The effect from public debt is now smaller – as public debt growth reaches three percent, GDP growth falls with only 2.5 percent, compared to eight percent in the short-term analysis. On the other hand, there is a sharper nonlinear effect from private debt growth, though insignificant, compared to the short-term analysis. As private debt growth reaches three percent, GDP growth reduces with two percent, compared to one percent in the short-term analysis. Hence, the negative effect on growth from private debt is larger in the long-term. Important to note is that only household debt provides significant effects on GDP growth. Growth of household debt has a linear negative effect on GDP growth. No significant coefficients for corporate debt are found. Hence, on the longer term there seems to be a greater reason to worry about household debt accumulation.

Regarding the effect on the capital stock, public debt growth has both linear and nonlinear significant negative effects on capital growth. These results are robust. Compared to the short-term analysis, the nonlinear effects are larger. Hence, once again support is given to the theoretical channels of impact pointing to a negative effect on capital accumulation, and the support is stronger on the longer run. Similar to the short-term analysis, the relationship between capital growth and total private debt is U-shaped – lower growth of private debt is associated with lower capital growth, while higher growth of private debt is associated with higher capital growth. The same holds for corporate debt. The nonlinear long-term positive effects on capital growth are larger than the short-term effects. Thus even on the long-term, private and corporate debt boosts the capital stock, which is somewhat unexpected according to the theoretical reasoning. Regarding household debt, there are linear negative effects on capital growth, although no robust results are found. Hence, on the long-term, the negative effect on GDP growth from household debt seems to partly operate through a negative effect on capital growth.

Similar to the results in the short-term analysis, large standard errors for the estimates in model 3 points to some misspecification. Once again, an effort to correct this through different types of re-specifications of the model was made, but no improvements were found. That is, results should be interpreted with some caution. Once again, public debt growth is significantly associated with lower TFP growth. The same holds for private debt growth, yet no significant results are found. Regarding household and corporate debt results are inconclusive, and once again only household debt provides significant results, however not robustly. Opposite to the result in the short-term analysis, household debt affects TFP growth negatively in the long run.

Effect on household consumption

In the longer run, higher public debt growth affects private consumption growth positively, contrary to the short-term effect. The nonlinear significant result is not robust over the estimators though. However, the long run positive effect on consumption growth from public debt is in line with previous research (Gogas, 2014)[33]. The results for total private debt are inconclusive, and no robust or significant results are found. The same holds for corporate and household debt. Generally, household debt seems to be associated with higher consumption growth, while corporate debt seems to be associated with lower consumption growth.

Before continuing, some notes on the results on private consumption should be made. Both in the short- and long-term analysis, few significant results are retrieved. The most intuitive explanation to this is the problem of endogeneity (see Berben and Brosens, 2005). As discussed in Johnson and Li (2007), debt might not have a direct impact on household consumption, but instead capture the relationship between consumption and income. Omitted variable bias is addressed in the SGMM estimator by including internal instruments. As already discussed, the SGMM estimator can be subject to a small sample bias due to weak instruments, which should be taken into consideration. In

[33] Gogas (2014) finds that there is no empirical evidence of the Ricardian-equivalence hypothesis - that households should consume less and save more as governments accumulate debt - in the longer run.

addition, the results differ to some extent between the two estimators, providing some evidence that endogeneity is present, since the BOLS estimator does not address endogeneity among regressors included except the lagged dependent variable. When running the Arellano/Bond test for autocorrelation, there is no indication of serial correlation with p-values ranging between 0.23 and 0.43 for both estimators. However, the Hansen J-statistic provides p-values of one in the short-term analysis and high p-values of 0.93-0.96 in the long-term analysis, which is a sign of trouble. Hence, this implies that the Hansen J-test is unable to detect weather the instruments are exogenous or not due to overfitting, which should be taken into consideration.

Summary

In conclusion, the results on the long-term are similar to the short-term analysis, even though some interesting differences stand out. Important to highlight is that there are fewer significant and robust results regarding long-term effects. A potential explanation relates to the importance of the time dimension when measuring the effect of debt on growth, rather than its cross-sectional explanatory power (Pattillo et al., 2004). The choice of including five-year non-overlapping averages is based on previous research (see e.g. Cecchetti et al., 2011). However, there is the possibility that longer time-periods are needed in order to capture the effect. In addition, it is important to highlight that the number of observations reduce when measuring the effect using 5-year averages, in turn affecting the possibility to detect any significant relationships (Behr, 2003).

Considering *public debt* growth, there are still negative nonlinear effects on GDP, capital and TFP growth in the long run, however smaller and non-significant. Contrary to the short-term analysis, higher public debt growth is associated with higher household consumption growth. Once again, few significant and robust results are found for private debt growth. Notable is that *household debt* growth pose a larger problem for growth in the longer run compared to the short run. Growth of household debt significantly lowers GDP, capital and TFP growth, while it boosts consumption growth. Hence the larger nonlinear negative effect on GDP growth from total *private debt* growth seems to be driven by household debt. Similar, *corporate debt* affects growth negatively, mainly through the capital channel, however few robust results are found.

Hence, also in the longer run, support is given to the theoretical channels pointing to a negative effect on growth. The positive effect from public debt on consumption growth confirms the third channel of impact – that higher public debt crowds out private investments in the longer run. This crowding-out effect is likely captured in the stronger negative effect on growth from private debt. Hence, higher private consumption crowds out private savings, which reduces resources available for the corporate sector, in turn reducing investments and affecting capital accumulation negatively (as shown corporate debt affects growth negatively mainly through the capital channel). As previous research finds, private credit cycles move in tandem with house price cycles. Thus, as property values increase, households are likely to feel richer, consuming more and saving less (since house loans constitute a large share of household debt) (Rajan, 2005; Claessens et al., 2011; and Borio, 2012). As shown in the results, this affects investment negatively, in turn lowering capital accumulation and

long run growth. Hence, as stated in Panizza (2013), it is possible that "the 'too much finance' result of Arcand et al. (2012) is really a 'too much household finance' result".

Hence, in the short run, growth of public debt seems to be a bigger problem for growth, while on the longer run, a larger focus should be put on the effects from household debt growth. A potential explanation to this result may lie in the role of financial crisis in the debt-growth nexus. As described in the theoretical part, private debt expansions are good predictors of financial crisis as they increase economic volatility and instability (Taylor, 2012). In addition, the increasing trend of private debt has moved in tandem with credit market deregulation and financial liberalization (Reinhart et al., 2012; Barba and Pivetti, 2009; and Taylor, 2012). The link between credit booms and financial instability can be explained by the failure of regulating the financial system (Schularick and Taylor, 2012). Lax regulation encourages higher risk-taking among actors (Rajan, 2005), and the quality of lending deteriorate as credit tend to go to weak public and private enterprises and the real estate market, feeding bubbles (Zagha and Nankani, 2005). This was seen both in the United States and in many European countries in connection to the financial crisis and the Eurozone crisis. In addition, once the private debt accumulation becomes unsustainable and defaults starts spreading, there usually is a countercyclical response of public debt increases to meet fiscal constraints. The stronger short-term negative effect of public debt can then relate to government debt financing transfers (such as taxes and social benefits), rather than boosting public consumption and investment in the short run, where the latter have a more direct effect on growth (Nautet and van Meensel, 2011).

For the interested reader, an important and fairly unexplored topic for the future would be to further relate credit expansions and booms to financial liberalization and deregulation, since both have moved in tandem for the last three decades. For instance, are there any combined effects of credit expansion and financial liberalization on growth? In addition, disaggregating private debt further by studying both length and composition of loan contracts may provide important insights, for instance in terms of understanding the effect on both consumption and investments. However, the research of debt is still constrained due to the lack of comprehensive data (Eberhardt and Presbitero, 2015), even though important contributions on historical debt data have been provided recently by for instance Reinhart and Rogoff (2009).

