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DEBT-DRIVEN GROWTH OR GROWTH-DRIVEN DEBT

Dissertation

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Dissertation

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Statement

I hereby confirm that the content of this dissertation thesis is my own work and all the resources that were used are listed among references.

Date: June 2024 ……

Ing. Dávid Hojdan

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ABSTRACT

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This dissertation examines the relationship between government debt and economic growth, highlighting the heightened relevance of this question in the aftermath of the global financial crisis, the European debt crisis and the COVID-19 pandemic. These crises have pushed government debt to new heights, highlighting the need for a nuanced understanding of how debt affects economic growth as governments face ongoing challenges such as ageing populations and climate change, which will put further pressure on public finance. Using panel autoregressive distributed lag (ARDL) models and quarterly data for 37 advanced economies from 1990 to 2019, the dissertation provides insights into the short- and long-term effects of government debt on real GDP. This methodological choice reveals a significant yet complex relationship between government debt and economic growth, suggesting that traditional growth regression models may not capture the full spectrum of this dynamic. The results do not provide conclusive evidence of a universal debt threshold that significantly affects growth, challenging previous claims of a one-size-fits-all threshold. In addition, the study applies an instrumental variables approach to assess the causal relationship between government debt accumulation and economic growth, while navigating the intricacies of endogeneity. Focusing on EU countries, components of the stock-flow adjustment are used as an instrument to examine the impact of government debt accumulation on economic growth. Despite the comprehensive approach, our results show no strong causal effect of debt accumulation on growth. The dissertation examines how government debt affects economic growth through channels such as country risk perceptions and sovereign bond yields. Using a methodological framework that combines panel ordered logit models and an event study methodology, the findings suggest that higher levels of government debt are associated with lower credit ratings, and credit rating downgrades consequently leading to higher sovereign risk premia. This relationship is particularly significant during economic downturns or financial instability,

highlighting the complex pathways through which government debt affects the economy. The findings suggest the debt-growth nexus is rather indirect and future studies should focus on examining the indirect effects of government debt on economic growth.

Keywords: government debt, economic growth, debt-growth nexus, panel ARDL model, instrumental variables method, ordered logit, event study

ABSTRAKT

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Táto dizertačná práca skúma vzťah medzi vládnym dlhom a ekonomickým rastom, s osobitným dôrazom na jeho dôležitosť v súvislosti s nedávnymi globálnymi ekonomickými krízami, vrátane finančnej krízy, dlhovej krízy v eurozóne a pandémie COVID-19. Tieto udalosti zvýšili vládny dlh na rekordné úrovne a zdôraznili nutnosť pochopenia vplyvu dlhu na hospodársky rast v čase, keď sa vlády zaoberajú výzvami ako starnutie populácie a klimatické zmeny. Analyzujúc štvrťročné údaje z 37 vyspelých ekonomík od roku 1990 do 2019 pomocou panelových ARDL modelov, dizertačná práca odhaduje ako krátkodobé, tak dlhodobé dopady vládneho dlhu na reálny HDP. Tento prístup poukazuje na zložitý vzťah medzi dlhom a hospodárskym rastom, signalizujúc, že bežné skúmanie pomocou rastových regresií nemusí dostatočne odzrkadľovať túto dynamiku. Naše zistenia nepotvrdzujú existenciu všeobecnej hranice dlhu, za ktorým rast signifikantne spomaľuje. Následne s využitím prístupu založeného na metóde inštrumentálnych premenných odhadujeme kauzálny vzťah medzi akumuláciou dlhu a hospodárskym rastom, pričom sa zameriavame na krajiny EÚ a používame špecifické komponenty zosúladenia dlhu a deficitu ako inštrument pre zmenu dlhu. Na základe tohto prístupu nebol preukázaný signifikantný kauzálny efekt akumulácie dlhu na rast. Navyše, práca skúma dopady vládneho dlhu na ekonomiku prostredníctvom kreditného rizika krajiny a výnosov na štátnych dlhopisoch, pričom sme zistili, že vyšší dlh vedie k nižším ratingom a zhoršenia ratingu zvyšujú rizikové prirážky na 10-ročných štátnych dlhopisoch, najmä počas ekonomických alebo finančných turbulencií, čo poukazuje na komplexné kanály, cez ktoré môže dlh ovplyvňovať ekonomiku. Zistenia dizertačnej práce naznačujú, že vzťah medzi dlhom a rastom je skôr nepriamy a budúce štúdie by sa mali zamerať na preskúmanie nepriamych účinkov vládneho dlhu na ekonomický rast.

Kľúčové slová: štátny dlh, hospodársky rast, vzťah medzi dlhom a rastom, panel ARDL, metóda inštrumentálnych premenných, ordered logit, event study

Contents

Introduction

The debt-growth nexus undoubtedly belongs to one of the most discussed and investigated topics in economic research. Research on the debt-growth nexus focusses on three key issues: examining the causal relationship between government debt and economic growth, the optimal level of debt and its sustainability over the long term. Studying the relationship between government debt and growth is crucial, especially in light of the global economic turmoil of the past two decades. The global financial crisis forced advanced economies to implement substantial fiscal interventions, leading to a significant increase in government debt. This increase was exacerbated during the European debt crisis, when countries such as Portugal, Italy, Ireland, Greece and Spain encountered severe sovereign financing challenges, turning debt management at the center of the eurozone's concerns. The Covid-19 pandemic in 2020 plunged the world into unprecedented economic turmoil. To combat the severe downturn caused by the lockdown and shutdown of key sectors, governments around the world were forced to implement massive fiscal stimulus packages. While these measures were necessary to stabilize economies and save jobs, they led to significant increases in government debt. As economies began to recover from the effects of the pandemic, another challenge emerged in 2022 with Russia's invasion of Ukraine. This conflict disrupted global commodity markets, particularly for energy and agricultural products, leading to a sharp rise in prices (Arndt et al., 2023). In response to inflationary pressures, governments have stepped up with subsidies and financial support programmes to ease the burden on households and businesses (Sgaravatti et al., 2021). This immediate surge in spending to address current economic hurdles further aggravate the scale of government debt, especially as nations shift to addressing more enduring challenges. As many have argued (for instance, Mian (2024)), the dominant problem of government debt during the crisis period is that most of the resources have been used to boost demand and less so to support the supply side of the economy, which is more important for long term growth. With the challenges of ageing population, rising security threats requiring greater military investment and the pressing need to tackle climate change, it's highly likely that countries around the world will see a further increase in government debt. Hence, understanding both the short-term and long-term implications of rising government debt on economic growth is essential in today's ever-changing global economic landscape.

Motivated by the vast literature and mounting policy concerns, this dissertation examines the relationship between government debt and economic growth, with a focus on developed economies. It aims to shed light on the complex interactions and causal pathways that are often neglected or overlooked in previous studies. In particular, the dissertation contributes to the existing literature by addressing previously under-investigated but important issues, including, but not limited to, reverse causality and the endogeneity of government debt and economic growth. Therefore, the study provides new methodological framework that promotes better understanding of these critical dynamics. By conceptualizing a new approach, this thesis establishes a new link between government debt and economic growth and the channels of government debt on broader areas of the economic system in three directions. First, unlike previous studies, this dissertation examines both the short-term and long-term effects of government debt on economic growth using quarterly data. The use of quarterly data allows for a more nuanced analysis, particularly in capturing the complexity and volatility inherent in turbulent economic periods. We hypothesize that separating the short-run effects of debt from its long-run effects is necessary for several reasons. One fundamental reason is related to the well-known channel of government debt to private sector investment decisions through its crowding out effect and/or through Ricardian equivalence, although the effect of the latter may differ depending on the time horizon. In the short run, the effect of reverse causality and simultaneity are likely to be more pronounced, when recessions are immediately transmitted to debt through automatic stabilizers and mechanical effects through the denominator. However, in the long run, as the market adjusts to new economic realities and assuming that governments allocate resources efficiently, government debt may yield higher economic growth. Second, this dissertation contributes to the study of the debt-growth nexus by investigating non-linear and conditional effects, while distinguishing between the long-run and short-run effects of government debt on economic performance. This is important because, one of the main concerns in studying the impact of government debt on economic growth is endogeneity and reverse causality, which leads to biased estimates. Many studies address this issue by applying instrumental variables methodology. In doing so, they often rely only on the previous level of debt (Cecchetti et al., 2011), which is not satisfactory due to the persistent nature of debt. Finding an appropriate external instrument for government debt is a very difficult task. The study by Panizza & Presbitero (2014) is the only major contribution in terms of introducing new instruments other than lagged values of debt. Our main contribution in this study is to

propose a novel instrument for debt change, which consists of components of stock-flow adjustment and can be used for advanced economies. Using this novel instrument, which we assume helps to minimize endogeneity, we estimate the causal effects of government debt accumulation on economic growth in a sample of EU countries between 2003 and 2019. Moreover, unlike most previous studies, we consider cross-sectional dependence in the debt-growth nexus as an important issue. Our sample of countries consists of high-income economies, mainly from Europe, many of which share a common currency, are highly interconnected and can be affected by common factors. This issue is particularly profound in the context of the debt-growth nexus due to common bailout mechanisms such as the European Stabilization Mechanism. Due to such "burden sharing" and interconnectedness, contagion can be more profound and fiscal policy in one country can affect several countries. Based on this, we contribute to the literature by using estimation techniques that properly account for cross-sectional dependence. Third, the dissertation contributes to the literature by examining how government debt shapes perceptions of country risk and influences government bond yields, shedding light on the broader economic implications of escalating debt levels. Methodologically, our first contribution in this direction lies in the use of a novel methodological approach by applying the fixed effects ordered logit model developed by Baetschmann et al. (2015) to quarterly data for EU countries, which includes turbulent periods such as the financial crisis and the aftermath of the European debt crisis. The second contribution lies in the event study estimates of the effect of rating downgrades on sovereign risk premia. In this case, we differ from previous studies by using scenario approach, where we find that effects of such downgrades were profound mainly in countries with bad reputation and during debt crisis period. We also contribute by finding that the effects of rating downgrades are most pronounced when countries reach non-investment grade.

Providing in-depth analysis, the dissertation contributes to a more nuanced and complex relationship between government debt and economic growth with the aim providing policymakers with better understanding that could enhance or promote more rigorous public finance management in a constantly changing global economic landscape. The dissertation also provides new conceptual and empirical approaches on how the complex debt-growth nexus should be further explored.

The thesis is organised as follows. The first chapter outlines the current understanding of how government debt affects economic growth. It reviews theoretical

frameworks that propose different channels through which government debt affects growth and other economic variables. Given the empirical focus of this dissertation, the existing empirical research is reviewed in detail. This includes discussions of studies investigating potential debt thresholds that could trigger a decline in growth, analyses of the conditional effects of debt, approaches to dealing with the endogeneity of debt and reverse causality, and examinations of the pathways through which debt can affects growth. The chapter wraps up with an overview of meta-analyses and review articles, providing a comprehensive picture of the research landscape.

The second chapter articulates the research objectives and describes how this study contributes to a broader understanding of the relationship between government debt and economic growth. The specific sub-objectives and hypotheses to be tested in subsequent chapters are detailed.

The third chapter investigates the complex relationship between government debt and real GDP in 37 advanced economies from 1990 to 2019. It uses a panel autoregressive distributed lag (ARDL) model to examine both the short-run and long-run effects of debt, inspired by theoretical research that posits different effects over different time horizons. In addition to assessing the direct impact of debt, the chapter also explores the potential for non-linear and conditional effects of government debt in order to gain a deeper insight into the complex ways in which debt levels affect economic outcomes.

Chapter 4 builds on the findings of the previous chapter and focuses on the causal relationship between government debt accumulation and economic growth. Recognizing the importance of addressing endogeneity to avoid bias, this chapter uses an instrumental variables approach to examine the impact of debt change on growth in 26 EU countries between 2003 and 2019. By using specific components of the stock-flow adjustment as instrument for changes in debt, it seeks to isolate the direct effects of debt accumulation on economic growth, ensuring that these components are unlikely to affect growth through other channels.

The fifth chapter examines the complex channels through which government debt affects economic growth, focusing in particular on risk perceptions and risk premia on government bonds. It examines how higher debt levels might affect sovereign credit ratings and, using an event study methodology, the impact of credit rating downgrades on

bond risk premia. This analysis seeks to shed light on the indirect channels through which sovereign debt can affect the economy, going beyond the direct impact on growth.

The final chapter draws conclusions and offers insights for future research and policy recommendations.

1 Literature review

In this section, we provide an overview of the existing research on the impact of public debt on economic growth. First, we look at theoretical frameworks that shed light on the mechanisms underlying this relationship. We then turn to empirical studies, a field that has expanded significantly following the seminal work of Reinhart & Rogoff (2010). We organize the empirical research by covering topics such as debt thresholds, the conditional effects of debt, studies dealing with endogeneity and reverse causality, research examining the channels through which debt affects growth, and the findings of meta-analyses and reviews.

1.1 The debt-growth nexus: Theory

Ricardian equivalence theory, which is attributed to David Ricardo, a key figure in the classical school of economics in the 19th century, revolves around the idea that changes in government spending are neutralized by opposite changes in private saving. In his 1820 work "Essay on the Funding System", Ricardo argues that whether the government finances its spending through taxes or debt, the outcome in terms of real economic variables remains unchanged. This is because an increase in taxes reduces disposable income, offsetting any potential shift in aggregate demand. Conversely, if the government chooses debt financing, households are likely to save more in anticipation of future tax increases. However, Ricardo himself was skeptical about the practical application of this theory, given the unlikely high level of rationality among economic agents. Despite its foundational status, Ricardo's theory did not gain much attention until Robert Barro's work formalized it into an overlapping generations model (Barro, 1974; Barro, 1989). For Ricardian equivalence to hold, several stringent conditions must be met, including perfect financial markets, constant population growth, rational behavior of economic agents based on the permanent income hypothesis, an infinite time horizon with the possibility of intergenerational transfers, and lump-sum taxation. Barro’s influential model has been criticized, particularly for its assumptions of population growth and economic stagnation, critics such as Feldstein (1976) argue that in an expanding economy, new debt does not necessarily lead to higher future taxes, especially if the growth rate exceeds the interest rate on public debt. In such scenarios, the government could finance debt service through new borrowing without increasing the tax burden, challenging the assumptions of the Ricardian model.

In their work Elmendorf & Mankiw (1999) describe what they call the conventional view on the issues of public debt and deficit. This conventional view outlines a standard approach in which the economy behaves in a Keynesian manner in the short run (with rigid prices and wages), while in the long run its behavior is consistent with classical theory with flexible prices. Elmendorf & Mankiw (1999) consider a deficit-financed fiscal stimulus, such as a tax cut, which increases households' disposable income in the short run. This increase in income translates into higher consumption of goods and services, thereby increasing aggregate demand. Due to the short-term rigidity of wages and prices, this shift in aggregate demand also increases real output in the economy. In the long run, however, this deficit-financed fiscal policy leads to a reduction in public savings and lower national savings. Elmendorf & Mankiw (1999) suggest that the increase in private saving will be smaller than the decrease in public saving. Consequently, lower national savings lead to lower total investment in the economy and a lower capital stock. These effects in turn lead to a reduction in national output. With a lower capital stock, the marginal product of capital increases, which drives up the income from this factor of production, thereby raising the interest rate. In summary, from this conventional theoretical perspective, while deficit financing may boost real output in the short run, it is detrimental to economic growth in the long run due to the crowding out effect. However, this conventional view does not distinguish between the sources of government borrowing, which could significantly alter the economic outcomes described. If the government engages in debt monetization by borrowing directly from the central bank, this may have different macroeconomic consequences than if it borrows externally from the bond market, especially from foreign investors. Debt monetization can potentially lead to inflationary pressures if it increases the money supply excessively (Burdekin & Wohar, 1990). On the other hand, external borrowing, especially from international markets, may attract foreign capital but may also lead to vulnerabilities in terms of exchange rate fluctuations and increased dependence on foreign investors (Nyambuu, 2016). This distinction is crucial, as the source of borrowing affects not only the immediate macroeconomic impact but also the long-term financial stability of the economy. Therefore, assessing the impact of deficit-financed fiscal policies requires a more nuanced approach that takes into account these different borrowing mechanisms.