Regarding the overall fit of the model, high R-squared values are confirmed also in the long-term analysis, even though they are weaker compared to the short-term analysis. When using five-year averages, the overall goodness of fit ranges between 30-50 percent. This is in line with previous research (see Checherita-Westphal and Rother, 2012) [34]. The weaker explanatory power is likely due to the lower variance when measuring the effect using five-year average growth rates compared to annual growth rates. Compared to the short-term analysis, the Hansen J-test for over-identifying restrictions provides high p-values, but not as high as one. The p-values range between 0.25-0.96. The higher p-values are found for the specifications incorporating more variables, i.e. the ones

[34] Even though no goodness-of-fit measure for the effect on capital stock, TFP and consumption is provided in their study.

incorporating government, household and corporate debt, hence, the result is not surprising. However, such high p-values are a sign of trouble and thus also in the longer run the Hansen J-test is unable to assess the validity of the instruments included.

There is no indication of serial correlation on the long-term though, as the null hypothesis of no second-order serial correlation cannot be rejected for any of the specifications. Once again, the AR(2) p-values are lower when modeling the effect on TFP (p-values ranges between 0.11-019). Hence, the instruments in model 3 are weak also in the longer run. Lastly, as discussed in the beginning of the sub-section the results from the different estimators differ to a larger extent in the long run analysis compared to the short run. Since the BOLS estimator only controls for endogeneity caused by the model structure, the results may differ between the two estimators if endogeneity is present among regressors other than the dependent variable. Hence, there seems to be a larger problem of endogeneity among the variables included in the longer run. Since the test for autocorrelation fails to detect any serial correlation, the instruments included should be valid. However, as indicated by the Hansen J-test there is a problem of over-identification of the endogenous variables, which should be taken into consideration.

6 Concluding remarks

The increased indebtedness of advanced countries for the last three decades has resulted in an important debate regarding the sustainability of both public and private credit expansion. This became further relevant in connection to the global financial crisis in 2007, that was preceded by a rapid expansion of private credit and proceeded by an expansion of public sector credit (Schularick and Taylor, 2012). The interplay between public and private debt has so far been fairly unexplored, even though important contributions on the subject has been made (see e.g. Reinhart and Rogoff, 2009 as well as Reinhart et al., 2012).

The scope of this thesis is to provide further insights to the relationship between public (government) and private (household and corporate) debt and economic growth. This is done through an empirical approach investigating short- and long-term effects, nonlinear relationships, as well as potential channels through which the impact is likely to occur focusing on capital stock, TFP, and private consumption. On the one hand, debt can affect growth positively through consumption smoothing and increased capital and technology. On the other hand, debt accumulation can affect growth negatively through a crowding out effect on private investments, increased financial volatility and crisis as well as a brain-drain in productive sectors of the economy as the financial sector grows.

In the short-term analysis, this thesis finds nonlinear relationships between both public and private debt and GDP growth. Reductions of debt are associated with higher GDP growth, while accumulation of debt is associated with lower GDP growth. The relationship is stronger for public debt compared to private debt in the shorter run. The negative effect on GDP growth from *public debt* growth operates through lower capital growth, lower TFP growth and lower household consumption growth. Regarding private debt, the relationship is more complex. The negative effect on GDP growth from *private debt* seems to mainly operate through a negative effect on TFP growth. Few robust results are found for *household* and *corporate debt*, but household debt seems to affect GDP growth positively in the shorter run through both the capital and consumption channel, while corporate debt affects GDP growth negatively in the shorter run mainly through the capital and TFP channel.

Similar results emerge in the long-term analysis, even though some interesting differences stand out. Notable is that in the longer run, household debt growth seems to pose a larger problem. There are still negative nonlinear effects from *public debt* on GDP, capital and TFP growth, however smaller and non-significant. Contrary to the short-term analysis, higher public debt growth is associated with higher consumption growth. Most importantly, *household debt* growth significantly lowers GDP, capital and TFP growth, while it boosts consumption growth. Similar, *corporate debt* affects growth negatively, mainly through the capital channel. Hence, in the longer run there is a larger negative nonlinear effect on GDP growth from total *private debt*. The positive effect on consumption growth from both public and private debt provides evidence of the third channel of impact – that higher debt crowds out private investments. This crowding-out effect is likely captured in the stronger

negative effect on growth from private debt. Hence, higher private consumption crowds out private savings, which reduces resources available for the corporate sector, affecting capital accumulation and growth negatively.

The results provide important policy insights. As private sector credit booms are regarded good predictors of financial crisis (Taylor, 2012; and Gourinchas and Obstfeld, 2012), the developments of household debt should be carefully monitored in the future. As found in previous research, the link between credit booms and financial instability partly lies in the failure of regulating financial markets (Schularick and Taylor, 2012). Lax regulation not only encourages higher risk-taking, it also reduces the quality of lending as more credit is directed to weak public and private enterprises and the real estate market, feeding bubbles (Rajan, 2005; Zagha and Nankani, 2005). In addition, with financial liberalization and freer capital flows, central banks largely lose control over interest rates, making increasing household debt problematic, as political reforms are needed to halt booms (Barba and Pivetti, 2009). As private credit cycles and house price cycles are strongly synchronized (Claessens et al., 2011), not only should developments of household credit be carefully monitored, but also the developments of housing markets.

In addition, the results provide important insights to the relation between public and private debt. As outlined in the background, there usually is a pattern of countercyclical responses of public debt accumulation to meet fiscal constraints once private debt expansions become unsustainable. The significant short-term negative effect from public debt may then relate to government debt mainly financing transfers (such as taxes and social benefits) rather than boosting public consumption and investment in the shorter run, where the latter have a more direct positive effect on growth (Nautet and van Meensel, 2011). Hence, the instability related to private credit expansions can reduce the efficiency of public borrowing. Countries such as the United States, Spain, Portugal, and the United Kingdom have witnessed a decreasing trend of household debt in the aftermath of the financial crisis. However, countries such as Australia, Sweden, Finland, France, Norway, Belgium and Korea still shows an upward trend, providing a warning sign for the future, especially since interest rates are still low in most parts of the world (BIS, 2015; and Chmelar, 2013). Hence, the importance of fiscal stimulus is likely to increase.

So should we worry? Those who answer no might argue that financial reform and globalization has made it easier to carry high debt burdens. However, those who answer yes points to sharper volatility and crisis in debt markets (Reinhart et al., 2012). The advanced world has entered an era known by overhang of private and public debt. The recent crisis reminded us of what happens when there is a sudden stop of capital flows. Debt burdens increase dramatically and fiscal deficits rise with a deep recession as a result. With a slowly increasing FED-rate we might see capital flows reversing, flowing from emerging to advanced markets, potentially increasing imbalances (Wheatley and Kynge, 2015). In relation to this, interest rates will sooner or later have to be raised also in Europe, increasing the probability of another burst as households are sensitive to interest rate changes when debt levels are high (Andersson and Jonung, 2015). One thing is for sure, that monetary policy and financial stability

is highly interlinked and as the results of this thesis shows, both governments and central banks in advanced countries should worry about increased debt.

Regarding future directions, views diverge. The majority highlight the need of debt deleveraging or debt restructuring, including raising the cost of credit and regulate capital flows (see e.g. Taylor, 2013, Reinhart et al., 2012; and see Engel (2012) for a discussion on capital controls). On the other hand, Eggertsson and Krugman (2012) points to the problem of credit constraints, often imposed in times of crisis, being even more hurtful and reducing aggregate demand. Nevertheless, should lower growth caused by debt crises be cured with more debt? Important to highlight is that the demand for savings will not decrease in the future. The age dependency ratio increases in most advanced countries, resulting in higher health and social spending, in turn imposing an upward pressure on debt accumulation (Cecchetti et al., 2011).

7 References

Abbas, S. A.; Akitoby, B.; Andritzky, J.; Berger, H.; Komatsuzaki, T.; and Tyson, J. 2013, "Dealing with High Debt in an Era of Low Growth", *The IMF, Staff Discussion Note 13/07*, European and Fiscal Affairs Department.

Abbas, S. A.; Belhocine, N.; ElGanainy, A. and Mark H. 2010, "A Historical Public Debt Database". *IMF Working Paper /10/245*.

Aghion, Phillippe and Howitt, Peter, 2009. *The Economics of Growth*, the MIT Press, Cambridge, London.

Akerlof, G. and Shiller, R 2010, *Animal spirits: how human psychology drives the economy, and why it matters*, Princeton University Press.

Andersson, F. NG. and Jonung, L. 2015, "Boom, krasch, boom. Den svenska kreditcykeln", *Policy Paper 2015:2, Knut Wicksells centrum för finansvetenskap*, Lund.

Arcand, J. L.; Berkes, E. and Panizza, U. 2012, "Too Much Finance?", *IMF Working Paper 12/161*

Arcand, J. L.; Berkes, E and Panizza, U 2015, "Too much finance?", *Journal of Economic Growth*, vol. 20, p. 105-148.

Arellano, M. and Bond, S. 1991, "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, vol. 58, no. 2, pp. 277–97.

Arellano, M. and Bover, O. 1995, "Another Look at the Instrumental Variables Estimation of Error-Components Models", *Journal of Econometrics*, vol. 68, pp. 29–51.

Azzimonti, M.; de Francisco, E. and Quadrini, V. 2014, "Financial Globalization, Inequality, and the Rising Public Debt", *American Economic Review*, vol. 104, no. 8, pp. 2267–2302.

Baldacci, E. and Kumar, M. S. 2010, "Fiscal Deficits, Public Debt, and Sovereign Bond Yields", *IMF Working Paper /10/184*.

Barba, A. and Pivetti, M. 2009, "Rising household debt: Its causes and macroeconomic implications—a long-period analysis", *Cambridge Journal of Economics*, vol. 33, pp. 113–137.

Barro, R. J. 1979, "On the Determination of the Public Debt", *Journal of Political Economy,* vol. 87, no. 5, pp. 940-971.

Barro, R. and Lee, J-W. April 2010, "A New Data Set of Educational Attainment in the World, 1950-2010." *Journal of Development Economics*, vol. 104, pp.184-198.

Beck, T., Degryse, H., and Kneer, C. 2014, "Is more finance better? Disentangling intermediation and size effects of financial systems", *Journal of Financial Stability*, vol. 10, pp. 50–64.

Behr, A. 2003, "Investment and Liquidity Constraints. Empirical Evidence for Germany". *Deutscher Universitäts-Verlag.*

Berben, R-P., and Brosens, T. 2005. "The Impact of Government Debt on Private Consumption in OECD Countries", *DNB Working Paper, no. 45*.

Bernanke, B. 2005. "The global saving glut and the US current account deficit", Speech at the Sandridge Lecture, Richmond, 10 March. Found here:

http://www.federalreserve.gov/boarddocs/speeches/2005/200503102/.

Bernanke, B.; Bertaut, C.; DeMarco, L; and Kamin, S 2011, "International capital flows and the returns to safe assets in the United States, 2003–2007", *International Finance Discussion Papers*, no 1014.

BIS – Credit to the non-financial sector data (2015). Series on credit to households, non-financial corporations as well as total private non-financial sector.

Bloch, D. and Fall, F. 2015, "Government debt indicators: Understanding the data", *OECD Economics Department Working Papers, no. 1228*.

Blundell, R. and Bond, S. 1998, "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models", *Journal of Econometrics*, vol. 87, no. 1, pp. 115–43.

Borio, C. 2012, "The financial cycle and macroeconomics: What have we learnt?", *BIS Working Papers, no. 395*.

Bricongne, J-C. and Mordonu, A. M. 2015, "Interlinkages between Household and Corporate Debt in Advanced Econmies", *European Commission Discussion paper 017*., Directorate-General for Economic and Financial Affairs.

Bruno, G. S. F. 2005a, "Estimation and inference in dynamic unbalanced panel data models with a small number of individuals", *CESPRI Working Paper, no. 165*, University Bocconi-CESPRI, Milan.

Bruno, G. S. F. 2005b, "Approximating the bias of the LSDV estimator for dynamic unbalanced panel data models, *Economic Letters,* vol. 79, pp. 145-152.

Buttiglione, L.; Lane, P. R., Reichlin, L; and Reinhart, V. 2014, "Deleveraging? What Deleveraging?", Geneva Reports on the World Economy, *International Center for Monetary and Banking Studies (ICMB) and Center for Economic Policy Research.*

Cecchetti, S., and Kharroubi, E. 2015, "Why does financial sector growth crowd out real economic growth?", *BIS Working Paper, no. 490*.

Cecchetti, S. G.; Mohanty, M. S. and Zampolli, F. 2011, "The real effects of debt", *BIS Working Paper, no 352*.

Checherita-Westphal, C. and Rother, P. 2012, "The impact of high government debt on economic growth and its channels: an empirical investigation for the euro area", *European Economic Review*, vol. 56, no. 7, pp. 1392–1405.

Chmelar, A. 2013, "Household Debt and the European Crisis", *European Credit Research Institute and the Centre for European Policy Studies*, *no. 13*.

Claessens, S.; Kose, M. A.; and Terrones, M. E. 2011 "Financial Cycles: What? How? When?", *IMF Working Paper/11/76*.

Cochrane, J. H. 2011, "Understanding policy in the great recession: Some unpleasant fiscal arithmetic", *European Economic Review*, vol. 55, pp. 2–30.

Dell'Ariccia, G.; Igan, D.; Laeven, L.; and Tong H. 2012, "Policies for Macrofinancial Stability: Dealing with Credit Booms and Busts", *IMF Staff Discussion Note /12/06*.

Dembiermont, C.; Drehmann, M. and Muksakunratana, S. 2013, "How much does the private sector really borrow? A new database for total credit to the private non- financial sector". *BIS Quaterly*

Review.

Dembiermont, C.; Scatigna, M.; Szemere, R. and Tissot, B. 2015, "A new database on general government debt", *BIS Quaterly Review*.

Dynan, K.; Elmendorf, D; and Sichel, D. 2006, "Can financial innovation help to explain the reduced volatility of economic activity?", *Journal of Monetary Economics*, no. 53, pp 123–50.

Easterly, W. 2001, "Growth implosions and debt explosions: Do growth slowdowns cause public debt crises?" Contributions to Macroeconomics, vol. 1, no. 1, pp. 1-24.

Easterly, W., Islam, R., and Stiglitz, J. 2000, "Shaken and stirred, explaining growth volatility", In *Annual World Bank Conference on Development Economics*, World Bank, Washington, DC.

Eberhart, M. and Presbitero, A. F. 2015, "Public debt and Growth: Heterogeneity and non-linearity", *Journal of International Economics*, vol. 97, p. 45-58.

Égert, B. 2015, "Public debt, economic growth and nonlinear effects: Myth or reality?", *Journal of Macroeconomics*, vol. 43, p. 226-238.

Eggertsson, G. B. and Krugman, P. 2012, "Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach", *The Quarterly Journal of Economics*, pp. 1469–1513.

Eichengreen, B. 2014, "Secular stagnation: A review of the issues." in *Secular Stagnation: Facts, Causes and Cures*, edited by Coen Teulings and Richard Baldwin, pp. 41– 46. London: CEPR Press.

Elmendorf, D. W. and Mankiw. N. G. 1999, "Government Debt", In (J. B. Taylor & M. Woodford (ed.)) Handbook of Macroeconomics 1, part 3, pp. 1615-1669.

Engel, C., 2012, "Capital Controls: What Have We Learned?" *BIS Papers no 68*. Available at: http://www.bis.org/publ/bppdf/bispap68f.pdf.