Delong & Summers (2012) examine the effectiveness of fiscal policy during economic downturns, suggesting that fiscal deficits can have a positive impact on

economic growth in both the short and long term. They highlight the concept of hysteresis in the labor market, where prolonged periods of high unemployment can lead to a sustained increase in the natural rate of unemployment, thereby reducing the future potential output of the economy. In such situations, where the economy is significantly sluggish, DeLong and Summers argue for the use of expansionary fiscal policies financed by deficits. This approach, they suggest, can stimulate growth by using underutilized resources. A key insight from their study is that, in a low interest rate environment, such expansionary fiscal policy could potentially be self-financing. This is because the economic boost from government spending can lead to higher tax revenues and economic growth, which can offset the cost of the initial spending. This strategy is particularly relevant when traditional monetary policy tools are not effective, especially in economies with very low or zero interest rates. By using fiscal measures, governments have the opportunity to break a cycle of economic stagnation and pave the way for a stronger recovery. Such policies could allow accumulated debt to be repaid through the resulting economic growth (Delong & Summers, 2012).

The paper by C. Checherita-Westphal et al. (2014) combines a theoretical model with empirical analysis to examine the relationship between public debt and economic growth. The basic assumption of the model is that a government can only finance investment through debt, while current expenditure must be covered by government revenues. The optimal level of public debt is a function of the output elasticity of public capital (e.g. public infrastructure), suggesting that the lower the elasticity, the lower the optimal level of debt. This study, which covers the period 1960-2010, estimates the average debt level that maximizes growth for three groups of countries: OECD, EU, and euro area. The results suggest that euro area countries should aim for a public debt level of around 50% of GDP, while the recommendation for OECD countries is around 65% of GDP. The authors argue for the importance of integrating forward-looking budget reaction functions into debt targeting frameworks, which would allow for a more realistic and flexible management of public debt. Such an approach not only ensures fiscal discipline but also supports economic growth, thereby maintaining fiscal sustainability in the face of unexpected economic shocks and policy uncertainties. The research emphasizes the need for long-term optimizing behavior in public debt management, highlighting that these targets are not arbitrary, but are based on the golden rule of financing (the principle that governments should only borrow to finance investment, while current expenditure should

be covered by current revenues) and are essential for the sustainable management of public finances in an uncertain economic and political environment (C. Checherita-Westphal et al., 2014).

Greiner (2012) examines the relationship between public debt and economic growth. The paper investigates whether this relationship exhibits an inverted U-shaped pattern, building on Checherita-Westphal et al. (2012) who proposed an endogenous growth model with public capital and debt. Greiner extends this by allowing for a more general debt policy and finds that smaller public deficits and lower public debt consistently lead to higher long-run growth rates. This finding challenges the assumption that an optimal level of debt maximizes growth, suggesting instead that economic growth improves as debt declines. The paper provides a nuanced view of the impact of public debt on economic growth, emphasizing the importance of balanced budgets and controlled public spending (Greiner, 2012).

Teles & Mussolini (2014) investigate the relationship between public debt and economic growth within an endogenous growth framework. The study proposes a theoretical model which suggests that the ratio of public debt to GDP negatively affects the impact of fiscal policy on growth. The main reason for this is that government debt diverts part of the savings of the younger generation to pay interest on the debt, similar to a pay-as-you-go pension system, thereby altering the savings rate of the economy. The authors examine how the size of the public debt-to-GDP ratio limits the impact of productive government spending on long-term growth. Their model, an extension of the work of Barro (1990), incorporates overlapping generations and endogenous growth, allowing the government to incur debt to increase productive spending. However, they find that the impact of this spending on growth is limited not only by the tax burden and the debt ratio, but also by the debt-to-GDP ratio itself. Empirical analysis supports the theoretical model and shows significant variations in the impact of public debt on economic growth. The model shows that increases in productive expenditure lead to permanent productivity shocks and higher wages, which should increase economic growth. However, this positive effect is offset by the fact that public debt reduces the savings available for private investment, leading to a crowding out effect. This effect increases as public debt rises, reducing the marginal effect of productive spending on growth. Teles & Mussolini (2014) conclude that the relationship between debt and growth can vary under certain circumstances and that the effect of productive spending, such as on infrastructure,

education, and health, depends on both the government's primary surplus and the level of debt.

Proaño et al. (2014) develop a dynamic growth model that focuses on the nonlinear interactions between sovereign debt, financial stress, and economic growth. This model challenges traditional linear approaches by introducing the concept that the impact of government debt on economic growth varies depending on financial market conditions and a country's membership in a monetary union. The model suggests that debt affects the economy in a non-linear way, especially under conditions of high financial stress. It uses Non-Linear Model Predictive Control (NMPC) to solve the model numerically and highlights the role of bond yields as a crucial link between financial market conditions and economic activity. In particular, the model suggests that in an environment of high financial stress, the debt-to-GDP ratio can have a negative impact on growth, with this effect being more pronounced in countries within the European Monetary Union. This theoretical framework provides a nuanced understanding of how government debt and financial market conditions interact to influence economic growth and offers valuable insights for fiscal policy in different economic contexts (Proaño et al., 2014).

Exploring the complex relationship between public debt and GDP growth requires an understanding of how high debt levels can limit the effectiveness of countercyclical fiscal policy. Ramey & Ramey (1995) provide a crucial examination of this dynamic, revealing a negative correlation between economic volatility and growth rates across countries. This relationship highlights a critical channel through which elevated public debt could dampen GDP growth: by constraining the government's fiscal responsiveness during economic downturns. Such constraints not only increase output volatility, but also potentially dampen growth, as governments with high debt levels may opt for restrictive fiscal policies to mitigate the risks associated with shifts in investor sentiment. This is particularly evident in environments of financial distress or within tightly knit monetary unions, where fiscal flexibility becomes paramount. De Grauwe (2012) further enriches this discourse by emphasizing the importance of monetary arrangements and debt structures, rather than the sheer level of the public debt-to-GDP ratio, in determining a government's fiscal maneuverability.

1.2 The debt-growth nexus: Empirics

The study of the debt-growth nexus has mainly focused on the non-linear effects of public debt. Central to this discussion is a hypothesis introduced by Reinhart & Rogoff (2010), which suggests that debt levels above a threshold, typically around 90% of GDP, begin to hamper economic growth. Although it has triggered extensive discussion, the evidence remains inconclusive due to the complex interdependencies involved. A major challenge is to address the endogeneity of public debt and its bidirectional causality with economic growth, where weak growth can trigger expansionary fiscal policies and a surge in debt. Moreover, the relationship between debt and growth is complex, with debt potentially affecting growth through various indirect channels. Our dissertation navigates through the extensive empirical literature, starting with an overview of the predominant studies on the non-linear effects of debt on economic growth. We then move on to a detailed discussion of studies that explore the nuances of endogeneity and reverse causality. We then turn to analyses that examine how debt might indirectly affect other economic variables, which in turn might affect growth. Our final section summarizes the evidence from comprehensive review studies and meta-analyses, bringing together the range of findings and interpretations that have contributed to our understanding of the debt-growth dynamic.

1.2.1 Public debt thresholds

The discussion on the complex interaction between public debt and economic growth was initiated by Reinhart & Rogoff (2010) with their publication "Growth in times of debt". By examining a historical dataset of public debt figures for 44 countries, both developed and developing, they found that the relationship between public debt and economic growth is minimal when debt levels are low. However, they observed a significant negative impact on actual economic growth once public debt exceeds the 90% of GDP benchmark. Beyond this point, median growth rates fall by almost 1 percentage point and average growth rates can fall by up to 4 percentage points compared to rates observed at lower debt levels. They find that this phenomenon holds for both developed and developing countries. Reinhart & Rogoff (2010) were not the only ones to find a critical decline in economic growth once a certain level of debt, around 90% of GDP, was exceeded. Similarly, Baum et al. (2013) conducted an analysis of the impact of debt on growth in twelve euro area countries from 1990 to 2010. Using a panel model with a dynamic threshold, their research found that crossing a 95% public debt-to-GDP ratio was

correlated with a subsequent decline in real economic growth, echoing Reinhart and Rogoff's important findings on the negative impact of high debt levels on a country's economic performance.

In the aftermath of the Great Financial Crisis, Reinhart & Rogoff (2010) study "Growth in times of debt" triggered a significant response not only in academic circles but also among policymakers. In the postcrisis period, a strong narrative in favor of austerity measures came to the forefront in both the US and Europe. The US House Budget Committee cited the work of Reinhart and Rogoff as evidence that high debt-to-GDP ratios undermine current economic performance and could trigger another crisis in the future (Ryan, 2012). Similarly, in an open letter to European finance ministers (Rehn, 2011), the European Commissioner warned of the risks associated with breaching the '90% rule', arguing that it could dampen economic activity and business dynamism. A similar stance in favor of austerity was taken by the former UK finance minister (Osborne, 2013).

The study by Reinhart & Rogoff (2010) served as a strong scientific endorsement of policies aimed at reducing deficits in order to avoid the negative effects of high debt levels. However, the conclusions of this study were challenged by Herndon et al. (2014), who identified numerous problems in the handling of the data that cast serious doubt on Reinhart and Rogoff's findings. After a thorough replication of the original study, Herndon and colleagues uncovered selective exclusion of data, coding errors, and inappropriate weight adjustments. These significant flaws led to inaccuracies and an exaggerated portrayal of the negative growth impact of public debt in advanced economies. After correcting for these errors, they found that the average growth rate for developed countries with public debt levels above 90% in the post-war period was 2.2% per annum, in stark contrast to the -0.1% growth rate reported by Reinhart and Rogoff. Consequently, Herndon et al. (2014) argued that the other results were likely biased by these errors, undermining the original paper's claim of a universal, robust debt threshold across countries and time periods.

Cecchetti et al. (2011) examined the impact of public debt on economic growth in OECD countries from 1980 to 2010, using a standard growth regression with dummy variables for different debt thresholds. They estimated the optimal level of public debt, beyond which real GDP per capita growth slows down, and identified this threshold at 85% of GDP. The accumulation of 10 percentage points of public debt above this level slows down GDP per capita growth by 0.13 percentage points on average. However, they

advise policymakers not to target this debt level because of potential unexpected economic shocks and future debt accumulation due to ageing populations.

Minea & Parent (2012) revisited the conclusions of Reinhart & Rogoff (2010), applying more advanced econometric techniques and drawing on different data sources. Using a panel smooth threshold regression (PSTR), they identified several public debt thresholds at which the effect of additional debt on growth shifts from positive to negative and vice versa. Specifically, they found that real GDP per capita growth declines between debt levels of 90 and 115% - albeit less drastically than Reinhart and Rogoff originally reported. Interestingly, beyond 115%, they found another threshold at which further debt accumulation begins to have a positive impact on economic growth, with average growth rates at this point comparable to those found for debt levels between 60% and 90%. This study suggests a more complex relationship between debt and growth than previously understood. Karadam (2018) further explored this complexity by analyzing a broad dataset for 135 countries from 1970 to 2012, and also using a PSTR model to determine the debt threshold at which the impact of public debt on growth shifts from positive to negative. He found the general threshold for the sample to be around 106% of GDP, while for developing countries it was estimated to be 88%. The methodology highlighted the gradual rather than abrupt shift in the impact of debt on growth at these thresholds. In addition, Karadam (2018) contributed by exploring the importance of the composition of public debt on the debt-growth nexus, showing that both total short-term external debt and long-term public external debt have significant non-linear effects on economic growth. These debts, like total public debt, start to have a negative impact on growth once certain thresholds are crossed, highlighting the nuanced dynamics of the debt-growth relationship.

Arčabić et al. (2018) undertook a comprehensive investigation to identify a potential public debt threshold that could negatively affect economic growth, using a variety of econometric techniques, methods and databases. Using a panel model with a dynamic threshold, their goal was to identify a debt level beyond which growth is negatively affected. Despite analyzing three different datasets and using different estimators and specifications, they were unable to identify a consistent public debt threshold that universally leads to a slowdown in economic growth.

Caner et al. (2010) conducted a comprehensive analysis of a wide range of countries, including 75 developing and 26 developed economies, over the period 1980-2008. Their research aimed to identify the existence of a critical debt level, beyond which economic

growth begins to deteriorate significantly. Across the entire dataset, they identified a public debt threshold of 77% of GDP. Exceeding this threshold means that each additional percentage point of debt is associated, on average, with a 0.017 percentage point reduction in economic growth. The results are even more pronounced for developing countries, where the debt threshold is 64% of GDP, with each additional percentage point of debt leading to a 0.02 percentage point reduction in growth. However, Caner et al. (2010) emphasize that these thresholds are derived from long-term data averages and suggest that the relationship between debt and growth may not be as observable over shorter time horizons.

Égert (2015) conducted a thorough econometric analysis to reassess the findings of the Reinhart & Rogoff (2010) study, attempting to closely match the data from the original research. Similar to the findings of Herndon et al. (2014), Égert (2015) highlighted the difficulty of establishing a definitive public debt threshold, noting that any estimated limits are highly dependent on the choice of time periods, countries and econometric methods. Nevertheless, his analysis suggests a negative correlation between debt and economic growth starting at relatively low debt levels, namely between 20 and 60% of GDP. He argues that this underscores a broader point: the impact of public debt on economic growth can vary significantly depending on the country, the historical period, and the prevailing economic circumstances.

Bentour (2021) critically reassesses the debt threshold debate, questioning the notion of a universal 90% threshold for advanced economies. Through a novel application of Hansen (2017) regression kink model to data from 1880 to 2010 for 20 advanced countries, Bentour's study shows that the relationship between public debt and economic growth is not only variable over time, but also distinctly country-specific. This analysis shows that any existing debt threshold is not universal, but rather varies significantly across countries, undermining the concept of a one-size-fits-all debt threshold. By focusing on country-specific thresholds rather than a generalized benchmark, Bentour (2021) highlights the complexity and heterogeneity of the debt-growth nexus across countries and historical periods. The results underscore the instability and variability of the debt-growth relationship, suggesting that country-specific factors play a crucial role in shaping this dynamic.

Kassouri et al. (2021) examine the relationship between public debt and economic growth in 62 emerging and developing countries from 2000 to 2018, using interactive fixed

effects and dynamic panel threshold methods. Their analysis reveals an inverted U-shaped relationship, showing that public debt supports economic growth up to certain thresholds: 50% of GDP for upper-middle-income countries and 25% for low-income countries, beyond which it hampers growth, especially in low-income countries. The study addresses key technical issues such as cross-sectional dependence, heterogeneity, and endogeneity, and provides a detailed examination of how public debt affects growth differently across countries depending on their income level. The results suggest that while upper-middle-income countries can sustain higher debt levels, low-income countries face more severe growth constraints once they exceed their lower debt thresholds.

1.2.2 Conditional effects of debt

Afonso & Jalles (2013) explored the dynamics between public debt and economic growth by analyzing data from 155 countries over the period 1970-2008. Their study went beyond the direct relationship by considering factors such as fiscal consolidation, investment accumulation and aggregate factor productivity. They found a consistently negative effect of public debt on growth across all countries in their sample and noted that this finding held up even when a variety of econometric techniques were used and numerous variables were controlled for. However, they found no evidence to support the idea that the relationship between debt and growth reflects a quadratic function similar to the Laffer curve. Furthermore, Afonso & Jalles (2013) found that the composition of debt maturity plays an important role in this relationship. Specifically, OECD countries with predominantly longer-term debt maturities tend to experience higher economic growth, suggesting that longer debt maturities may provide better protection against sovereign debt financing crises. The study also highlights how the impact of debt varies with its level: for countries with public debt below 30% of GDP, a 10% increase in debt marginally boosts economic growth by 0.1%. Conversely, for countries with debt levels above 90% of GDP, an additional 10% of debt correlates with a 0.2% reduction in growth. Using a methodology developed by Hansen (2000), Afonso & Jalles (2013) estimate an endogenous threshold for public debt to GDP of 59% for the aggregate sample, 58% for euro area countries and a higher threshold of up to 79% for developing countries, suggesting that the optimal level of debt before adverse effects set in varies significantly across economic contexts.

Afonso & Alves (2015) examined the impact of public debt on real GDP per capita growth in fourteen EU countries from 1970 to 2012, using both annual data and five-year

averages to distinguish between short-term and long-term effects. A key aspect of their research was to analyze how the impact of public debt on growth interacts with various macroeconomic factors. For example, they found that taxes on profits and private sector credit growth had a negative impact on growth when combined with debt, while factors such as current account balances and urbanization rates had a positive impact. Their findings consistently showed a negative relationship between the level of public debt and economic growth in both the short and long term, with a 1% increase in public debt leading to a 0.01% reduction in growth. Significantly, they also found that the cost of servicing the debt had a much larger negative impact on growth - up to ten times greater than the impact of the debt itself. Afonso & Alves (2015) suggest a nuanced, inverted U-shaped non-linear relationship between debt and growth, with an estimated optimal debt limit for the EU countries studied of around 75% of GDP for annual periods and a very similar figure of 74% for five-year averages.

Ahlborn & Schweickert (2018) examined how the impact of public debt on economic growth differs significantly across groups of countries, categorizing them according to their institutional and economic frameworks. They identified three distinct clusters within OECD countries: liberal economies, characterized by a market-oriented approach and consumption-driven public spending; continental economies, which include EU founding members with conservative welfare states; and Nordic economies, known for their regulated markets and extensive welfare systems. The results show different effects of debt across these classifications. In particular, continental economies show a pronounced negative impact of public debt, especially when it exceeds 75% of GDP. Conversely, liberal economies experience a positive effect of public debt on growth. The Nordic countries show a non-linear relationship, with a debt threshold of 60% of GDP marking the point at which the effect turns from neutral to negative. Ahlborn & Schweickert (2018) attribute these different results to factors such as fiscal uncertainty and the efficiency of government operations and provide a theoretical framework for understanding the heterogeneous effects of debt in different economic and institutional settings.

Chudik et al. (2017) advanced the debate on the impact of public debt on economic growth by challenging the notion of a universally applicable debt threshold. They introduced a novel econometric approach to detect a 'debt frontier' within panel data models that account for heterogeneity across subjects and cross-sectionally dependent errors. This methodology was applied to data from 40 developed and developing countries

over the period 1960-2010. A key finding of their research is the nuanced impact of public debt on growth: economic growth declines significantly when public debt exceeds 50-60% and the country is on an upward debt trajectory. Conversely, when debt is above this range but falling, the impact on economic growth is not statistically different from that of countries with lower debt levels. Furthermore, Chudik et al. (2017) find a consistently negative long-term effect of public debt on economic growth, which depends on the duration of the debt increase. Short-term increases in debt, which may counteract cyclical fluctuations, do not have a long-term negative effect on growth. However, persistent increases in government debt ultimately harm long-term economic growth. Importantly, the study shows that there is no single debt threshold that applies to all countries; instead, the critical debt level is variable, influenced by a country's specific debt dynamics and its institutional, financial, and political context. This underscores the complexity of the relationship between public debt and economic growth and highlights the importance of considering a wide range of factors when assessing the impact of debt on an economy.

Chiu & Lee (2017) delve into the nuanced effects of public debt on economic growth, taking into account the different degrees of risk associated with different countries and time periods. Using a panel smooth transition regression (PSTR) model, they analyse data from 61 countries over the period 1985 to 2009. Their results show that in high-risk environments, increases in public debt tend to slow economic growth. Conversely, in low political and financial risk environments, the negative impact of debt on growth is mitigated. Moreover, they find that in conditions of low overall and economic risk, an increase in public debt can actually stimulate economic growth. The research also highlights that the impact of public debt on growth is influenced by the income group of the country and the existing debt level, suggesting a different response to debt accumulation in different economic contexts. Chiu & Lee (2017) suggest that the decision to take on additional debt should be carefully weighed against economic indicators and the prevailing risk landscape of the country in question, emphasizing a tailored approach to debt management based on specific national circumstances.

Kourtellos et al. (2013) examined how different growth determinants interact with public debt and its influence on economic performance, noting that the impact of public debt on growth cannot be attributed solely to debt levels. Their analysis included a number of variables to assess how increased public debt affects economic growth in different countries. Looking at data from 82 countries between 1980 and 2009, they found that the

quality of democracy plays a key role in mediating the effect of debt on growth. Specifically, in countries with lower levels of democratic quality (below a certain threshold), higher public debt accumulation correlates with lower economic growth. Conversely, in highly democratic countries (above the threshold), the effect of public debt on growth is not statistically significant. Kourtellos et al. (2013) set a relatively low threshold for the quality of democracy, highlighting that high levels of democracy have been observed over the past decade not only in European countries, but also in Latin American countries. This finding suggests that the relationship between public debt and economic growth is significantly influenced by a country's democratic governance, highlighting the complexity of the impact of debt on economic dynamics and the importance of including political and institutional factors in such analyses.

Butkus (2022) examine the interaction between public debt and economic growth, with a particular focus on the role of uncertainty, using an extensive unbalanced panel dataset covering 104 countries across different geographical regions and income groups from 1998 to 2017. Using interest rate spreads and risk premia as measures of financial risk and uncertainty, the study sheds light on how different levels of uncertainty affect debt growth dynamics. The results show that lower levels of uncertainty can amplify the positive effects of debt on growth, while higher levels of uncertainty can weaken these positive effects. In addition, Butkus (2022) highlight the importance of uncertainty in defining the thresholds at which public debt begins to impede economic growth. The research suggests that these thresholds are significantly lower in situations characterized by high uncertainty than in scenarios with less uncertainty. This underlines the importance of managing and mitigating uncertainty for countries seeking to use debt as a means of economic expansion without experiencing the negative growth effects often associated with high debt levels.

Ostrihoň, et al. (2023) examine the relationship between public debt and economic growth in the EU, searching for an optimal debt threshold in different economic contexts. They analyze data from 28 EU states from 1995 to 2014 using an augmented Solow growth regression model, assessing factors such as euro area membership, government spending and private sector debt. Their results challenge the notion of a universal debt threshold, revealing variable optimal debt levels influenced by specific economic conditions. In particular, high government consumption is associated with lower public debt thresholds, while private debt can raise them. Although the average optimal thresholds

are in line with the EU's 60% debt-to-GDP guideline, the significant cross-country variability underlines the limits of a one-size-fits-all approach. The study argues for tailored fiscal policies within the EU, taking into account the unique economic landscapes of its member states.

1.2.3 Endogeneity and reverse causality

Panizza & Presbitero (2014) use an instrumental variables approach to investigate the causal relationship between public debt and economic growth. Their work challenges previous studies, such as those by Reinhart & Rogoff (2010) and Cecchetti et al. (2011), which found a negative impact of debt on growth, suggesting that an unobserved factor affecting both variables could be responsible. This factor could be a banking crisis, which simultaneously leads to a decline in GDP growth and an increase in debt. In order to accurately determine the causal effect of debt on growth, it is crucial to find an instrument that is related to public debt but doesn't affect economic growth through another channel. Panizza & Presbitero (2014) use an innovative instrument that combines the currency composition of public debt with exchange rate fluctuations. This instrument is particularly relevant for countries with a portion of their debt in foreign currency, as a change in the exchange rate directly modifies the amount of debt without affecting economic growth through other channels. Their analysis showed no causal effect of public debt on growth. This conclusion, together with the results of other studies such as Arčabić et al. (2018), points to the possibility of reverse causality between debt and growth, which could explain the negative correlation observed between these variables.

Checherita-Westphal & Rother (2012) contribute to the discussion on the non-linear effects of public debt on economic growth, particularly in twelve euro area countries from 1970 to 2010. Using a panel fixed effects model, they identify a debt threshold of 90-100% of GDP, beyond which additional debt is correlated with lower economic growth. A major criticism of such analyses often revolves around the issue of reverse causality. To mitigate the influence of the business cycle on their results, Checherita-Westphal & Rother (2012) use multi-year moving averages of economic growth as their dependent variable. To further address the challenge of endogeneity, they use instrumental variable models, selecting instruments such as different time lags of debt and average debt levels in other euro area countries. Despite these methodological adjustments, the identified debt threshold of 90-100% of GDP is consistent across different model specifications.

Ash et al. (2017) provide a comprehensive assessment of the relationship between public debt and GDP growth in advanced economies, using data from the late 19th century to 2011. Their analysis, which accounts for endogeneity by focusing on the timing of changes in public debt and growth, finds no significant negative relationship or threshold effects between public debt and growth, challenging previous influential studies that suggested a significant negative impact when debt exceeded 90% of GDP. The authors attribute previous findings to specific parametric models or the undue influence of outliers in small samples. Through a robust assessment using a variety of methods - including time series analysis, instrumental variables and controlling for lagged GDP growth, Ash et al. (2017) show that any perceived negative impact of public debt on GDP growth diminishes or becomes statistically insignificant when past growth is taken into account or when data after 1970 are examined. Their semi-parametric analysis also shows that the relationship between debt and growth is essentially flat for debt levels above 50% of GDP, suggesting that the causal direction is more likely to be from GDP growth to public debt. This conclusion is reinforced by the observation that public debt is more strongly correlated with past GDP growth than with future GDP growth, suggesting that weaker GDP growth may lead to higher public debt due to factors such as higher deficits from lower tax revenues and higher public spending. Importantly, Ash et al. (2017) criticize the methodology and sample selection of previous studies, highlighting how small variations or the influence of outliers can distort the results. They argue against the existence of a public debt threshold that significantly affects growth and question austerity policies based on such thresholds.

Amann & Middleditch (2020) also critically reassess the widely discussed debt threshold hypothesis. They do so through time-series approach, using both revised datasets and recent high-frequency data. Their comparative analysis spans different frequencies and critical time periods, in particular the periods before and after the financial crisis. This approach provides compelling evidence that challenges the debt threshold theory. Contrary to the findings of Reinhart & Rogoff (2010), Amann & Middleditch (2020) find little support for the premise that elevated debt levels directly constrain economic activity. They propose an alternative interpretation in which economic recessions are more likely to lead to an increase in debt, suggesting a reverse causality scenario.

In their study, Bell et al. (2015) revisit data from Reinhart & Rogoff (2010) to examine the consistency and causal direction of the relationship between public debt and

economic growth. Their main contribution is to account for the heterogeneity of this relationship across countries, using multilevel models that allow statistical parameters to vary both within and across countries. Their analysis confirms significant differences in the debt-growth relationship across countries. Remarkably, when a time trend is included in their model, the average effect of debt on growth becomes statistically insignificant. Moreover, by using a multi-level distributed lag model to explore causality, they find predominantly evidence supporting the notion that economic growth affects public debt in most countries, rather than the reverse. This finding contrasts sharply with the conclusions of Reinhart & Rogoff (2010), which Bell et al. (2015) criticize as being overly simplistic and not representing stylized facts.

Much of the research exploring reverse causality in the debt-growth nexus uses Granger causality techniques. Developed by Granger (1969), this approach examines whether the inclusion of historical data on a variable X, along with past observations of a variable Y, improves the prediction of Y's future values beyond what could be achieved with Y's history alone. The central point of Granger causality is its ability to improve forecasting: if the addition of X's past data to the model leads to more accurate predictions of Y's future, then X is said to Granger cause Y. Importantly, this method emphasizes the improvement in predictive accuracy, which differs from traditional notions of causality that imply a direct influence of one variable on another. A paper by Kempa & Khan (2017) examines the direction of Granger causality between public debt and economic growth across G7 countries. The authors use a causality test based on an augmented VAR model to identify the direction of causality. Kempa & Khan (2017) find unilateral Granger causality in the direction from growth to debt in Canada, Italy, Germany and Japan, bilateral causality in France, and no causality in the United Kingdom and the United States. With a limited sample of data ending before the Great Financial Crisis, the authors find no causality between debt and growth in any country except Canada and the United Kingdom, where causality runs from growth to debt. Granger causality between public debt and economic growth has also been investigated by Lof & Malinen (2014), Ferreira (2009) and Puente-Ajovín & Sanso-Navarro (2015). In contrast to Kempa & Khan (2017), these studies tested Granger causality in panel data. The paper by Ferreira (2009) was one of the first in which the author empirically tested reverse causality in the aforementioned relationship. Using panel data for OECD countries between 1988 and 2001, Ferreira (2009) found that Granger causality is always present in both directions. Lof & Malinen (2014)

use data from 20 advanced economies and find no robust effect of public debt on growth, even at higher debt levels. This conclusion is confirmed by Puente-Ajovín & Sanso-Navarro (2015), who use a sample of 16 OECD countries over the period 1980-2009. However, instead of Granger causality from public debt to growth, both Lof & Malinen (2014) and Puente-Ajovín & Sanso-Navarro (2015) find the existence of Granger causality in the opposite direction. They interpret these results consistently, namely that the negative correlation between high public debt and economic growth observed in a number of studies (Reinhart & Rogoff, 2010; Cecchetti et al., 2011) is actually due to reverse causality, with debt accumulation driven by automatic stabilizers, tax cuts and expansionary fiscal policies when growth is low.

Arčabić et al. (2018) explored the complex relationship between public debt and economic growth, with a particular focus on the possibility of reverse causality, using a panel vector autoregression model. Their findings challenge the conventional wisdom that high public debt necessarily leads to lower economic growth, which they found to be the case even when debt exceeds 90% of GDP. Interestingly, by applying Granger causality tests, they discovered an inverse dynamic: it is often the slowdown in GDP growth that leads to an increase in public debt, rather than the other way around. This finding reveals a more nuanced interplay between public debt and economic outcomes, suggesting that the flow of causality is predominantly from economic growth to rising debt levels.

The aforementioned studies dealing with reverse causality have investigated this phenomenon using standard tools based on the Granger causality principle. However, as explained by De Vita et al. (2018), these methods are limited by the assumption of a linear relationship between variables. De Vita et al. (2018) address this gap by investigating both linear and non-linear Granger causality between public debt and economic growth. Their study, which covers nine euro area countries, the UK, the US and Japan from 1970 to 2014, does not confirm a significant causal relationship in either direction for eight of the countries. There was no robust causal relationship, with two-way causality found only in Austria. One-way causality from debt to growth was found in France, Luxembourg and Portugal, but with minimal estimated elasticities, underlining the complexity of these economic relationships.

1.2.4 Channels of impact

Relatively few studies have attempted to go beyond standard growth regressions to examine the impact of public debt on growth, and to explore the channels of influence suggested by the theoretical literature. This substantial research gap is also highlighted by review studies, such as those by Panizza & Presbitero (2013) and Heimberger (2023), which highlight the lack of investigation into these nuanced dynamics.