Feenstra, Robert C.; Inklaar, Robert; and Timmer, Marcel P. (2015), "The Next Generation of the Penn World Table" forthcoming American Economic Review, available for download at www.ggdc.net/pwt.

Feldstein, M. and Horioka, C. 1979, "Domestic Savings and International Capital Flows", *NBER Working Paper Series, no. 310*.

Fischer, S. 1993, "The Role of Macroeconomic Factors in Growth", *NBER Working Paper Series, no. 4565*.

Friedman, B. M. 1987, "New directions in the relationship between public and private debt", *NBER Working Paper Series, no. 2186*.

Gogas, P.; Plakandaras, V.; and Papadimitriou, T. 2014, "Public Debt and Private Consumption in OECD countries", *The Journal of Economic Asymmetries*, vol. 11, pp. 1-7.

Gourinchas, P-O. and Obstfeld, M 2012, "Stories of the Twentieth Century for the Twenty-First", *American Economic Journal: Macroeconomics*, vol. 4, pp. 226-265.

Herndon, T.; Ash, M. and Pollin, R. 2013, "Does High Public Debt Consistently Stifle Economic Growth? A Critique of Reinhart and Rogoff", *University of Massachusetts*, *Working Paper Series, no 322*.

Hoang, N. T. and McNown, R. F. 2006, "Panel Data Unit Roots Tests Using Various Estimation Methods*", Department of Economics, University of Colorado at Boulder, Working Paper*.

IMF – World Economic Outlook Database (2015). Series on national savings and current account balance.

Johnson, K. W.; and Li, G. 2007, "Do High Debt Payments Hinder Household Consumption Smoothing?", *Finance and Economics Discussion Series*, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington D.C.

Judson, R. A. and Owen, A. L 1996, "Estimating Dynamic Panel Data Models: A Practical Guide for Macroeconomists, *Federal Reserve Board of Governors.*

Kiviet, J. F. 1995, "On bias, inconsistency, and efficiency of various estimators in dynamic panel data models", *Journal of Econometrics*, vol. 68, pp. 53–78.

Klein, M. W. and Olivei, G. P. 2008, "Capital account liberalization, financial depth, and economic growth", *Journal of International Money and Finance*, vol. 27, pp. 861–875.

Kneer, C. 2013, "Finance as a magnet for the best and brightest: Implications for the real economy". *DNB Working Paper, no. 392*.

Koeda, J. 2006, "A Debt Overhang Model for Low-Income Countries: Implications for Debt Relief', *IMF Working Paper /06/224*.

Krugman, P. 1988, "Financing vs. Forgiving a Debt Overhang", *Journal of Development Economics*, vol. 29, pp. 253-268.

Kumar, M.S., Woo, J. 2010, "Public Debt and Growth", *IMF Working Papers 10/174*.

Lane, P. R. and Pels, B. 2012, "Current Account Imbalances in Europe", *IIIS Discussion Paper, no. 397*.

Maddala, G.S and Kim, I-M. 2002, *Unit Roots, Cointegration and Structure Change*, Cambridge University Press.

Meakin, E. *The Difference Between Public and Private debt,* veived 5 January 2016, https://fleximize.com/articles/000543/public-and-private-debt

Mian, A.; Sufi, A.; and Verner, E. 2015, "Household Debt and Global Growth", Available at: http://www.riksbank.se/Documents/Avdelningar/AFS/2015/Session%203%20-%20MianSufiVerner.pdf.

Nautet, M. and Van Meensel, L. 2011, "Economic Impact of the Public Debt", *Economic Review,* vol. 2, pp. 7-19.

Nehru, V. and Dhareshwar, A. 1993, "A New Database on Physical Capital Stock: Sources, Methodology and Results", Revista de Analisis Economica, vol. 8, no. 1, pp. 37-59.

OECD – Monthly Monetary and Financial Statistics Dataset. Series on long-term interest rates.

Panizza, U. 2013, "Financial development and economic growth: Known knowns, known unknowns, and unknown unknowns", IHEID Working Paper, no. 14.

Panizza, U. and Presbitero, A. F. 2014, "Public debt and economic growth: is there a causal effect?" *Journal of Macroeconomics*, vol. 41, pp. 21-41.

Pattilo, C.; Poirson, H. and Ricci, L. 2002, "External Debt and Growth", *IMF Working Paper no. 02/69*.

Pattilo, C.; Poirson, H. and Ricci, L. 2004, "What are the Channels through which External Debt Affects Growth?", *IMF Working Paper No. 04/15*.

Pescatori, A., Sandri, D., Simon, J. 2014, "Debt and Growth: Is There a Magic Threshold*?" IMF Working Papers 14/34*.

Philippon, T., and Reshef, A. 2013, "An international look at the growth of modern finance", *Journal of Economic Perspectives*, vol. 27, pp. 73–96.

Rajan, R. G. 2005, "Has Financial Development Made the World Riskier?" *NBER Working Paper Series, no. 11728*.

Randveer, M.; Uusküla, L.; and Kulu, L. 2010, "The Impact of Private Debt on Economic Growth", *Eesti Pank Working Paper Series 10/2011*.

Reinhart, C. M. and Rogoff, K. S. 2009, *This time is different. Eight centuries of financial folly*, Princeton University Press.

Reinhart, C. M. and Rogoff, K. S., 2010, "Growth in a time of debt", *American Economic Review,* vol. 100, no. 2, pp. 573–578.

Reinhart, C.M. and Rogoff, K.S. 2011, "From financial crash to debt crisis", *American Economic Review*, vol. 101, no. 5, pp. 1676–1706.

Reinhart, C. M.; Reinhart, V. R. and Rogoff, K. S. 2012, "Public Debt Overhangs: Advanced-Economy Episodes since 1800", *Journal of Economic Perspectives*, vol. 26, no. 3, pp. 69–86.

Reinhart, C. M.; Reinhart, V. R. and Rogoff, K. S. 2015, "Dealing with debt"*, Journal of International Economics*, vol. 96, pp. S43-S55.

Reem Limam, Y. and Miller, S. M. 2004, "Explaining Economic Growth: Factor Accumulation, Total Factor Productivity Growth, and Production Efficiency Improvement", *Working Papers, no. 20, University of Connecticut*, Department of Economics.

Roodman, D. 2009, "How to Do xtabond2: An Introduction to Difference and System GMM in Stata," *Center for Global Development, Working Paper no.103*

Sachs, J. 1989, "The Debt Overhang of Developing Countries," in Debt Stabilization and Development: Essay in Memory of Carlos Diaz Alejandro, ed. by Calvo, A. Guillermo, and others, (Basil Blackwell: Oxford), p. 80-102.

Sala-i-Martin, X.; Doppelhofer, G.; and Miller. R. 2004, "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach", *American Economic Review*, vol. 94, no. 4, pp. 813-835.

Schularick, M., and Taylor, A. 2012, "Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008", *American Economic Review*, vol. *102*, pp. 1029–1061.

Summers, L. H. 2015, "Demand Side Secular Stagnation", *American Economic Review: Papers & Proceedings*, vol. 105, no. 5, pp. 60–65.

Taylor, A. M. 2012, "The Great Leveraging", *NBER Working Paper, no. 18290*.

The Conference Board. 2015. The Conference Board Total Economy Database™, May 2015, http://www.conference-board.org/data/economydatabase/

Traum, N. and Yang, S-C. 2010, "When does government debt crowd out investment?", *Journal of Applied Econometrics*, vol. 30, pp. 24-45.

Verbeek, M. 2012, *A Guide to Modern Econometrics,* 4th edition, John Wiley and Sons Ltd: United

Kingdom.

Wheatley, J. and Kynge, J. 2015, "Interest rate rise: emerging markets set to feel the wrath", *Financial Times*, 9 September.