In examining the complex dynamics between public debt and economic growth, Schclarek (2004) provides a critical analysis of how public external debt acts as a central factor in shaping the economic trajectories of developing countries. Schclarek (2004) highlights the significant negative impact of public external debt on economic growth in developing countries, mainly through its adverse effects on capital accumulation. This research emphasizes that the channels through which public debt affects growth are not uniform across economies, with the most important channel in developing countries being the reduction in resources available for investment. The paper finds no substantial evidence linking debt to changes in total factor productivity or private saving rates. Instead, it suggests that the accumulation of public external debt can discourage investment in physical and human capital, thereby hampering growth.

Study by Kumar & Woo (2010) shows the significant negative impact of high public debt on economic growth, mainly through its effects on labor productivity and capital accumulation. The study finds that an increase in the debt-to-GDP ratio can slow down GDP growth, with the relationship being non-linear - indicating that higher debt levels have a disproportionately negative impact. Using a growth accounting methodology, the study examines the channels of impact and shows that the main channel through which public debt slows growth is a reduction in labor productivity. This is attributed to lower investment rates and slower growth of the capital stock, highlighting the crucial ways in which high public debt can hinder economic expansion by dampening the essential drivers of growth such as productive investment and efficient use of capital.

In addition to estimating the debt frontier, Checherita-Westphal & Rother (2012) also examined possible channels of the impact of public debt on growth. The impact through private saving, public investment and total factor productivity was found to be statistically significant. On the other hand, the effects through interest rates and private investment were not statistically significant. Kumar & Baldacci (2010) examine the impact of debt on interest rates in 31 developed and emerging countries from 1990 to 2008 and find a

significant relationship. Their research suggests that as government debt and deficits escalate, so do 10-year government bond yields. This correlation could be explained by traditional mechanisms, such as the crowding out effect described by Elmendorf & Mankiw (1999), or by the pathway through which rising debt increases the probability of default and subsequently raises interest rates.

In their 2011 study, Afonso et al. examine the impact of various factors on sovereign credit ratings, using data from the main international rating agencies for 1995-2005. They use advanced econometric models to distinguish between the immediate and longer-term effects of fiscal and macroeconomic variables on ratings. The research finds that in the short run, sovereign ratings are significantly affected by fiscal variables such as government debt and budget balance, as well as GDP per capita and real GDP growth. In the long run, however, ratings are influenced by government effectiveness, external debt, foreign exchange reserves, and past defaults. Afonso et al. (2012) analyze the effect of rating announcements by Standard & Poor's, Moody's and Fitch on EU sovereign bond yields and CDS spreads from 1995 to 2010. Their event study shows that markets react significantly to rating changes, especially negative ones, suggesting that downgrades catch markets by surprise. They find a rapid reaction within days to such announcements and a bidirectional causality between ratings and spreads in the short run. In particular, the study finds spillovers within the EU, especially from lower-rated to higher-rated countries, and a persistence effect, where recently downgraded countries face higher spreads. This research underlines the importance of strong macroeconomic and fiscal fundamentals in avoiding downgrades and their negative impact on borrowing costs, while suggesting further research into the underlying reasons for rating changes and their impact on markets.

1.2.5 Review and meta studies

In their review paper, Panizza & Presbitero (2013) critically assess the complex relationship between public debt and economic growth, challenging prevailing assumptions that high public debt necessarily leads to lower economic growth. Their comprehensive analysis reveals a lack of substantive evidence for commonly cited debt thresholds that allegedly impede growth. The paper highlights the variability and heterogeneity of the debt-growth relationship across countries and time periods and argues for a nuanced approach to understanding the impact of debt on the economy. Key factors such as the quality of institutions and the specifics of public debt accumulation are highlighted as crucial to this relationship. Panizza & Presbitero (2013) call for future research to explore

these differences and the mechanisms through which debt may affect growth, suggesting the use of advanced econometric techniques to shed light on the true nature of these dynamics. Their review underscores the importance of prudent debt management, while cautioning against oversimplified narratives that directly link debt to economic decline based on empirical evidence.

Rahman et al. (2019) conducted a systematic review to explore the consensus on the relationship between public debt and economic growth, particularly in light of the controversial 90% debt-to-GDP threshold proposed by Reinhart & Rogoff (2010). Their analysis, based on 33 selected articles from the SCOPUS database, shows that the impact of public debt on economic growth varies considerably, with results suggesting positive, negative or even non-linear relationships. This suggests that the Reinhart & Rogoff (2010) hypothesis of a universal 90% threshold is not universally applicable across countries. The study underlines the importance of the purpose for which debt is incurred, highlighting that borrowing for productive investment can boost economic growth. However, it also cautions against indiscriminate borrowing, pointing out that debt without proper management can be detrimental to economic growth. Concluding that there is no one-size-fits-all approach to public debt and economic growth, Rahman et al. (2019) argue for tailored fiscal policies that take into account the unique circumstances of each country.

The seminal meta-study by Heimberger (2023) thoroughly examines the complex relationship between public debt levels and economic growth through a comprehensive review and meta-regression analysis of 816 estimates from 47 studies. This research is a crucial intervention in the ongoing debate on the impact of public debt on economic growth, a topic that has produced several conflicting results over the years. Heimberger's analysis specifically targets the heterogeneous results reported in the literature and finds that, on average, a 10-percentage point increase in the public debt-to-GDP ratio is correlated with a modest 0.14 percentage point decrease in annual growth rates. However, this relationship loses its statistical significance after adjustment for publication bias, suggesting that existing studies may have overstated the negative impact of debt. The study critically evaluates the notion of a universal public debt-to-GDP threshold - in particular, the 90% mark posited by contributions such as Reinhart & Rogoff (2010) and finds that it lacks robust empirical support. Heimberger's nuanced approach shows that threshold estimates vary considerably depending on data and econometric choices, effectively challenging the premise of a single threshold above which economic growth is

significantly hampered. Moreover, the meta-regression analysis highlights the importance of accounting for the endogeneity between public debt and growth, suggesting that the negative impact of public debt on growth appears less pronounced when such interdependencies are taken into account. This comprehensive meta-study not only challenges prevailing narratives about the universally harmful effects of high public debt on economic growth, but also opens avenues for future research. Heimberger (2023) argues for studies that explore the conditional factors and transmission channels through which public debt affects growth, suggesting the need for a deeper understanding of the diverse effects of debt in different national and temporal contexts. By highlighting the limitations of current empirical evidence and the potential biases within the literature, Heimberger's work makes a significant contribution to the discourse on public debt and economic growth, emphasizing the need for nuanced analysis and policy formulation in the face of rising global debt levels.

2 Research objectives and contributions

The main objective of this dissertation is to examine and estimate the relationship between government debt and economic growth, with a particular focus on causality and transmission channels in developed economies. This focus on causality is essential as much of the existing literature does not adequately address issues of reverse causality and the endogeneity of government debt, which can significantly drive the results observed in empirical studies (Ash et al., 2017). In line with this perspective, Heimberger (2023) suggests that further research on the debt-growth nexus should pay particular attention to a comprehensive treatment of endogeneity and a more thorough investigation of how debt affects growth. In response to these gaps, this dissertation breaks down the main objective of exploring the relationship between government debt and growth into more specific complementary objectives. These are thoroughly addressed in chapters 3 to 5.

Our first partial objective is to analyze the relationship between government debt and economic growth in advanced economies on a quarterly basis, using a panel cointegration approach. The practice of examining this relationship using quarterly data is not common in the literature on the debt-growth nexus. The use of a cointegration approach, specifically the estimation of panel ARDL (autoregressive distributed lags) models, allows us to assess the impact of government debt in both the short and long run, which is grounded in the theoretical literature (Elmendorf & Mankiw, 1999). In addition, in chapter three we pursue a secondary partial objective of investigating potential nonlinearities and conditional effects of government debt. The existence of nonlinearities, suggesting that economic growth slows down significantly when debt exceeds a certain threshold (e.g., 90% of GDP), has been proposed in various studies (e.g., Reinhart & Rogoff (2010); Minea & Parent (2012)). However, the impact of debt may also vary depending on other moderating variables, as noted by Ostrihoň, et al. (2023) and Butkus (2022). This thesis has also addressed the issue of cross-sectional dependence, an important aspect highlighted by Heimberger (2023).

The third partial objective of the dissertation is to identify an appropriate instrument for estimating the causal effects of government debt accumulation (changes in debt) on economic growth. While the use of instrumental variables methodology in the debt-growth nexus is relatively common, the instrument often chosen is the prior level of debt (Cecchetti et al., 2011). However, this approach aiming to deal with endogeneity may not

be entirely satisfactory given the persistent nature of debt. The only study we are aware of that has addressed the challenge of finding a relevant instrument is Panizza & Presbitero (2014), who used the valuation effect. This effect captures the changes in the value of debt denominated in foreign currency due to exchange rate fluctuations and is appropriate for countries with a significant share of their debt in foreign currency. This situation is not typical for advanced economies, which tend to issue debt in domestic currency. We propose a new variable as an instrument that, to the best of our knowledge, captures the exogenous part of debt changes. We then examine the relationship between government debt accumulation and subsequent economic growth. Conducted with annual data on a set of 26 EU countries from 2003 to 2019, our analysis represents a novel approach to investigate the causal impact of debt accumulation on economic growth, with detailed results and methodology described in chapter 4.

The fourth partial objective of this dissertation examines the influence of government debt on perceived country risk and its subsequent impact on sovereign bond yields. While much of the existing literature on the debt-growth relationship focuses primarily on estimating growth regressions, there's a notable gap in the empirical investigation of how government debt might affect growth through various channels. In chapter 5, we address this gap by first assessing how government debt affects sovereign credit ratings. We then use daily data on EU countries to analyze the immediate impact of a rating downgrade on 10-year sovereign bond risk premia. We expect that an increase in government debt will increase perceived risk and lead to lower credit ratings. This escalation in perceived risk and the resulting downgrades in credit ratings will lead to higher risk premium, which in turn will increase the cost of government debt financing. Higher financing costs, coupled with higher interest rates, inevitably constrain the private sector, leading to lower investment and slower economic growth. The results and methodology of this comprehensive analysis are presented in detail in chapter 5.

Based on our main objective and specific partial objectives, we have developed the following hypotheses to be tested in this dissertation:

1. There is a long-run non-linear relationship between government debt and real GDP in developed economies.

2. The effect of government debt on real GDP is conditional on other macroeconomic variables, hence we hypothesize that there is no „one-size-fits-all“ debt threshold.

3. The accumulation of government debt (change in debt) has a causal negative effect on economic growth in developed countries, identifiable through instrumental variable analysis that addresses endogeneity concerns.

4. Increases in government debt lead to a deterioration in sovereign creditworthiness and subsequently increase the risk premium on 10-year government bond yields.

5. The impact of sovereign credit rating downgrades on the risk premium on 10-year government bond yields is more pronounced during periods of economic downturn or financial instability.

3 Long-term, non-linear, and conditional effects of government debt in advanced economies

In this chapter, we examine the relationship between government debt and real GDP, using quarterly data from 37 advanced economies between 1990 and 2019. Our methodological approach adopts a panel autoregressive distributed lag (ARDL) model to capture both the short-run and long-run effects of debt. This choice is also guided by the theoretical literature, in particular Elmendorf & Mankiw (1999), which expects different effects of debt over different time horizons. In addition to assessing the direct impact of debt, we also take a closer look at models that assume a non-linear or conditional impact of government debt. Moreover, we address cross-sectional dependence, which is crucial to ensure the robustness of our findings, as economic shocks and external factors may affect outcomes in other countries.

3.1 Methodology

In examining the dynamics between government debt and real GDP, we use a panel autoregressive distributed lag (ARDL) approach for a sample of 37 advanced economies with unbalanced quarterly data from 1990 to 2019. The panel ARDL model is chosen for its robustness in capturing the multiple interactions over time and its flexibility in dealing with data with different levels of integration. In addition, the ARDL model can estimate both short-run and long-run coefficients simultaneously, allowing for a comprehensive economic interpretation. This dual estimation provides insights into both the immediate effects and the eventual long-run relationships. Recognizing that the economies under consideration may react differently to variations in government debt, the panel ARDL model incorporates cross-sectional heterogeneity, allowing for country-specific variations. This aspect is crucial as it recognizes that advanced economies are likely to exhibit unique responses due to differences in fiscal policies and economic structures. To estimate the models, we use the Pooled Mean Group (PMG) estimator, a technique that is in line with the objectives of our study. The PMG estimator, developed by Pesaran et al. (1999) assumes homogeneity in the long-run coefficients while allowing for heterogeneity in the short-run dynamics, a premise that is particularly appropriate for advanced economies, which may share similar long-term economic trends while experiencing distinct short-term fluctuations. The PMG approach is also well suited to panels with many cross-sections and time periods, which is the structure of our dataset.

In baseline regressions, we estimate the effect of government debt on economic performance, controlling for many other variables in addition to the variables of interest. The following panel ARDL model has been estimated using the PMG estimator:

$$\Delta rGDP_{i,t} = \sum_{j=1}^{p-1} \phi_i \Delta rGDP_{i,t-j} + \sum_{j=0}^{q-1} \Pi_i \Delta debt_{i,t-j} + \sum_{j=0}^{r-1} \theta_i \Delta X_{i,t-j} + \beta_{0,i}\left(rGDP_{i,t-1} - \beta_1 debt_{i,t} - \sum_{j=2}^{u} \beta_j X_{i,t} - \mu \right) + \epsilon_{i,t} \quad (1)$$

where $rGDP_{i,t}$ is the log of the real GDP index in country *i* and quarter *t*. The $debt$ variable is the general government debt as a percentage of GDP and the vector X is a set of control variables. The coefficient β_1 expresses the estimated long-run effect of government debt on economic growth, while Π_i is the short-run effect of debt accumulation. $\beta_{0,i}$ represents the error correction term, which expresses the speed of adjustment to the long-run equilibrium. We report the results of the baseline model estimates in Table 4.

Many studies have pointed to the presence of a non-linear relationship between debt and economic growth, where debt may increase growth, but after a certain threshold, further debt accumulation is associated with a slowdown in growth (Reinhart & Rogoff (2010); Baum et al. (2013)). In this analysis, we tested the hypothesis of a nonlinear impact of government debt by estimating the following regression using the PMG estimator:

$$\Delta rGDP_{i,t} = \sum_{j=1}^{p-1} \phi_i \Delta rGDP_{i,t-j} + \sum_{j=0}^{q-1} \Pi_i \Delta debt_{i,t-j} + \sum_{j=0}^{q-1} \rho_i \Delta debt^2{}_{i,t-j} + \beta_{0,i}\left(rGDP_{i,t-1} - \beta_1 debt_{i,t} - \beta_2 debt^2{}_{i,t} - \sum_{j=3}^{u} \beta_j X_{i,t} - \mu \right) + \epsilon_{i,t} \quad (2)$$

where the variable $debt^2$, representing government debt as a percentage of GDP squared, is added to the baseline specification in both the short-run and long-run equations. This approach to modelling non-linear effects is also common in the literature on the debt-growth nexus (Checherita-Westphal & Rother (2012); Afonso & Alves (2015)). From the coefficient estimates in the long-run equation, we can then express the debt threshold beyond which further government debt accumulation is detrimental to economic performance. The resulting estimates are shown in Table 5.