World Bank - World Development Indicators (2015). Series on GDP, gross fixed capital formation, household final consumption expenditure, population, trade, age dependency, general government consumption and inflation.

Zagha, R. and Nankani, G. T. 2005, "Economic Growth in the 1990s: Learning from a Decade of Reform, *World Bank Publication*.

Appendix 1

Table A3. Summary of empirical studies examining public and private debt and growth.

Study	Sample description, study period, and methodology	Summary of empirical findings and conclusions	Comments
Reinhart and Rogoff (2010)	Study the relationship between public debt, growth and inflation including 44 advanced and emerging economies spanning almost 200 years. They use a non-parametric method, comparing average real GDP growth rates across four groups of public/debt ratios: <30 %, 30-60 %, 60-90 % and >90 %.	Main findings are that in both advanced and emerging markets, debt/GDP >90 % is associated with lower growth. For advance countries, median growth is almost 1 % lower for debt/GDP >90 % compared to lower debt ratio groups. For emerging markets, growth rates are cut in half when gross external debt[35] reaches debt/GDP levels >90 %.	No relationship between higher debt levels and inflation is found for advanced countries, however a relationship is detected in emerging markets.
Herndon, Ash and Pollin (2013)	Replicate Reinhart and Rogoff (2010) and correct for coding errors, selective exclusion of available data, and the weighting procedure of summary statistics.	Main finding is that, when correcting for errors, average GDP growth for debt/GDP >90 % is 2.2 %, not -0.1 % as presented in RR. That is, compared to lower debt ratios, growth for high debt ratios is not radically different.	Coding errors in RR excluded five countries, high and positive growth data in the top debt/GDP group for New Zealand, and weights in each group of debt levels was put equally by country, i.e. ignoring the number of years belonging to each group.
Kumar and Woo (2010)	Explore the impact of public debt on long run growth using a panel of 38 advanced and emerging economies between 1970-2007. Methodologies considered include between estimator, pooled OLS, fixed effects panel regression, and SGMM dynamic panel regression.	Main findings are that average annual GDP/capita decreases by 0.2 % in EMs when the initial debt/GDP is increased by 10 %, the effect is 0.15 % in advanced countries. Higher levels of initial debt show a proportional larger negative effect on growth and hence there is some proof of nonlinearity.	The negative effect on growth originate from a slowdown in labor productivity growth (declines 0.2 % when initial debt/GDP increases with 10 %), mainly due to reduced investment and a slower growth of capital per worker.
Cecchetti, Mohanty and Zampolli (2011)	Investigate all forms of non-financial debt: household, corporate and government debt and its effect on growth using a nonlinear approach. Sample includes 18 OECD countries from 1980 to 2010. Estimation method includes a dynamic fixed effects panel data regression model.	Main results show a negative effect on growth from high public debt. Estimates for corporate and household debt are imprecise. The threshold for government debt is 84 percent of GDP, for corporate debt it is 90 percent and for household debt it is 85 percent (though the results are inconclusive for household debt and should be interpreted carefully).	In addition, a forecast including age dependency ratios is performed, to project public debt levels up until 2040. Assuming unchanged fiscal policy, debt quickly rises to debt/GDP ratios above 100 %, a level proven to affect growth negatively.
Pattillo, Poirson and Ricci (2004)	Investigate growth channels affected by debt, focusing on factor accumulation and TFP, including nonlinear effects. Dataset consists of 61 developing countries over the period 1969-1998 using a dynamic panel specification including simple OLS, 2SLS, fixed effects and differenced and system GMM.	Main results are that the negative effect on growth stems from both a negative effect on physical capital accumulation and TFP growth. A nonlinear effect is present with low debt levels having a positive effect on growth and TFP growth, while high debt levels have a negative effect. For physical capital, the negative effect is on average larger for higher debt levels.	Capital accumulation accounts for about 1/3 of the effect of debt on growth, while TFP accounts for about 2/3.
Eberhart and Presbiter (2015)	Study the long run relationship between public debt and growth, searching for common or country-specific non-linearity or thresholds.	Main results show that countries with higher average debt/GDP ratios are more likely to get a negative effect on long run growth. However, there is no	

[35] Total gross external debt includes both private and public debt and is mainly denominated in foreign currency, compared to total public debt that mainly consists of domestic currency (Reinhart and Rogoff, 2010).

Study	Sample description, study period, and methodology	Summary of empirical findings and conclusions	Comments
	Dataset consists of 118 advanced, emerging and developing countries between 1960-2012 using a dynamic non-linear model and a common correlated effects estimator.	evidence of systematic nonlinearities within countries. Hence, no evidence of a common threshold is found.	
Panizza and Presbitero (2014)	Study whether public debt has a causal effect on economic growth using a sample of 17 OECD countries. Estimation method includes an IV approach including a new instrument capturing valuation effects from exchange rate movements.	Main findings are that no causal effect of public debt on economic growth is found when accounting for endogeneity. Hence, there is no country-specific threshold, above which debt affects growth negatively.	The authors highlight that the results does not imply that any debt level is sustainable for a given country.
Checherita-Westphal and Rother (2012)	Investigate a nonlinear relationship between public debt and GDP/capita growth using a sample of 12 Euro area countries between 1970-2010. In addition, growth channels are analyzed. Estimation methods include fixed-effects as well as IV techniques such as 2SLS and GMM.	Main results are that a nonlinear relationship between public debt and growth is found, with a debt/GDP threshold level of 90-100 %, above which the effect on growth is negative. The non-linear impact on growth operates through the channels of private saving, public investment and TFP.	
Égert (2015)	Examines the existence of threshold effects for the debt-growth nexus using data on both central and government debt between 1946-2009. Estimation methods include bivariate and multivariate regressions as well as Bayesian model averaging.	Little evidence of a negative nonlinear relationship is found. The results are sensitive to data coverage and modeling choices, but in rare cases when a negative relationship is found, it starts at public debt/GDP ratios between 20-60 %.	
Pescatori, Sandri and Simon (2014)	Analyze threshold effects of public debt on growth. Using the IMFs historical data on public debt, dated back to 1875, the focus is on the long-term relationship between public debt and growth by analyzing growth performance up to 15 years after debt exceeds a specific threshold.	No evidence of a threshold, above which medium-term growth is significantly changed, is found. However, the debt trajectory is important, as countries with lower debt appear to grow equally as fast as countries with high but declining debt. In addition, a relationship between higher debt and high output volatility is found.	
Arcand, Berkes and Panizza (2015)	Examine a nonlinear relationship between financial development and growth using different datasets (country-level and industry-level) and empirical approaches (cross-sectional and panel regressions as well as semi-parametric estimators) between 1960-2010.	Results show that there can be "too much" finance. When credit to the private sector reaches approximately 80-100 percent of GDP, growth is affected negatively.	
Reinhart, Reinhart and Rogoff (2012)	Examine growth associated with longer periods of exceptionally high public debt, defined as episodes where public debt to GDP exceeded 90 percent for at least five years, between 1800-2011.	Results show 26 episodes where public debt to GDP is > 90 % for at least five years. In 23 of these high debt episodes, growth is substantially slower. On average, debt/GDP levels > 90 % are associated with an average annual growth rate 1.2 % lower than in periods with debt/GDP < 90 %.	

Appendix 2

Table A2. Variables included in the analysis.