Several studies have suggested that the influence of government debt on growth may depend on the presence of other variables (Ostrihoň, et al. (2023); Butkus (2022)). As shown by Afonso & Furceri (2010), unsustainable government consumption can slow economic growth, and Ostrihoň, et al. (2023) find that in EU countries, higher government consumption can reduce optimal-growth-maximizing level of government debt. Also drawing on the findings of_Ostrihoň, et al. (2023), we include interactions with private credit and private debt in our regression. This approach is guided by their findings that increasing domestic credit can lead to a lower turning point, in line with the too-much-finance hypothesis, which links economic growth slowdowns to over-financialization in developed economies. In addition, their results show that higher levels of private debt increase country-specific turning points, further underlining the need to include these variables to fully understand the dynamics at play. In our analysis, we examine the moderating effects of government consumption, private credit, private debt and long-term interest rates. Equation (3) illustrates a specification where we introduce government consumption ($GovCons$) as a moderating variable in relation to debt. Beyond model (3), we extend our investigation to a model with debt squared to assess the impact of the moderating variable on the government debt threshold. The PMG estimator is used to estimate these equations, capturing the nuances of the interaction effects.

$$\Delta rGDP_{i,t} = \sum_{j=1}^{p-1} \phi_i \Delta rGDP_{i,t-j} + \sum_{j=0}^{q-1} \Pi_i \Delta debt_{i,t-j} + \sum_{j=0}^{q-1} \rho_i \Delta GovCons_{i,t-j} + \sum_{j=0}^{r-1} \theta_i \Delta X_{i,t-j}$$

$$+\beta_{0,i}\left(rGDP_{i,t-1} - \beta_1 debt_{i,t} - \beta_2 GovCons_{i,t} - \beta_3 GovCons_{i,t} \times debt_{i,t} - \sum_{j=4}^{u} \beta_j X_{i,t} - \mu \right) + \epsilon_{i,t} \qquad (3)$$

Prior to estimation, we conducted panel unit root tests to assess the stationarity of the variables in our dataset. These included the Im, Pesaran, and Shin (IPS) test, which allows for heterogeneity between cross-sectional units, and traditional tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, which account for autocorrelation and heteroskedasticity. Both levels and first differences of the variables were tested to detect non-stationarity, while maintaining the null hypothesis of each test. For all panel unit root tests, the null hypothesis was that all panels have a unit root. Specifically, for the IPS test, the alternative hypothesis is that some panels are stationary. In contrast, for the ADF and PP tests, the alternative hypothesis is that at least one panel is stationary. The choice of lag lengths was guided by the Akaike Information Criterion to ensure optimal test specifications for the subsequent analysis. Determining whether

variables are integrated of order zero or order one is a crucial step when using the Pooled Mean Group (PMG) estimator. This distinction ensures the validity of long-run equilibrium relationships and the reliability of the error correction mechanism of the PMG. The results of the panel unit root tests are presented in the Appendix.

In our analysis, to assess the long-run relationships between the variables, we employ robust cointegration tests, specifically the Kao (1999), Pedroni (1999, 2004), and Westerlund (2005) tests. These tests are designed to detect whether a cointegrating relationship exists within panel data, considering both the baseline and nonlinear specifications. The Kao test is a residual-based test that assumes homogeneity of the cointegration vector across cross-sections. The Pedroni test accommodates heterogeneity across different units in the panel. Lastly, the Westerlund test allows for the examination of cointegration in the presence of cross-sectional dependence, providing a more flexible framework for understanding the dynamic interactions among the panel data. By employing these tests, we ensure a thorough investigation into the potential long-run equilibrium relationships present in our data, which is crucial for the validity of our subsequent PMG estimation. Results of these cointegration tests are documented in Table 3. We also conducted Granger causality tests on the first differences of our main variables of interest: real GDP and government debt. For this purpose, we used the panel Granger causality test of Dumitrescu & Hurlin (2012). In particular, we were interested in testing whether there is evidence of bidirectional Granger causality between changes in government debt and economic growth in our sample. The results of the tests are documented in Table A.6 in the Appendix.

As a final step in this chapter, we address cross-sectional dependence, which is crucial to ensure the validity of our panel data analysis. This step is essential to avoid spurious correlations caused by unobserved common factors. Ignoring these cross-dependencies can lead to biased and inconsistent estimators. To correct for this, we use the Common Correlated Effects Pooled Mean Group (CCEPMG) estimator, as proposed by Pesaran (2006) and further developed by Chudik & Pesaran (2015). The CCEPMG estimator extends the standard PMG approach by incorporating cross-sectional averages of the dependent and independent variables as proxies for the unobserved common factors. This technique effectively captures cross-sectional dependence and allows for heterogeneous coefficients across panel units, while preserving long-run relationships and short-run dynamics consistent with the PMG model. By using CCEPMG, we ensure a

more robust estimation in the presence of cross-sectional dependence, thereby enhancing the credibility and reliability of our findings. We employed the CCEPMG estimator to estimate models with a non-linear term (as specified in equation 2) and models with interactions with other variables (as specified in equation 3). The results of these estimations are presented in Tables 7 and 8. In these tables we also present the results of cross-sectional dependence tests for each model specification.

3.2 Data

Our dataset consists of an unbalanced panel of quarterly data for 37 advanced economies, covering the period from 1990 to 2019. We deliberately excluded the period of the global pandemic to avoid the unusual and heightened volatility observed in the global economy during this period. The selection of countries for our study was guided by the World Bank's income level classification, with a focus on high-income economies. However, not all high-income countries were included in our analysis due to a lack of data for some countries. A detailed list of these countries is presented in Table 1. The literature on the impact of government debt on economic performance, especially at frequencies higher than annual, is scarce, with notable exceptions such as Lim (2019). To the best of our knowledge, no study has yet examined the relationship between debt and growth using panel ARDL models at a quarterly frequency. The choice of quarterly data offers important advantages. First, it allows for a more granular and timely analysis of economic activity than is possible with annual data. This granularity is particularly useful when estimating panel ARDL regressions that distinguish between short and long-term effects of government debt. In addition, the increased frequency of data points should improve the robustness and reliability of our statistical analysis, leading to more precise and nuanced insights.

Working with quarterly data often presents the challenge of dealing with seasonality. In our analysis, it's crucial to address this issue, as seasonal variation can add noise, hinder accurate comparisons and potentially lead to misleading results in regression analyses. Most of the variables in our study were either already seasonally adjusted or did not show any significant seasonality. However, for some variables where we found a lack of seasonally adjusted data, we made the adjustments ourselves. These variables include gross fixed capital formation, trade openness and government consumption, all expressed as a percentage of GDP. We used the TRAMO-SEATS method, which includes automatic

detection of outliers and calendar effects, a technique widely used by international statistical organizations such as Eurostat[1].

Table 1: List of countries.

Australia (1995-2019)	Greece (2000-2019)	Poland (2000-2019)
Austria (2000-2019)	Hong Kong (1999-2019)	Portugal (1995-2019)
Belgium (1995-2019)	Hungary (1995-2019)	Romania (2000-2019)
Canada (1995-2019)	Israel (1995-2019)	Saudi Arabia (2010-2019)
Chile (2008-2019)	Italy (1996-2019)	Singapore (1995-2019)
Croatia (1995-2019)	Japan (1997-2019)	Slovak Republic (2006-2019)
Cyprus (2000-2019)	Latvia (2000-2019)	Spain (1995-2019)
Czech Republic (1999-2019)	Lithuania (1998-2019)	Sweden (1995-2019)
Denmark (2000-2019)	Luxembourg (2000-2019)	Switzerland (1995-2019)
Estonia (2000-2019)	Malta (2000-2019)	United Kingdom (1995-2019)
Finland (2000-2019)	Netherlands (1996-2019)	United States (1995-2019)
France (2000-2019)	New Zealand (1995-2019)	
Germany (1998-2019)	Norway (2000-2019)	

Another challenge inherent in quarterly data is the occasional lack of data points, as many indicators are typically collected on an annual basis. This is often the case for variables such as institutional factors, GDP at purchasing power parity or educational attainment. In order to deal with this, we have chosen to use linear interpolation for these annually collected variables to generate the missing quarterly observations. This approach has been applied to variables such as GDP (PPP) per capita at current prices, average years of schooling, size of government and the political risk indicator. These interpolated variables are relatively stable over time and are mainly used for cross-country comparisons. For example, the inclusion of GDP (PPP) per capita helps to account for conditional convergence. The use of linear interpolation as a means of approximating quarterly data has a precedent in the literature (e.g. Fisera et al. (2021))

In our analysis, the dependent variable is seasonally adjusted real GDP, which we express as an index with an initial value of 100 for the first observation of each country. Contrary to the usual approach in growth regressions, which focuses on growth rates, we use the level of this variable. This choice is motivated by the requirement of the Pooled Mean Group (PMG) estimator that variables in the long-run equation should exhibit cointegration. Using a dependent variable that is non-stationary in its levels improves the

[1] Available at: https://ec.europa.eu/eurostat/documents/3859598/5910549/KS-RA-09-006-EN.PDF

statistical properties of our analysis, as noted in the works of Fišera (2021) and Asteriou et al. (2021). Therefore, we use the logarithm of the real GDP index in our regressions. This approach means that in the short-run equation we effectively have quarter on quarter growth in percentage terms on the left-hand side. Data for seasonally adjusted quarterly real GDP are taken from the IMF's International Financial Statistics database. Figure A.1 in the Appendix shows the evolution of real GDP over time for the different countries in our sample.

The main variable of interest in this work is government debt. We have chosen general government debt as a percentage of GDP, which is widely used in studies of the relationship between debt and growth. We obtained this data from the World Bank's Quarterly Public Debt Database, which provides comprehensive coverage. For a handful of countries where the World Bank data has gaps, we supplemented our dataset with data from the Bank for International Settlements database. Figure A.2 in the appendix shows the evolution of government debt as a percentage of GDP for each country in the sample.

Our choice of control variables is guided by the prevailing literature on the relationship between debt and growth. We aim to keep the number of variables in each model to a minimum to avoid the risk of multicollinearity (Fišera, 2021). As a control variable, we include logarithm of lagged GDP per capita at purchasing power parity (PPP) in current prices, which primarily reflects income disparities between countries. This variable allows us to account for the convergence hypothesis, which suggests that countries with lower incomes tend to experience faster growth rates, as highlighted by Mankiw et al. (1992). The GDP (PPP) per capita data were taken from the Penn World Table (Feenstra et al., 2015) and linearly interpolated to fit our quarterly data model. In addition, we included the investment rate, another variable that is commonly found to be significant in growth regressions. We used gross fixed capital formation as a percentage of GDP to represent the investment rate, a choice consistent with established practice in economic research (Ahlborn & Schweickert, 2018). The quarterly data on gross fixed capital formation, obtained from the IMF database, showed significant seasonal patterns, which led us to perform seasonal adjustment on this variable. Gross fixed capital formation and GDP (PPP) per capita are our main control variables and are included in all specifications. We also tested a number of other control variables, which are described below.

The degree of openness of an economy is often associated with higher economic growth (Sakyi et al. (2015); Jamel & Maktouf (2017)). Given this, we included a measure

of economic openness in our regressions, defined as the sum of the value of exports and imports as a share of GDP. The source of this variable is the IMF database and the data have been seasonally adjusted. We have also included consumer inflation as an indicator of macroeconomic stability, as suggested by Cecchetti et al. (2011). This variable is calculated as the quarter-on-quarter percentage change in the Consumer Price Index (CPI), with data taken from the IMF database. Human capital, often represented by educational attainment, is a common component in growth regressions (Mankiw et al. (1992); Panizza & Presbitero (2014)). In our analysis, we measure human capital using the average years of schooling of the population aged 25 and over. These annual data are taken from the Penn World Table (Feenstra et al., 2015) and converted to quarterly frequency by linear interpolation. Changes in exchange rates can have a significant impact on economic performance, especially in the short term, by changing the relative price of products and affecting price competitiveness. We therefore included the real effective exchange rate (REER), based on the consumer price index (CPI), as a control variable in one of our models. We obtained the quarterly REER data from the IMF database. Central banks influence economic output by setting interest rates. These rates are then transmitted through various channels to different sectors of the economy, affecting areas such as lending to businesses and households, and thus investment and consumption. We gathered data on policy rates from national sources, using the Macrobond software for this purpose. Keynesian theory posits that government consumption stimulates growth, but empirical evidence often suggests the opposite. Barro (1990) found that government consumption often hinders economic growth by not boosting private productivity and distorting effects through taxation and government spending. Government consumption is often used as a control variable in empirical studies that examine the impact of government debt on economic growth, as seen in the work of Ostrihoň, et al. (2023). In our analysis, we include government consumption as a percentage of GDP as a control variable in one of our model specifications. We obtained these data at quarterly frequency from the IMF database and then we applied seasonal adjustment. In some specifications, we incorporate institutional variables, specifically the size of government from the Economic Freedom of the World (EFW) database and the political risk indicator from the International Country Risk Guide (ICRG) database. Both are expressed as indices, and their quarterly values were derived through linear interpolation. The size of government indicator was employed as a control in Chiu & Lee (2017), and the political risk indicator was similarly utilized in Ahlborn & Schweickert (2018).

The literature on the debt-growth nexus is increasingly exploring how the impact of debt on growth varies with other variables (Ostrihoň, et al. (2023); Butkus (2022)). Theese studies suggest that factors such as government consumption, private credit and private debt significantly influence the debt threshold at which economic growth starts to slow down (Ostrihoň, et al., 2023). In our analysis, we examine the interactions between government debt and these variables. We have obtained data on private debt and bank credit to the private sector as a percentage of GDP from the Bank for International Settlements' Total Credit Statistics database. We also examine the interaction with long-term interest rates, obtained from the OECD database, hypothesizing that lower financing costs may raise the debt threshold at which growth declines.

Table 2 presents the summary statistics for the variables analyzed in this study. Real GDP is indexed with an average of 159.68 and shows considerable variation as indicated by the standard deviation of 49.93. General government debt, expressed as a percentage of GDP, has an average of 68.97% and displays a wide range from a minimum of 1.60% to a maximum of 212.08%. Gross fixed capital formation accounts for an average of 22.53% of GDP, suggesting investment levels vary across the sample. GDP (PPP) per capita in current prices shows a mean of 38701.27 PPP USD and a substantial range, indicating significant differences in living standards. Trade openness, measured as the sum of exports and imports relative to GDP, averages at 110.71%, pointing to high levels of economic integration. Consumer CPI inflation, calculated quarter-on-quarter, has a modest mean of 0.55% but varies widely, demonstrating the differing inflationary environments. The real effective exchange rate, an index, averages at 98.52 with variations that reflect changing currency strength. Policy rates show a small average of 2.73% and a standard deviation of 3.07%, highlighting diverse monetary policies. Education levels, represented by the average years of schooling, have a mean of 11.34 years, with less variability among the countries. Government consumption and the size of government indicators, show average levels of 19.09% of GDP and 6.27 index points, respectively, indicating how public spending and government size differ across nations. Political risk, measured by an index, has an average of 80.40, with a sizeable range, pointing to varying degrees of political stability. Private credit and debt, both as percentages of GDP, have substantial averages of 93.17% and 160.22%, respectively, suggesting significant roles in the economies. Lastly, long-term interest rates average at 3.90%, with a range that underscores different

borrowing cost environments. Notably, some data points are the result of linear interpolation from annual to quarterly frequency to ensure consistency across the dataset.

Table 2: Summary statistics.

Variable	Unit	Obs	Mean	St. Dev.	Min	Max
Real GDP	Index	3131	159.68	49.93	92.88	504.78
General government debt	% of GDP	3131	68.97	39.69	1.60	212.08
Gross fixed capital formation	% of GDP	3131	22.53	3.83	9.55	40.86
GDP (PPP) per capita in current prices	PPP, USD	3131	38701.27	16349.59	7701.00	112000.00
Trade openness	% of GDP	3131	110.71	84.73	17.43	454.03
Consumer CPI inflation	% QoQ	3131	0.55	0.95	-2.83	9.90
Real effective exchange rate	Index	3131	98.52	10.21	63.23	150.59
Policy rate	%	2829	2.73	3.07	-0.75	28.00
Average years of schooling	Years	3131	11.34	1.59	5.92	15.80
Government consumption	% of GDP	3034	19.09	3.94	8.20	31.60
Size of government	Index	2759	6.27	1.02	3.56	9.09
Political risk indicator	Index	2583	80.40	7.30	58.75	96.08
Private credit	% of GDP	2487	93.17	38.53	21.40	254.40
Private debt	% of GDP	2499	160.22	60.86	37.10	400.90
Long-term interest rate	%	2569	3.90	2.42	-0.78	25.40

Note: variables are seasonally adjusted, quarterly data for: GDP (PPP) per capita, average years of schooling, size of government and political risk indicator were obtained via linear interpolation from yearly data.