Variable	Unit	Description	Source	Comment
GDP	USD	Gross domestic product in constant 2005 USD. The variable is logged and differentiated.	WB - WDI	
Capital stock	Thousands	The variable is constructed from data on gross fixed capital formation using the standard perpetual inventory method, assuming a common and constant depreciation rate of five percent. The variable is logged and differentiated.	WB – WDI and Nehru and Dhareshwar (1993) for initial value.	The initial value was obtained by specifying $K_{t-1} = \frac{I_t}{0{,}05+g_I}$ where d=0.05 is the depreciation rate of capital and g_I is the average growth rate of investments during 1980-1990. The capital stock was further calculated as $K_t = 0.95*K_{t-1} + I_t$. In the case of a negative value of g_I, it was set to zero.
TFP	Index	The variable is constructed using data on share of gross capital formation (at current PPPs) from Penn World Tables 8.1 and persons employed (in thousands of persons) from the Conference Board. The variable is differentiated and data on share of gross capital formation had to be interpolated for the last three years.	Conference Board, PWT 8.1 and Aghion and Howitt (2009)	Departing from a simple Cobb-Douglas production function: $Y_{it} = A_{it}(K_{it})^{\alpha}(L_{it})^{1-\alpha}$ and rearranging $ln(A_{it}) = ln(Y_{it}) - \alpha ln(L_{it}) - (1-\alpha)ln(K_{it})$, an estimate on TFP is obtained by using data on capital formation share ($1-\alpha$) and persons employed (L_{it})[36].
HH cons	% of GDP	Household final consumption expenditure. The variable is differentiated.	WB - WDI	
Debt_HH	% of GDP	Credit to households and NPISHs[37] from all sectors - market value[38]. The variable is adjusted for breaks and differentiated.	BIS	
Debt_C	% of GDP	Credit to (non-financial) corporations from all sectors - market value. The variable is adjusted for breaks and differentiated.	BIS	
Debt_public	% of GDP	Gross general government debt. The variable is differentiated.	IMF Historical Public debt Database	
Debt_total	% of GDP	The sum of public debt and total private debt. The variable is differentiated.	BIS and IMF Historical Public debt Database	
Debt_private	% of GDP	Credit to private (non-financial) sector from all sectors - market value. The variable is adjusted for breaks and differentiated.	BIS	
Population	Total	The variable is logged and second differentiated.	WB - WDI	

[36] See e.g. Reem Limam and Miller (2004) and Aghion and Howitt (2009:107) on obtaining TFP estimates.
[37] NPISHs stands for non-profit institutions serving households.
[38] Market value is the amount for which a creditor could exchange assets or settle a liability at any moment in time, and is the most common measure (Dembiermont et al., 2015).

Variable	Unit	Description	Source	Comment
Schooling	Years	Average years of schooling for total population aged 15 and over. The variable is logged, second differentiated and interpolated (raw data only every five year).	Barro and Lee	
Trade	% of GDP	Trade is the sum of exports and imports of goods and services. The variable is differentiated.	WB - WDI	
Age dependency	% of working-age population	Age dependency ratio is the ratio of dependents, people younger than 15 or older than 64, to the working-age population, those ages 15-64. The variable is second differentiated.	WB - WDI	
GG cons	% of GDP	General government final consumption expenditure. The variable is differentiated.	WB - WDI	
Inflation	Index	Consumer price index (2010=100). The variable is logged and differentiated	WB - WDI	
Savings	% of GDP	Gross national savings. The variable is differentiated.	IMF-WEO	
CA balance	% of GDP	Current account balance. The variable is differentiated.	IMF-WEO	
Long interest rate	%	Long-term interest rates refer to government bonds maturing in ten years.	OECD	
Crisis	Index	The BCDI index is a combined index for banking, currency, debt (domestic and external), and inflation crises[39]. The index sums up the number of types of crises a country experience in a given year, i.e. the index takes the value zero if no crises is hit a given year, and five if experiencing all crises. When feasible, a stock market crash variable is added to the five-crises composite and in that case, the index runs from zero to six.	Reinhart and Rogoff (2009)	Note that the index does neither capture defaults on household debt nor corporate defaults. Though, these types of episodes may be captured in the banking crisis indicator.

[39] The following definitions for the various types of crises are made in Reinhart and Rogoff (2009). Inflation crisis: inflation rates of 20 percent or higher. Currency crash: an annual depreciation to USD of 15 percent or more. Banking crisis: a bank run that leads to the closure, merging, or takeover by the public sector of one or more financial institutions, or if there are no runs, the closure, merging, takeover or large-scale government assistance of an important financial institution. Debt crisis: the failure to meet a principal or interest payment on the due date. Stock market crash: a cumulative decline of 25 percent or more in real equity prices.

Appendix 3

Table A3. Results for stationarity tests on annual growth rates.

Variables	GDP	Capital stock	TFP	HH cons	Debt_HH	Debt_C	Debt_public	Debt_total	Debt_private	Pop
Im–Pesaran–Shin test										
IPS	-12.135***	-4.028***	-17.506***	-19.448***	-4.096***	-10.018***	-8.220***	-10.681***	-7.393***	-16.418***
IPS, trend	-12.298***	-3.804***	-15.868***	-17.380***	-1.706**	-8.070***	-5.945***	-8.385***	-5.311***	-14.320***
Augumented Dickey-Fuller unit root test (reporting inverse normal statistic)										
ADF	-5.980***	-2.066**	-8.849***	-10.976***	-1.393*	-6.288***	-6.781***	-5.687***	-7.145***	-7.633***
ADF,trend	-6.328***	-1.337*	-7.151***	-8.859***	2.023	-3.410***	-4.156***	-2.875***	-4.503***	-5.072***
Phillips–Perron unit-root tests (reporting inverse normal statistic)										
PP	-12.692***	-1.262	-18.149***	-20.449***	-3.994***	-8.795***	-8.545***	-10.527***	-6.852***	-16.035***
PP,trend	-12.062***	0.210	-16.212***	-18.357***	-1.466*	-6.251***	-6.075***	-7.921***	-4.553***	-13.615***

Variables	Trade	Age Dep	GG cons	Inflation	Savings	CA balance	Crisis	Schooling	Long rate
Im–Pesaran–Shin test		H0: unit root, Ha: stationary							
IPS	-19.411***	-13.040***	-17.149***	-9.728***	-21.609***	-20.280***	-14.109***	-20.257***	-17.939***
IPS, trend	-17.026***	-11.009***	-15.1187***	-6.843***	-19.153***	-18.655***	-13.163***	-18.248***	-16.470***
Augumented Dickey-Fuller unit root test (reporting inverse normal statistic)						H0: unit root, Ha: at least one panel is stationary			
ADF	-12.437***	-5.651***	-9.301***	-5.785***	-11.457***	-9.956***	-5.260***	-1.864***	-9.298***
ADF,trend	-10.349***	-2.958***	-7.159***	-3.472***	-8.919***	-7.290***	-3.604***	-5.408***	-8.279***
Phillips–Perron unit-root tests (reporting inverse normal statistic)						H0: unit root, Ha: at least one panel is stationary			
PP	-20.770***	-14.287***	-17.281***	-10.277***	-21.527***	-21.615***	-14.698***	-20.740***	-19.209***
PP,trend	-18.644***	-11.984***	-15.221***	-7.160***	-19.117***	-19.443***	-13.515***	-18.390***	-17.210***

As can be seen in the above results, for the majority of the variables the null hypothesis of a unit root can be rejected and we can conclude that the variables are stationary, or at least do not contain a unit root. The analysis is based on variables transformed as described in Appendix 2. Due to unbalanced data, only three tests could be performed: The Im-Pesaran-Shin test, the Augumented Dickey-Fuller unit root test and the Phillips-Perron unit root test. The different tests show comprehensive results for all variables except capital stock, where the Phillips–Perron is unable to reject the null of a unit root. There is a wide array of research on which test outperforms the other and there is no clear-cut result. Hoang and McNown (2006) conclude that the IPS approach outperforms both ADF and PP while Maddala and Wu (1996) concludes the opposite. Since two out of three tests reject the null of a unit root, the tests conclude that capital stock is stationary.

Appendix 4

Table A4. Descriptive statistics for annual growth rates.