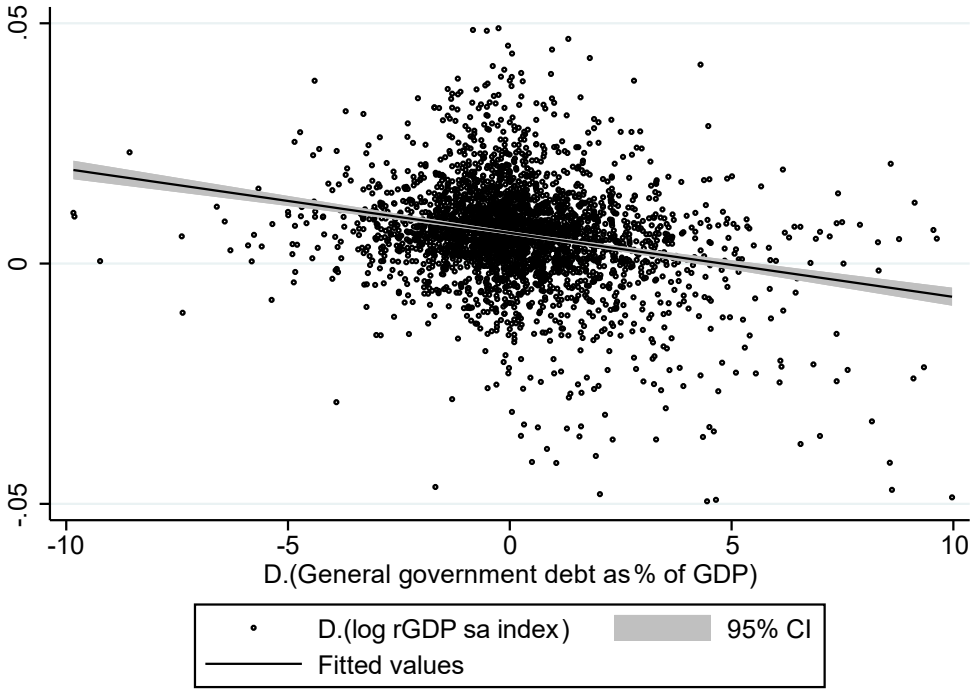
3.3 Results

This section presents the results of our estimates, which are based on quarterly data from 37 advanced economies over the period 1990 to 2019. Figure 1 illustrates the data, with the x-axis showing the change in government debt and the y-axis showing the change in the logarithm of seasonally adjusted real GDP, which serves as a proxy for quarter-on-quarter growth. The graph shows a clear negative correlation, suggesting that an increase in debt is associated with lower economic growth. However, it is important to consider the possibility of reverse causality in this observed relationship, where a contraction in real GDP could lead to an expansionary fiscal response and the activation of automatic stabilizers, thereby increasing the nominal debt level. In addition, there is a mechanical aspect to consider, as government debt is expressed as a percentage of nominal GDP.

To examine the relationship between government debt and growth in more detail, we estimate various panel ARDL models using a pooled mean group (PMG) estimator. This method allows us to control for other variables that may affect both debt and growth. In addition, the panel ARDL specification allows us to focus on the long-run effects of debt on real GDP, which are more relevant for our analysis, in addition to the short-run effects,

which may be driven more by mechanical effects and reverse causality. However, the use of the PMG estimator assumes that the variables in the regressions are stationary in their levels or first differences.

Figure 1: Change in general government debt and quarterly change in log real GDP.



The panel unit root tests conducted, as shown in Tables A.2 to A.5, include the Im-Pesaran-Shin, Dickey-Fuller and Phillips-Perron tests, which are robust methods for determining the stationarity of panel data. In the first set of tests on variables at their levels (Tables A.2 and A.3), the results of the Im-Pesaran-Shin test are mixed, with some variables such as gross fixed capital formation as % of GDP, CPI inflation, REER, policy rate, government consumption as % of GDP, government size and the political risk showing signs of stationarity. However, other variables show high p-values, indicating non-stationarity in levels: real GDP, government debt, GDP (PPP) per capita, trade openness as % of GDP, years of schooling, private credit as % of GDP, private debt as % of GDP and long-term interest rate. For the Im-Pesaran-Shin test, the null hypothesis (H0) is that all panels contain unit roots, while the alternative hypothesis (Ha) is that some panels are stationary. The Dickey-Fuller and Phillips-Perron tests confirm these findings, with similar patterns of p-values across variables. For both the Dickey-Fuller and Phillips-Perron tests, H0 implies unit roots in all panels, while Ha indicates that at least one panel is stationary. The second set of tests on the first differences of the variables (Tables A.4 and A.5) provides a clear indication that all variables become stationary after first differencing

across all tests. This strongly suggests that the variables are integrated of order one, I(1), which is a typical requirement for cointegration analysis and the use of estimators such as PMG that assume a long-run equilibrium relationship between the variables. In the context of estimating the impact of government debt on real GDP, the PMG estimator is particularly suitable for dealing with panel data, where the long-run relationship is modelled with non-stationary I(1) variables, while allowing for heterogeneity in the short-run coefficients.

Table 3: Panel cointegration tests for baseline and nonlinear specifications (1) and (10).

	Model (1)	Model (1)	Model (10)	Model (10)
	Westerlund test for cointegration: AR panel specific parameter			
	Without trend	With trend	Without trend	With trend
Variance ratio - Ha some panels	-3.4152	-4.6954	-2.9113	-4.8133
	(0.0003)	(0.0000)	(0.0018)	(0.0000)
Variance ratio - Ha all panels	-1.6588	-4.0540	-1.2531	-3.5296
	(0.0486)	(0.0000)	(0.1051)	(0.0002)
	Pedroni test for cointegration: AR panel specific parameter			
	Without trend	With trend	Without trend	With trend
Modified Phillips–Perron t	-1.2371	-6.5517	-1.2371	-6.5517
	(0.108)	(0.0000)	(0.108)	(0.0000)
Phillips–Perron t	-0.4465	-6.0439	-0.4465	-6.0439
	(0.3276)	(0.0000)	(0.3276)	(0.0000)
Augmented Dickey–Fuller t	0.313	-5.214	0.313	-5.214
	(0.3772)	(0.0000)	(0.3772)	(0.0000)
	Kao cointegration test			
Modified Dickey–Fuller t	4.3757		4.4172	
	(0.0000)		(0.0000)	
Dickey–Fuller t	4.9381		5.0401	
	(0.0000)		(0.0000)	
Augmented Dickey–Fuller t	5.0823		5.1607	
	(0.0000)		(0.0000)	
Unadjusted modified Dickey–Fuller	4.1276		4.1607	
	(0.0000)		(0.0000)	
Unadjusted Dickey–Fuller t	4.501		4.5826	
	(0.0000)		(0.0000)	

Note: p-values in parentheses.

The panel cointegration tests, comprising the Westerlund, Pedroni and Kao tests, have been applied to our baseline and non-linear model specifications to determine the

existence of a long-run equilibrium relationship between the variables. The results of the Westerlund tests suggest cointegration with and without trend, as evidenced by p-values close to zero. This indicates a long-run relationship between the variables. In the Pedroni test, the trended models show cointegration in all statistics, reinforcing the importance of including trends in the models to capture long-term dynamics. The Kao test consistently supports the cointegration hypothesis for both model specifications, with p-values of 0.00 across the board. In essence, these cointegration test results robustly validate the use of long-run estimators in the analysis, confirming that the variables are indeed cointegrated and move together in the long run. This strengthens the foundation of our PMG estimation and the study of the relationship between government debt and economic growth.

Table 4 presents the estimation results of our baseline regressions, which examine the logarithm of real GDP as the dependent variable against government debt, expressed as a percentage of GDP, as the main variable of interest. In developing our models, we follow the approach by Asteriou et al. (2021) and Fišera (2021), focusing on a clear specification of each model and maintaining a limited number of control variables per regression. Although this method improves clarity and reduces complexity, it increases the risk of omitted variable bias. Consistently across models, we include as controls the log of lagged GDP per capita in purchasing power parity and the share of gross fixed capital formation in GDP. In addition, we include other variables such as trade openness, inflation, exchange rate, policy rate, schooling, government consumption, government size index and a political risk indicator. For the short-run equation, controls are limited to those variables with quarterly observations that are not based on linear interpolation. Due to the limited space available, only the short-run effects of government debt and investment are shown in Table 4. The number of observations varies slightly due to data availability for each variable, with the sample of countries ranging from 35 to 37. We employed the Pooled Mean Group (PMG) estimator developed by Pesaran et al. (1999) to estimate the individual panel ARDL models.

In models (1) to (9), we tested the linear impact of government debt on economic performance in the long and short run. In most specifications we found no significant linear impact of government debt. A positive effect was found in models (6) and (9), where we controlled for the real effective exchange rate and the political risk indicator in addition to the baseline control variables. In contrast, a negative effect of government debt was found in specification (7), where we also included government consumption as a

percentage of GDP. The baseline control variables we included are statistically significant in most models. We found a positive effect for fixed investment and also for the level of economic development as measured by GDP per capita at purchasing power parity. Trade openness has no statistically significant effect on real GDP. Estimation results show that an increase in consumer prices, as indicated by the quarter-on-quarter change in the CPI, is associated with a decrease in the real GDP index in the long-run equation. The real effective exchange rate (REER) also shows a negative relationship with real GDP, with a significant coefficient in column (4), suggesting that an appreciation of the exchange rate is associated with a decline in real GDP. The policy rate is negatively associated with real GDP at the 1% significance level, suggesting that higher interest rates may dampen economic growth. Average years of schooling is positively associated with real GDP, reflecting the positive role of human capital in economic development. Government consumption as a percentage of GDP is negatively related to real GDP. On the other hand, the size of government is positively associated with real GDP in column (8), with a significant coefficient. Finally, political risk (a higher index value indicates a lower level of political risk) has a positive coefficient in column (9) that is significant at the 1% level, suggesting that lower political risk is associated with higher real GDP. In the short run, higher debt accumulation is associated with slower quarter-on-quarter real GDP growth. These results are statistically significant in all specifications in Table 4. The coefficients of the error correction term are negative and statistically significant in all models. The negative sign and significance of the error correction term suggest that any short-term deviations from the long-run equilibrium relationship between government debt and real GDP are corrected over time. The magnitude of these coefficients, which reflect the speed of adjustment, indicates that the real GDP index is estimated to return to its long-run equilibrium at a relatively slow pace. A similar slow adjustment was also found in Asteriou et al. (2021). This consistent error-correction dynamic across models confirms the existence of a stable long-run relationship between the variables in the context of the PMG estimation. The absence of a significant linear relationship between government debt and economic growth in our models could be an indication of the non-linear nature of this relationship, which is supported by previous studies such as those by C. Checherita-Westphal & Rother (2012) and Afonso & Alves (2015).

In Table 5, we present the estimates from models that assess the nonlinear impact of government debt on economic growth. In line with the methodology used by researchers

such as Ostrihoň, et al. (2023), we adopt a quadratic form of government debt in order to capture its nonlinear effects. This approach not only allows for the analysis of non-linearity, but also facilitates the identification of debt thresholds above which additional debt accumulation becomes detrimental to economic performance. These estimations are carried out using the same specifications and control variables as in our baseline models in Table 4, with addition of the squared government debt term in both the long-run and short-run equations. The sample of countries analyzed remains unchanged and we use the same PMG estimator for these non-linear specifications.

The results in Table 5 show that there is a statistically significant non-linear effect of government debt in seven out of nine model specifications. In line with our expectations, the debt variables suggest a positive but diminishing effect on real GDP, suggesting that above a certain threshold, debt slows economic performance. However, in specifications (14) and (16) we do not observe a significant nonlinear relationship. The insignificant result in specification (14) could be attributed to the inclusion of the central bank's policy rate, which led to a reduction in the data sample. In specification (16), the lack of significance of the debt effect could be due to potential collinearity issues, as we controlled for government consumption as a percentage of GDP. In all models, the coefficients on the error correction term are negative and statistically significant, suggesting a consistent speed of adjustment towards long-run equilibrium, similar to the baseline models presented in Table 4. For each model in which the debt effect was significant, we calculated the government debt threshold and estimated it to be between 95% and 110% of GDP, depending on the model. These results are consistent with previous research by Reinhart & Rogoff (2010), Baum et al. (2013) and C. Checherita-Westphal & Rother (2012). We do not elaborate further on the control variables, as their effects closely mirror those in Table 4. Marginal effects of government debt on real GDP are shown in Figure A.4 in the appendix.

In addition to estimating the debt threshold, we also examined several variables that could modify the impact of debt on real GDP and influence the determination of the debt limit. We included these variables in our models as interaction terms with government debt, as specified in equation (3). Our analysis included government consumption, private credit, private debt and the long-term interest rate as interaction variables. For each of these variables, we formulated two model specifications: one without and one with government debt expressed in quadratic form. In the first specification, we assume that the

effect of government debt on GDP is conditional on the level of the other variable. In the second specification, we consider the possibility that the interaction variable not only affects the impact of debt on GDP, but also plays a role in determining the debt threshold. We conducted these analyses following the methodology described in the study by Ostrihoň, et al. (2023). All model specifications were estimated using the Pooled Mean Group (PMG) estimator.

The conditional effects of debt on real GDP are shown in Table 6. In models (19) and (20) we examine how the interaction between government debt and government consumption affects economic performance. The interaction term is negatively signed and statistically significant in both models, implying that an increase in government consumption reduces the positive effect of government debt on real GDP. This could suggest that when government consumption is higher, additional government debt may be less effective in promoting growth or may indicate less productive government spending. Model (20) offers a somewhat more complex interpretation of the role of government consumption in influencing the effect of debt. The coefficients on our core variables suggest that higher government consumption not only reduces the growth-enhancing effect of government debt, but also lowers the debt threshold above which the effect on real GDP becomes negative. This is in line with the study by Ostrihoň, et al. (2023). In models (21) and (22) we examined the interaction of private credit with government debt. When the quadratic form of debt was not included, the long-run equation in model (21) failed to converge. Conversely, model (22), which includes the quadratic form of debt, showed no statistically significant interaction effect. Looking at private debt as an interaction variable in model (23), we find that a higher level of private debt, similar to government consumption, reduces the positive influence of government debt and also lowers the government debt threshold. Specifications (25) and (26) consider the interaction with long-term interest rates, but no significant relationship with government debt was found in these specifications.

Another important contribution of this dissertation is the estimation of the non-linear and conditional effects of government debt, with a special focus on the treatment of cross-sectional dependence. To address this and reduce the potential for bias, we use the Common Correlated Effects Pooled Mean Group (CCEPMG) estimator developed by Pesaran (2006) and later by Chudik & Pesaran (2015). This estimator extends the PMG approach by incorporating cross-sectional means that capture unobserved common factors.

We applied the CCEPMG estimator to re-evaluate the models presented in Table 5, which examines the nonlinear effects of government debt, and Table 6, which analyses the conditional effects of debt on real GDP. The use of a method that accounts for cross-sectional dependence strengthens the validity of our initial findings.