Variables	**Observations**	**Mean**	**Sd**	**Min**	**Max**
GDP	680	0.025	0.029	-0.093	0.142
Capital stock	680	-0.001	0.010	-0.027	0.070
TFP	680	0.010	0.214	-1.384	0.959
HH cons	680	0.000	0.011	-0.077	0.059
Debt_HH	623	0.014	0.023	-0.055	0.097
Debt_C	623	0.012	0.043	-0.211	0.215
Debt_public	680	0.017	0.052	-0.151	0.264
Debt_private	674	0.026	0.055	-0.213	0.245
Debt_total	623	0.042	0.071	-0.209	0.379
Population	680	0.007	0.007	-0.017	0.053
Trade	680	0.006	0.067	-0.794	0.410
Age dependency	680	-0.001	0.006	-0.022	0.018
GG cons	680	0.001	0.007	-0.022	0.031
Inflation	680	0.052	0.087	-0.014	0.724
Savings	680	0.000	0.018	-0.097	0.071
CA balance	680	0.002	0.021	-0.115	0.125
Crisis	700	0.526	0.787	0	5
Schooling	680	0.011	0.010	-0.012	0.056
Long interest rate	574	-0.003	0.012	-0.124	0.068
Number of id	20	20	20	20	20

Appendix 5

Table A5a. Correlation matrix for annual growth rates.

	GDP	Capital	TFP	HH cons	Debt HH	Debt C	Debt GG	Debt private	Debt total
GDP	1.00								
Capital	0.27*	1.00							
TFP	0.52*	0.11*	1.00						
HH cons	-0.37*	-0.13*	-0.20*	1.00					
Debt HH	0.06	0.18*	0.08	0.16*	1.00				
Debt C	-0.18*	0.22*	-0.12*	0.18*	0.35*	1.00			
Debt GG	-0.49*	-0.22*	-0.31*	0.21*	-0.20*	-0.06	1.00		
Debt private	-0.11*	0.27*	-0.05	0.17*	0.68*	0.92*	-0.15*	1.00	
Debt total	-0.47*	0.01	-0.30*	0.32*	0.39*	0.68*	0.62*	0.69*	1.00

* p<0.01

Table A5b. Correlations matrix for 5-year non-overlapping growth rates.

	GDP	Capital	TFP	HH cons	Debt HH	Debt C	Debt GG	Debt private	Debt total
GDP	1.00								
Capital	0.35*	1.00							
TFP	0.38*	0.16	1.00						
HH cons	-0.51*	-0.29*	-0.34*	1.00					
Debt HH	0.14	0.15	0.16	-0.00	1.00				
Debt C	-0.12	0.21	-0.13	0.19	0.40*	1.00			
Debt GG	-0.41*	-0.26*	-0.37*	0.36*	-0.39*	-0.22	1.00		
Debt private	-0.00	0.25*	0.02	0.05	0.75*	0.91*	-0.37*	1.00	
Debt total	-0.35*	-0.01	-0.33*	0.43*	0.40*	0.68*	0.47*	0.66*	1.00

* p<0.01

Appendix 6

Table A6 presents the short-term results for the control variables and includes the results for the specification tests – the Arellano/Bond test for autocorrelation and the Hansen J-test for over-identifying restrictions. Results are presented for each dependent variable and specifications (1), (3), (5) and (7) are estimated with the SGMM estimator, while specifications (2), (4), (6) and (8) are estimated with the BOLS estimator. The majority of the controls are of expected sign and size according to previous research. Focusing on the effect on GDP growth, all significant controls are of expected sign. Trade openness and national savings significantly increases GDP growth, while the age dependency ratio, government consumption, and the crisis index significantly lower GDP growth. In addition, there is a significant positive effect from the lagged dependent variable as expected (see e.g. Cecchetti et al., 2011; Kumar and Woo, 2010; and Checherita-Westphal and Rother, 2012 for similar results on the controls).

Table A6. Short-term regression results for control variables.

Dependent variable	**GDP growth**		**Capital stock growth**		**TFP growth**		**HH Cons growth**	
	SGMM[1/]	BOLS[2/]	SGMM	BOLS	SGMM	BOLS	SGMM	BOLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged dependent variable, one period	0.41***	0.27***	0.91***	0.97***	-0.05	0.04	0.07	0.07*
	(0.13)	(0.03)	(0.03)	(0.02)	(0.05)	(0.03)	(0.06)	(0.04)
Population	-0.31	-0.30	0.03	0.03	-1.13	-1.75	-0.23	-0.26***
	(0.76)	(0.23)	(0.10)	(0.02)	(2.97)	(1.74)	(0.25)	(0.09)
Trade	0.05*	0.04***	-0.01***	-0.01***	0.05	0.26***	-0.01	-0.00
	(0.03)	(0.01)	(0.01)	(0.00)	(0.12)	(0.08)	(0.01)	(0.00)
Age dep	-1.15**	-0.57***	-0.09	-0.04**	2.85	2.53*	0.31	0.08
	(0.51)	(0.19)	(0.10)	(0.02)	(5.38)	1.40	(0.28)	(0.07)
GG cons	-1.25**	-0.85***	0.05	-0.05***	-0.58	-2.28*	0.21	-0.04
	(0.60)	(0.16)	(0.06)	(0.02)	(2.43)	(1.20)	(0.15)	(0.06)
Inflation	0.05	-0.03	-0.01***	-0.01***	1.18**	0.08	0.02*	-0.00
	(0.03)	(0.02)	(0.00)	(0.00)	(0.52)	(0.17)	(0.01)	(0.01)
Savings	0.47**	0.68***	0.10**	0.08***	4.03***	6.95***	-0.40***	-0.35***
	(0.21)	(0.07)	(0.05)	(0.01)	(1.42)	(0.50)	(0.05)	(0.03)
CA balance	-0.56***	-0.57***	-0.13***	-0.10***	-7.98***	-8.57***	-0.06	-0.04**
	(0.19)	(0.05)	(0.04)	(0.01)	(0.82)	(0.38)	(0.05)	(0.02)
Crisis	-0.01*	-0.01***	-0.00	-0.00***	-0.12***	-0.03***	-0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.01)	(0.00)	(0.00)
Schooling	0.28	0.12	0.01	-0.01	-3.14*	-0.90	0.07	0.00
	(0.34)	(0.11)	(0.02)	(0.01)	(1.75)	(0.82)	(0.10)	(0.04)
Long interest rate	0.06	0.05	-0.03	-0.00	1.16	-0.11	0.06	-0.05**
	(0.14)	(0.06)	(0.02)	(0.01)	(0.95)	(0.48)	(0.08)	(0.02)
Constant	0.03***		0.00		0.02		-0.01	
	(0.01)		(0.00)		(0.09)		(0.01)	
Observations	561	542	561	542	561	542	561	542
Number of id	20	20	20	20	20	20	20	20
Number of instruments	96	86	96	86	96	86	96	86
Arrelano-Bond AR(2) test (p-value) (i)	0.11	0.03	0.68	0.24	0.23	0.17	0.67	0.19
Hansen J-test (p-value) (ii)	1		1		1		1	
R-squared	0.62	0.61	0.64	0.63	0.59	0.60	0.55	0.52

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

1/ For SGMM estimations: all debt variables lagged one period

2/ For BOLS estimations: all debt variables lagged one period; estimator chosen is the Blundell and Bond (BB) with no intercept; bias of order 1 included which forces an approximation up to O(1/T); number of bootstraps equal 1000. NOTE: The BOLS is estimated in two steps. In the first step, the initial estimates of the lagged dependent variable and the explanatory variables are obtained using the BB-estimator as described in section 4.2. The BB-estimator is a one-step SGMM and hence the number of instruments, the AR(2) p-value, and the R-squared value relates to the first estimation. In the second step, the estimates obtained is used to calculate the bias approximations and thus receive the LSDVC estimates presented above. For more information, see Bruno (2005a)
(i) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.
(ii) The null hypothesis is that the instruments used are exogenous. For the BOLS estimator, no reporting on the Hansen J-test is made. The Hansen J-test is robust but is weakened by many instruments. For more information, see Roodman (2009).