The results using the Common Correlated Effects estimator are summarized in Table 7, which shows the non-linear impact of government debt on real GDP across different model specifications. Neither the linear nor the squared government debt terms appear to have a consistent and statistically significant impact on growth across models. The squared debt term, which is intended to capture the non-linear effects, predominantly shows an insignificant impact in these models, suggesting that the non-linear relationship between government debt and real GDP may not be robust. The results for other variables, such as gross fixed capital formation and GDP per capita, are generally consistent and significantly positive, indicating their robust contribution to economic growth. Overall, the results suggest that the effect of government debt on real GDP may not be as clear-cut as suggested by the results of the PMG estimator. The lack of consistent significance of the government debt variables across models implies that the relationship between debt and growth is complex and may be influenced by a variety of factors not captured by the debt variables alone. The error correction term in the robustness test is only significant in about half of the model specifications, suggesting an inconsistent adjustment towards the long-run equilibrium. However, when significant, the use of the Common Correlated Effects Pooled Mean Group (CCEPMG) estimator generally indicates a higher speed of adjustment than the standard PMG estimator. In the short-run equation, the coefficient on government debt in linear form is consistently negative and significant across specifications, suggesting that increases in government debt may have a dampening effect on real GDP growth in the short run. In addition, we conducted panel Granger causality tests based on the methodology developed by Dumitrescu & Hurlin (2012). The results documented in Table A.6 suggest the existence of bidirectional causality between changes in government debt and economic growth, at least within one panel. In the following chapter, we address potential concerns about reverse causality by applying instrumental variable techniques.

Table 8 provides the results of robustness checks for the conditional effects of government debt on real GDP using the Common Correlated Effects estimator. The coefficients for gross fixed capital formation and GDP per capita are predominantly

positive and significant, reinforcing their established role as drivers of economic growth. The interaction terms in the models, which are designed to capture the conditional effects of variables such as government consumption, private credit, and private debt on the relationship between government debt and GDP, all have statistically insignificant coefficients, indicating that these variables do not significantly alter the impact of government debt on long-term economic growth.

In this chapter, we have examined the impact of government debt on real GDP for a panel of 37 advanced economies over the period from 1990 to 2019. Our methodological approach involved the use of panel ARDL models estimated using the PMG estimator, which distinguishes between short-run and long-run effects and assumes uniform long-run coefficients while allowing for short-run heterogeneity. Using this approach, our long-run equation identified a statistically significant non-linear relationship between government debt and real GDP, with an estimated debt threshold ranging from 95% to 110%. In addition, we investigated the conditional effects of government debt by examining how its relationship with GDP might be affected by additional variables. Our results showed that higher levels of government consumption reduced the positive effect of government debt and also lowered the debt threshold. A similar pattern emerged for private debt, which also shifted the debt threshold to a lower level. In the last part of this chapter, we estimate models with nonlinear and conditional debt effects using the Common Correlated Effects estimator, which adjusts the PMG estimator to account for cross-sectional dependence, a common problem in panel data analysis. However, once the issue of cross-sectional dependence was addressed, all significant non-linear and conditional effects of government debt disappeared in the long-run equations. This findings underline the critical influence of global economic interdependencies and highlights that external conditions can have a significant impact on national economic outcomes, possibly more so than domestic conditions. This could be particularly important in the context of a highly intertwined economic club, where most members share a common currency, contagion effects are more pronounced. It also points to the need for advanced econometric techniques that can deal with such complexity and ensure the accuracy of economic modelling. Moreover, these results underline the importance for policymakers to integrate considerations of global economic dynamics when formulating fiscal policy, as domestic debt management alone may not have the expected impact on economic growth if global interdependencies are

overlooked. These results also call for further research on how global economic conditions interact with national fiscal policies, suggesting a rich area for deeper investigation.

Table 4: Effects of government debt on real GDP.

Dep.: real GDP index	(1) PMG	(2) PMG	(3) PMG	(4) PMG	(5) PMG	(6) PMG	(7) PMG	(8) PMG	(9) PMG
Long-run equation									
Government debt (% of GDP)	0.002	0.001	0.002	0.003**	0.000	0.002	-0.003**	0.005	0.012***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)
Gross fixed capital formation (% of GDP)	0.019*	0.029**	0.026**	0.021***	0.014***	0.022**	0.032**	0.027	0.022
	(0.011)	(0.014)	(0.012)	(0.006)	(0.005)	(0.009)	(0.014)	(0.025)	(0.021)
L.GDP per capita (PPP)	0.532***	0.497***	0.520***	0.567***	0.524***	0.228***	0.745***	0.314**	-0.203
	(0.030)	(0.040)	(0.030)	(0.025)	(0.016)	(0.087)	(0.049)	(0.128)	(0.220)
Trade openness (% of GDP)		0.002							
		(0.002)							
Consumer prices, CPI (QoQ)			-0.064*						
			(0.036)						
REER				-0.008***					
				(0.002)					
Policy rate					-0.017***				
					(0.004)				
Schooling						1.184***			
						(0.363)			
Gov. consumption (% of GDP)							-0.112***		
							(0.023)		
Size of government								0.400*	
								(0.224)	
Political risk									0.102***
									(0.034)
Short-run equation									
Error correction	-0.007***	-0.006***	-0.007***	-0.013***	-0.014***	-0.010***	-0.007***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.000)	(0.001)
D.Government debt (% of GDP)	-0.002***	-0.002***	-0.002***	-0.002***	-0.001***	-0.002***	-0.001***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D.Gross fixed capital formation (% of GDP)	0.003***	0.002***	0.003***	0.003***	0.001***	0.003***	0.001***	0.003***	0.003***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Observations	3220	3220	3220	3140	2862	3220	3101	3220	3220
Countries	37	37	37	37	35	37	36	37	37

Note: standard errors are displayed within parentheses. * denotes significance at the 10% level, ** indicate significance at the 5% level, and *** represent significance at the 1% level. Estimates for other control variables in short-run equation are omitted. Dependent variable, L.GDP per capita (PPP) and Schooling are in logarithms.

Table 5: Nonlinear effects of government debt on real GDP.

Dep.: real GDP index	(10) PMG	(11) PMG	(12) PMG	(13) PMG	(14) PMG	(15) PMG	(16) PMG	(17) PMG	(18) PMG
Long-run equation									
Government debt (% of GDP)	0.01658***	0.00961*	0.01066**	0.01482***	0.00372	0.01480***	0.00374	0.01907**	0.01983***
	(0.00273)	(0.00544)	(0.00477)	(0.00236)	(0.00245)	(0.00201)	(0.00453)	(0.00784)	(0.00276)
Government debt squared (% of GDP)	-0.00008***	-0.00005*	-0.00005**	-0.00007***	-0.00003**	-0.00007***	-0.00003	-0.00010**	-0.00009***
	(0.00001)	(0.00003)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00004)	(0.00002)
Gross fixed capital formation (% of GDP)	0.03879***	0.03677**	0.03801***	0.03290***	0.01777***	0.03236***	0.03971***	0.02550	0.03643***
	(0.00658)	(0.01448)	(0.01294)	(0.00557)	(0.00563)	(0.00527)	(0.01526)	(0.01843)	(0.00592)
L.GDP per capita (PPP)	0.41198***	0.46100***	0.46523***	0.50554***	0.50494***	0.16320***	0.68075***	0.27707***	0.22022***
	(0.01964)	(0.04357)	(0.03448)	(0.02167)	(0.01932)	(0.03730)	(0.05499)	(0.08913)	(0.04515)
Trade openness (% of GDP)		0.00133							
		(0.00156)							
Consumer prices, CPI (QoQ)			-0.07279**						
			(0.03693)						
REER				-0.00779***					
				(0.00172)					
Policy rate					-0.01767***				
					(0.00367)				
Schooling						1.13302***			
						(0.17322)			
Gov. consumption (% of GDP)							-0.09965***		
							(0.02414)		
Size of government								0.35630**	
								(0.15732)	
Political risk									0.02535***
									(0.00494)
Short-run equation									
Error correction	-0.01099***	-0.00674***	-0.00780***	-0.01258***	-0.01568***	-0.01071**	-0.00678***	-0.00543***	-0.01052**
	(0.00401)	(0.00077)	(0.00097)	(0.00421)	(0.00287)	(0.00481)	(0.00063)	(0.00067)	(0.00422)
D.Government debt (% of GDP)	-0.00551***	-0.00476***	-0.00528***	-0.00565***	-0.00458***	-0.00566***	-0.00335***	-0.00666***	-0.00640***
	(0.00119)	(0.00121)	(0.00117)	(0.00120)	(0.00108)	(0.00113)	(0.00084)	(0.00131)	(0.00158)
D.Government debt squared (% of GDP)	0.00004*	0.00004	0.00004	0.00005*	0.00002	0.00005*	0.00000	0.00005*	0.00004
	(0.00003)	(0.00003)	(0.00003)	(0.00002)	(0.00001)	(0.00003)	(0.00002)	(0.00003)	(0.00003)
D.Gross fixed capital formation (% of GDP)	0.00235***	0.00156***	0.00240***	0.00235***	0.00138**	0.00237***	0.00141***	0.00250***	0.00251***
	(0.00059)	(0.00049)	(0.00058)	(0.00059)	(0.00054)	(0.00059)	(0.00045)	(0.00060)	(0.00060)
Debt threshold (% of GDP)	109.4	95.0	97.4	99.0	-	105.3	-	96.2	110.4
Observations	3220	3220	3220	3140	2862	3220	3101	3220	3220
Countries	37	37	37	37	35	37	36	37	37

Note: standard errors are displayed within parentheses. * denotes significance at the 10% level, ** indicate significance at the 5% level, and *** represent significance at the 1% level. Estimates for other control variables in short-run equation are omitted. Dependent variable, L.GDP per capita (PPP) and Schooling are in logarithms.

Table 6: Conditional effects of government debt on real GDP.

Dep.: real GDP index	(19) PMG	(20) PMG	(21)[a] PMG	(22) PMG	(23) PMG	(24) PMG	(25) PMG	(26) PMG
Long-run equation								
Government debt (% of GDP)	0.02118**	0.03194***	-2.28704e+10	0.01226***	0.00741	0.01704***	-0.00141	0.00354
	(0.00998)	(0.01232)	-	(0.00147)	(0.01168)	(0.00176)	(0.00129)	(0.00361)
Government debt squared (% of GDP)		-0.00004*		-0.00003**		-0.00004***		-0.00002
		(0.00002)		(0.00001)		(0.00002)		(0.00001)
Gross fixed capital formation (% of GDP)	0.03304**	0.03924***	-6.82422e+10	-0.00236	0.00949	-0.00344	0.01371**	0.02129***
	(0.01430)	(0.01484)	-	(0.00380)	(0.02777)	(0.00384)	(0.00653)	(0.00745)
L.GDP per capita (PPP)	0.56164***	0.50511***	-4.64813e+11	0.54584***	0.78037***	0.53646***	0.54513***	0.50716***
	(0.07153)	(0.07509)	-	(0.01479)	(0.18211)	(0.01489)	(0.01751)	(0.02640)
Interaction	-0.00115**	-0.00128***	1.0169e+08***	-0.00002	-0.00005	-0.00004***	-0.00033**	-0.00037**
	(0.00045)	(0.00045)	-	(0.00002)	(0.00006)	(0.00001)	(0.00015)	(0.00016)
Gov. consumption (% of GDP)	-0.02308	-0.01738						
	(0.03011)	(0.02799)						
Private credit (% of GDP)			2.79296e+10	-0.00259*				
			-	(0.00139)				
Private debt (% of GDP)					-0.00765	-0.00068		
					(0.00551)	(0.00085)		
Long-term interest rate							-0.02202*	-0.01592
							(0.01191)	(0.01229)
Short-run equation								
Error correction	-0.00709***	-0.00744***	0.00000***	-0.01735*	-0.00277***	-0.01671*	-0.01214***	-0.01259***
	(0.00075)	(0.00080)	(0.00000)	(0.01031)	(0.00027)	(0.00984)	(0.00222)	(0.00242)
D.Government debt (% of GDP)	-0.00101***	-0.00101***	-0.00118***	-0.00126***	-0.00111***	-0.00119***	-0.00125***	-0.00124***
	(0.00028)	(0.00028)	(0.00030)	(0.00026)	(0.00029)	(0.00027)	(0.00023)	(0.00024)
D.Gross fixed capital formation (% of GDP)	0.00165***	0.00163***	0.00293***	0.00300***	0.00295***	0.00294***	0.00290***	0.00286***
	(0.00051)	(0.00050)	(0.00069)	(0.00069)	(0.00071)	(0.00071)	(0.00063)	(0.00063)
Variable in interaction term	Government consumption	Government consumption	Private credit	Private credit	Private debt	Private debt	Long-term interest	Long-term interest
Observations	2665	2665	2584	2584	2596	2596	2627	2627
Countries	31	31	29	29	29	29	31	31

Note: standard errors are displayed within parentheses. * denotes significance at the 10% level, ** indicate significance at the 5% level, and *** represent significance at the 1% level. Estimates for other control variables in short-run equation are omitted. Dependent variable and L.GDP per capita (PPP) are in logarithms. [a] The model did not converge.

Table 7: Nonlinear impact of government debt on real GDP – robustness test using the common correlated effects estimator.

Dep.: real GDP index	(27) CCEPMG	(28) CCEPMG	(29) CCEPMG	(30) CCEPMG	(31) CCEPMG	(32) CCEPMG	(33) CCEPMG	(34) CCEPMG	(35) CCEPMG
Long-run equation									
Government debt (% of GDP)	0.00060	-0.00026	0.00043	0.00017	-0.00162	-0.00035	0.00095	-0.00074	-0.00098
	(0.00293)	(0.00253)	(0.00680)	(0.00139)	(0.00191)	(0.00240)	(0.00410)	(0.00348)	(0.00256)
Government debt squared (% of GDP)	-0.00000	-0.00000	-0.00000	-0.00000	0.00001	-0.00000	-0.00001	-0.00000	0.00000
	(0.00002)	(0.00002)	(0.00003)	(0.00001)	(0.00001)	(0.00001)	(0.00003)	(0.00003)	(0.00002)
Gross fixed capital formation (% of GDP)	0.00499***	0.00326***	0.00517***	0.00402***	0.00955***	0.00309	0.00417***	0.00276***	0.00496***
	(0.00132)	(0.00115)	(0.00197)	(0.00140)	(0.00200)	(0.00251)	(0.00099)	(0.00103)	(0.00119)
L.GDP per capita (PPP)	0.25594***	0.30233***	0.24811***	0.21665***	0.19903**	0.25672	0.20695*	0.29369***	0.14251*
	(0.07647)	(0.07601)	(0.08058)	(0.05626)	(0.09351)	(0.38014)	(0.11219)	(0.06025)	(0.07425)
Trade openness (% of GDP)		0.00037							
		(0.00030)							
Consumer prices, CPI (QoQ)			-0.00380						
			(0.00881)						
REER				-0.00109*					
				(0.00065)					
Policy rate					0.00327				
					(0.00285)				
Schooling						0.10760			
						(3.68711)			
Gov. consumption (% of GDP)							-0.01493***		
							(0.00409)		
Size of government								0.00790	
								(0.01264)	
Political risk									0.00174
									(0.00170)
Short-run equation									
Error correction	-0.20087*	-0.23323*	-0.19676	-0.24622**	-0.13128	-0.26592	-0.18513	-0.26144*	-0.31043**
	(0.11390)	(0.12549)	(0.21037)	(0.11115)	(0.22691)	(0.19092)	(0.17511)	(0.14116)	(0.14677)
D.Government debt (% of GDP)	-0.00277**	-0.00238**	-0.00234**	-0.00282**	-0.00222*	-0.00246**	-0.00174*	-0.00182**	-0.00261**
	(0.00108)	(0.00102)	(0.00108)	(0.00114)	(0.00116)	(0.00108)	(0.00098)	(0.00091)	(0.00111)
D.Government debt squared (% of GDP)	0.00001	0.00001	0.00000	0.00001	-0.00000	0.00001	-0.00001	-0.00000	0.00005
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00003)	(0.00001)	(0.00002)	(0.00001)	(0.00003)
D.Gross fixed capital formation (% of GDP)	0.00023	0.00027	0.00026	0.00043	-0.00006	0.00028	-0.00003	0.00040	-0.00017
	(0.00041)	(0.00044)	(0.00042)	(0.00043)	(0.00044)	(0.00042)	(0.00037)	(0.00043)	(0.00037)
CD Statistics	-2.62	-2.29	-2.71	-1.30	-0.99	-2.90	-1.96	-2.51	-2.81
p-value	(0.0088)	(0.0218)	(0.0067)	(0.1929)	(0.3241)	(0.0037)	(0.0500)	(0.0122)	(0.0050)
Observations	3050	3050	3050	3050	2756	3050	2955	2718	2528
Countries	37	37	37	37	35	37	36	37	37

Note: standard errors are displayed within parantheses. * denotes signif. at the 10% level, ** indicate signif. at the 5% level, and *** represent signif. at the 1% level.