As described in section 4.2, the GMM estimator is consistent but may suffer from a small sample bias since truly exogenous instruments are difficult to find. In addition, the estimator is sensitive to the number of instruments. As stated in Roodman (2009), the Hansen test for over-identifying restrictions should not be relied upon too faithfully, because such specification tests tend to become misleading as the number of instruments increase. Even though the number of instruments were reduced, only including two lags of the dependent variables and exogenous debt variables, the Hansen J-test points to some error as p-values equals one (indicating that the instruments are "perfectly" exogenous). Even though several efforts to mitigate this problem was made by modifying the model and including higher dynamic effects and/or reduce the number of lags and instruments, no improvements were shown. Hence, the contingency of the instruments should be taken into consideration. However, by including the BOLS estimator the robustness of the results is checked. As seen in table A6, there are no major differences between the coefficients for the two estimators, other than that the estimates are smaller when using the BOLS estimator.

Addressing the issue of autocorrelation, the Arellano-Bond test for autocorrelation provides p-values above 0.10 in the majority of the specifications in the short-term analysis, indicating that we cannot reject the null of no second-order serial correlation in the first-differenced error term (Roodman, 2009). This is an indication that the instruments included in the short-term analysis should be valid and that the misleading result of the Hansen J-test is rather grounded in the problem of overfitting the endogenous variables. In addition, as seen in Table A6, there is some indication of misspecification in model 3 that estimates the effect on TFP. Even though the AR(2) p-value does not reject the null of no autocorrelation, it is likely that some autocorrelation still exists when using time-series data. Hence, the instruments are likely weak in this model, which should be taken into consideration. Last, a note on the explanatory power of the models should be made. The computation of goodness-of-fit measures in panel data applications is fairly rare and is mostly appropriate when the model is estimated with OLS (Verbeek, 2011: 386). In addition, the R-squared takes into account the fixed effects, which to a large extent perfectly fit the variation (or at least capture it). Hence, R-squared values tend to be high and somewhat misleading (Verbeek, 2012: 387), which is confirmed in the short-term analysis. The explanation power ranges between 50-60 percent in the shorter run, for both estimators. Pattillo et al. (2004) gets similar results. However, the R-sqaured should not be used to evaluate the model rather than cautiously facilitate the choice of specifications (Verbeek, 2012: 387).

Appendix 7

Table A7 provides the long-term results for the control variables and the results for the specification tests. The set-up is the same as that for Table A6 in Appendix 6. For the long-term analysis, some controls show larger standard errors and are of the unexpected sign. In addition, there seems to be fewer significant results for the controls on the longer term compared to the short-term analysis. This is similar to the results found for the debt variables in section 5.2.2. The main explanation to this problem may lie in the choice of time-periods on the longer run. This thesis includes five-year average growth rates, but the effect may run through longer periods. In addition, the same controls are used in all four models. In an ideal world with limited time, the control variables should perhaps be further customized for all four models. However, the precision increased as debt variables were added to the regression[40].

Table A7. Long-term regression results for control variables[41].

Dependent variable	**GDP growth**		**Capital stock growth**		**TFP growth**		**HH Cons growth**	
	SGMM[1/]	BOLS[2/]	SGMM	BOLS	SGMM	BOLS	SGMM	BOLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged dependent variable, one period	0.33*	0.38***	0.42**	0.64***	-0.05	-0.05	-0.08	0.03
	(0.17)	(0.13)	(0.19)	(0.13)	(0.19)	(0.12)	(0.29)	(0.12)
Population	3.52**	1.61	-1.85**	0.03	-12.20	13.21	-0.69	-0.34
	(1.77)	(1.52)	(0.88)	(0.54)	(10.02)	(11.83)	(1.37)	(0.36)
Trade	0.08	-0.06	-0.15	-0.06**	-0.96*	-0.95*	-0.07	-0.00
	(0.16)	(0.06)	(0.11)	(0.02)	(0.56)	(0.50)	(0.05)	(0.01)
Age dep	1.14	-0.18	0.29	-0.13	3.01	7.21**	0.61	0.08
	(1.31)	(0.46)	(0.52)	(0.16)	(5.49)	(3.57)	(0.39)	(0.11)
Inflation	0.20**	0.09***	0.05	0.01	1.47***	0.25	0.00	0.01
	(0.09)	(0.03)	(0.04)	(0.01)	(0.39)	(0.24)	(0.02)	(0.01)
Savings	0.93*	0.59**	-0.17	-0.14*	2.14	1.12	-0.73***	-0.23***
	(0.50)	(0.24)	(0.36)	(0.08)	(3.09)	(1.75)	(0.19)	(0.05)
Crisis	-0.03***	-0.02***	-0.01***	-0.00***	-0.23***	-0.06*	-0.00	0.00**
	(0.01)	(0.00)	(0.00)	(0.00)	(0.06)	(0.03)	(0.01)	(0.00)
Schooling	1.24***	-0.15	-0.24	-0.04	-5.64**	-3.65*	-0.20*	-0.01
	(0.44)	(0.26)	(0.17)	(0.09)	(2.18)	(2.05)	(0.11)	(0.06)
Long interest rate	-2.10*	-0.80*	-0.22	0.12	-15.45**	-4.03	0.67	0.12
	(1.20)	(0.43)	(0.27)	(0.15)	(7.34)	(3.43)	(0.44)	(0.12)
Constant	-0.01		0.01**		0.07		0.01	
	(0.01)		(0.00)		(0.07)		(0.01)	
Observations	109	95	109	95	109	95	109	95
Number of id	20	20	20	20	20	20	20	20
Number of instruments	24	22	24	22	30	22	24	22
Arrelano-Bond AR(2) test (p-value) (i)	0.26	0.91	0.58	0.78	0.17	0.04	0.08	0.21
Hansen J-test (p-value) (ii)	0.37		0.42		0.91		0.97	
R-squared	0.41	0.51	0.36	0.52	0.40	0.18	0.30	0.41

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

1/ For SGMM estimations: all debt variables lagged one period

[40] A conscious decision is made not to include complete tables of both debt variables and control variables since such table/tables would be too extensive for any comprehending use.

[41] Since number of observations decrease with average growth rates, the number of controls is reduced.

2/ For BOLS estimations: all debt variables lagged one period; estimator chosen is the Blundell and Bond (BB) with no intercept; bias of order 1 included which forces an approximation up to O(1/T); number of bootstraps equal 1000. NOTE: The BOLS is estimated in two steps. In the first step, the initial estimates of the lagged dependent variable and the explanatory variables are obtained using the BB-estimator as described in section 4.2. The BB-estimator is a one-step SGMM and hence the number of instruments, the AR(2) p-value, and the R-squared value relates to the first estimation. In the second step, the estimates obtained is used to calculate the bias approximations and thus receive the LSDVC estimates presented above. For more information, see Bruno (2005a)

(i) The null hypothesis is that the first-differenced errors exhibit no second-order serial correlation.

(ii) The null hypothesis is that the instruments used are exogenous. For the BOLS estimator, no reporting on the Hansen J-test is made. The Hansen J-test is robust but is weakened by many instruments. For more information, see Roodman (2009).

Analyzing the results for the specification-tests for the estimators, the Hansen J-test still provides high p-values, even though not as high as one. P-values range between 0.37-0.97 and hence cannot the validity of the instruments be assured in the long-term either. In addition, there is little indication of autocorrelation as it is not possible to reject the null hypothesis of no second-order serial correlation in the majority of the specifications. However, autocorrelation seems to be present in the third model once again. The explanation power ranges between 30-50 percent in the longer run, i.e. it is lower than in the short-term analysis, but still fairly high and in line with previous research (Checherita-Westphal and Rother, 2012). The lower explanation power compared to the short-term analysis is likely explained by the lower variance when using five-year average growth periods.