Table 8: Conditional effects of government debt on real GDP – robustness test using the common correlated effects estimator.

Dep.: real GDP index	(36) CCEPMG	(37) CCEPMG	(38) CCEPMG	(39) CCEPMG	(40) CCEPMG	(41) CCEPMG	(42) CCEPMG	(43) CCEPMG
Long-run equation								
Government debt (% of GDP)	-0.00264	-0.00244	-0.00216	-0.00089	-0.00173	-0.00086	-0.00039	0.00009
	(0.00204)	(0.00184)	(0.00181)	(0.00265)	(0.00148)	(0.00300)	(0.00049)	(0.00112)
Government debt squared (% of GDP)		0.00000		-0.00001		0.00000		-0.00000
		(0.00001)		(0.00005)		(0.00001)		(0.00001)
Gross fixed capital formation (% of GDP)	0.00480***	0.00386***	0.00408**	0.00419**	0.00392**	0.00260	0.00457***	0.00524***
	(0.00150)	(0.00109)	(0.00160)	(0.00188)	(0.00198)	(0.00205)	(0.00130)	(0.00144)
L.GDP per capita (PPP)	0.23484***	0.26257***	0.18691***	0.19253**	0.15062*	0.18294**	0.17079***	0.17244***
	(0.08986)	(0.05693)	(0.06199)	(0.09663)	(0.08147)	(0.09180)	(0.05407)	(0.06355)
Interact	0.00009	0.00008	0.00002	0.00002	0.00001	0.00000	0.00003	0.00003
	(0.00010)	(0.00007)	(0.00002)	(0.00005)	(0.00001)	(0.00002)	(0.00008)	(0.00003)
Gov. consumption (% of GDP)	-0.01678*	-0.01426**						
	(0.00873)	(0.00616)						
Private credit (% of GDP)			-0.00127	-0.00104				
			(0.00128)	(0.00253)				
Private debt (% of GDP)					-0.00057	-0.00029		
					(0.00041)	(0.00100)		
Long-term interest rate							-0.00940	-0.00936**
							(0.00692)	(0.00430)
Short-run equation								
Error correction	-0.25178*	-0.25178*	-0.24401*	-0.27199	-0.23680	-0.28255	-0.23841	-0.24171*
	(0.14150)	(0.14150)	(0.13240)	(0.18244)	(0.14401)	(0.18172)	(0.15029)	(0.14489)
D.Government debt (% of GDP)	-0.00018	-0.00018	-0.00028*	-0.00025	-0.00008	-0.00014	-0.00042***	-0.00050***
	(0.00014)	(0.00014)	(0.00015)	(0.00018)	(0.00020)	(0.00018)	(0.00012)	(0.00016)
D.Gross fixed capital formation (% of GDP)	-0.00028	-0.00025	0.00053	0.00039	0.00040	0.00043	-0.00002	-0.00023
	(0.00040)	(0.00041)	(0.00040)	(0.00042)	(0.00042)	(0.00042)	(0.00033)	(0.00035)
Variable in interaction term	Government consumption	Government consumption	Private credit	Private credit	Private debt	Private debt	Long-term interest	Long-term interest
CD Statistics	-2.34	-2.64	-0.13	0.10	-1.48	-1.84	-1.23	-2.07
	(0.0193)	(0.0083)	(0.8974)	(0.9177)	(0.1387)	(0.0652)	(0.2184)	(0.0384)
Observations	2547	2547	2422	2422	2434	2434	2500	2500
Countries	31	31	29	29	29	29	31	31

Note: standard errors are displayed within parentheses. * denotes significance at the 10% level, ** indicate significance at the 5% level, and *** represent significance at the 1% level. Estimates for other control variables in short-run equation are omitted. Dependent variable and L.GDP per capita (PPP) are in logarithms.

4 The causal effects of government debt accumulation on economic growth

In the previous chapter, we were unable to demonstrate a robust long-term relationship between government debt and real GDP. However, we found that the short-term impact of changes in debt on economic growth is significant, even after addressing cross-sectional dependence issue. However, as e.g. Heimberger (2023) points out in a meta-study, when investigating the debt-growth nexus, it is important to take sufficient account of the endogeneity of the relationship in order to rule out potential biases in the estimates. Therefore, in this chapter we use the instrumental variables approach to assess the causal influence of government debt accumulation on economic growth in 26 EU countries from 2003 to 2019. For this purpose, we use certain components of the stock-flow adjustment as an instrument for debt change. These components are related to the change in debt but are unlikely to influence growth through the error term.

4.1 Methodology

In this section, we employ a panel two-stage least squares (2SLS) estimation method to analyze the impact of government debt change on economic growth for 26 European Union countries over the period 2003-2019. The choice of the 2SLS estimator is driven by the need to address the potential endogeneity of government debt. This endogeneity poses a significant challenge in deriving causal inferences, as conventional regression methods could lead to biased and inconsistent estimators. In particular, this may relate to the problem of reverse causality, where a country experiencing insufficient economic growth suffers a decline in tax revenues and at the same time policymakers tend to support the economy with higher spending, which together accelerate the accumulation of debt. A number of studies have addressed the issue of reverse causality, mainly using Granger causality methods (Lof & Malinen (2014); Kempa & Khan (2017)). However, some studies address endogeneity by lagging government debt by one year (Cecchetti et al. (2011); Ostrihoň, et al. (2023)). As noted by Panizza & Presbitero (2014), this treatment of endogeneity may be inadequate because debt and growth tend to be persistent, and also when policymakers expect the economy to slow, they tend to resort to expansionary fiscal policy, and then an increase in debt precedes the economic slowdown. Our approach is close to that of Panizza & Presbitero (2014), who instrument the level of debt by the change in the value of foreign currency-denominated debt due to the

depreciation/appreciation of the domestic currency (valuation effect). Our instrument was constructed by combining several parts of the stock-flow adjustment[2], that we argue are not directly related to economic growth but are associated with changes in government debt. A more detailed description of the chosen instrument is given in the next subsection.

In the first stage, we regress the potentially endogenous variable – change in government debt ($\Delta Debt_{i,t}$), on all exogenous variables in the model along with our instrumental variable ($SFAIV_{i,t}$). The first stage regression can be represented as:

$$\Delta Debt_{i,t} = \alpha + \gamma SFAIV_{i,t} + \eta' X_{i,t} + \lambda_i + \delta_t + \mu_{i,t} \quad (4)$$

In this equation, α is the intercept, $X_{i,t}$ encompasses the other exogenous regressors, λ_i are country fixed effects, δ_t are time dummies and $\mu_{i,t}$ is the error term. This stage provides the fitted values of general government debt change ($\Delta\widehat{Debt}_{\iota,t}$), which are used in second stage regression. The second stage involves regressing the dependent variable, 3-year overlapping real GDP (PPP) per capita growth, on the fitted values of government debt change obtained from the first stage, along with the exogenous variables, country fixed effects, and time dummies. The model for the second stage is expressed as:

$$Growth_{i,t+1,t+4} = \beta_0 + \beta_1 \Delta\widehat{Debt}_{\iota,t} + \theta' X_{i,t} + \lambda_i + \delta_t + \epsilon_{i,t} \quad (5)$$

The coefficient β_1 is the key parameter estimating the impact of government debt on economic growth. Comprehensive diagnostic tests, including tests for the strength of the instrumental variable and over-identifying restrictions, are conducted to ensure the robustness and validity of the 2SLS estimates. Through this approach, we aim to provide a clearer understanding of the causal relationship between government debt accumulation and economic growth, effectively addressing the biases associated with endogeneity.

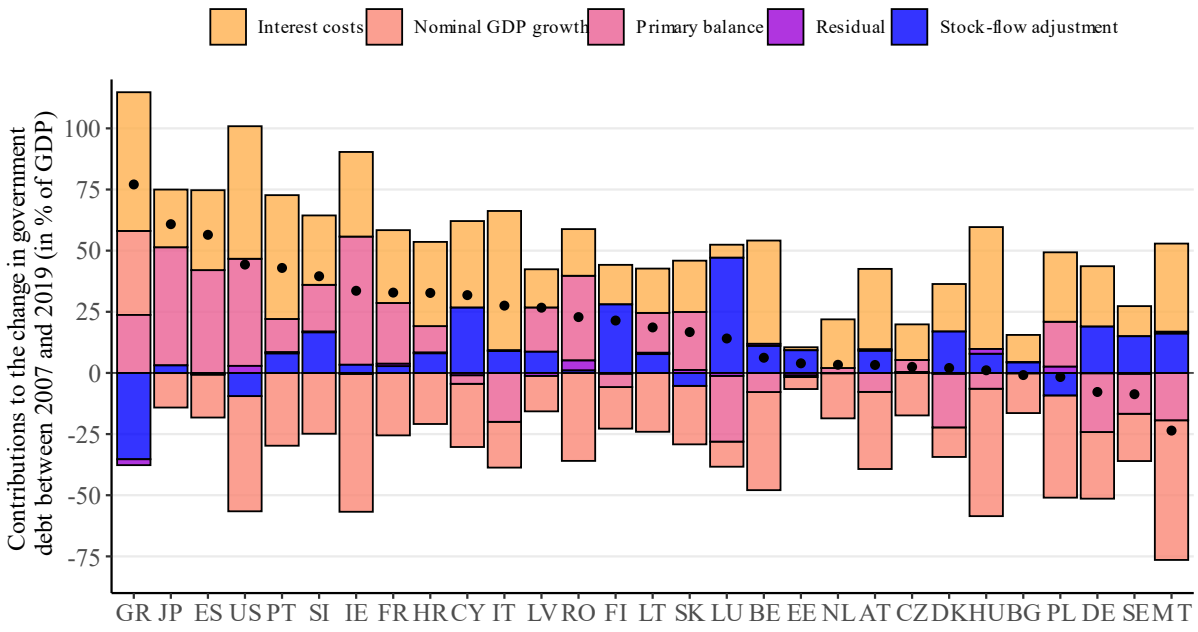
4.1.1 Instrument for government debt accumulation

In the context of instrumental variable (IV) regression, the exclusion restriction is a critical assumption that must be met for the instrumental variable to be valid. The exclusion restriction refers to the idea that the instrumental variable should only affect the dependent variable through its effect on the independent variable (also known as the endogenous variable) and not through any other channel. The change in government debt as a percentage of GDP can arise from the primary balance (the difference between government revenue and expenditure), interest expenditure, the change in nominal GDP or

[2] The stock-flow adjustment (SFA) accounts for the discrepancy between the variation in government debt and the recorded government deficit or surplus over a specific period.

the stock-flow adjustment (SFA). Suppose that interest rates rise as a result of an overheating economy, leading to an increase in the interest cost of servicing government debt. At the same time, the rise in interest rates leads to a sharp fall in household consumption, to which policymakers respond by deciding to stimulate the economy with expansionary fiscal policy. However, these events take place in the second half of year t and are reflected in the drop in real GDP in the following year. If we were to regress the level or change in government debt on GDP growth, we would obtain a negative relationship. In fact, the relationship is not driven by an exogenous change in debt, but by reverse causality and variables that simultaneously affect debt but also affect the economy through other observed or unobserved channels. Of the above-mentioned causes of debt change, we argue that the stock-flow adjustment is the most reasonable candidate for an instrument that affects changes in debt but does not fundamentally affect economic growth through the error term. In the following paragraphs, we explain in detail what the different parts of the SFA mean and describe the construction of an instrumental variable that could satisfy the exclusion restriction.

Figure 2: Decomposition of general government debt change between years 2007 and 2019



Source: Own calculations based on AMECO data

The stock-flow adjustment (SFA) accounts for the discrepancy between the variation in government debt and the recorded government deficit or surplus over a specific period. Deficits typically raise debt levels, and surpluses lower them, but other factors also

influence government debt. A positive stock-flow adjustment (SFA) indicates that debt grows more, or shrinks less, than the annual deficit or surplus suggests. Conversely, a negative SFA signifies that debt increases less, or decreases more, than the annual figures of government balance indicate. These SFA has valid accounting reasons; debt changes arise not only from deficits but also from actions like government loans or equity injections into corporations, which aren't reflected in deficit numbers. The stock-flow adjustment can conceptually be divided into three main categories: a) net acquisition of financial assets, b) effects of debt adjustment, and c) statistical discrepancies. Net acquisition of financial assets and adjustments account for a major part of the SFA, while statistical discrepancies generally account for only a minor fraction (European Commission, 2023).

4.1.2 Net acquisition of financial assets

There is very little literature describing the stock-flow adjustment in detail. We have taken the definitions of the various of SFA components from the European Commission's notes on the excessive deficit procedure (European Commission, 2023).

The primary contributor to the Stock-Flow Adjustment (SFA) is typically the net acquisition of financial assets. Financial assets transactions are recorded on a consolidated basis to exclude transactions among government units. This approach means that internal lending doesn't increase reported assets or debt. Similarly, government units buying government bonds are accounted for not as asset gains but as reduction in the overall consolidated debt. Net acquisitions of financial assets are made up of Currency and deposits (F.2), Debt securities (F.3), Loans granted by government to non-governmental units (F.4), Equity and investment fund shares/units (F.5), Financial derivatives (F.71), Other accounts receivable (F.8) and Other financial assets (Monetary gold and SDRs (F.1) and Insurance technical reserves (F.6)).

The Currency and Deposits (F.2) mainly represents the changes in central government deposits with banks, significantly influenced by treasury operations and activities of other government units like local governments. Significant year-to-year variations in this position can occur due to large-scale financial activities, such as a major bond issuance, leading to substantial cash inflows or outflows in a particular year, which may temporarily boost government deposits if not immediately allocated for expenses or debt servicing.

Debt Securities (F.3) primarily represent government purchases, especially by social security funds, of various financial instruments like bills, bonds, and shares from different entities, including financial institutions and foreign governments. Transactions within the general government sector, like investments in government securities, are not included here due to consolidation. Since 2012, this category also includes purchases of notes from the European Stability Mechanism (ESM) or the European Financial Stability Facility (EFSF). The acquisition and disposal of these notes are recorded in this category and correspondingly affect the government's debt level.

The Loans (F.4) category of the Stock-Flow Adjustment (SFA) encompasses loans made by the government to non-government entities, excluding intra-governmental loans due to consolidation. This typically includes loans to public corporations, foreign governments, and individuals such as students. The value of this loan component increases with new lending activities and decreases with repayments or cancellations. Some loans may convert into capital, affecting this item. Loans with no expected repayment are considered capital transfers, not recorded here.

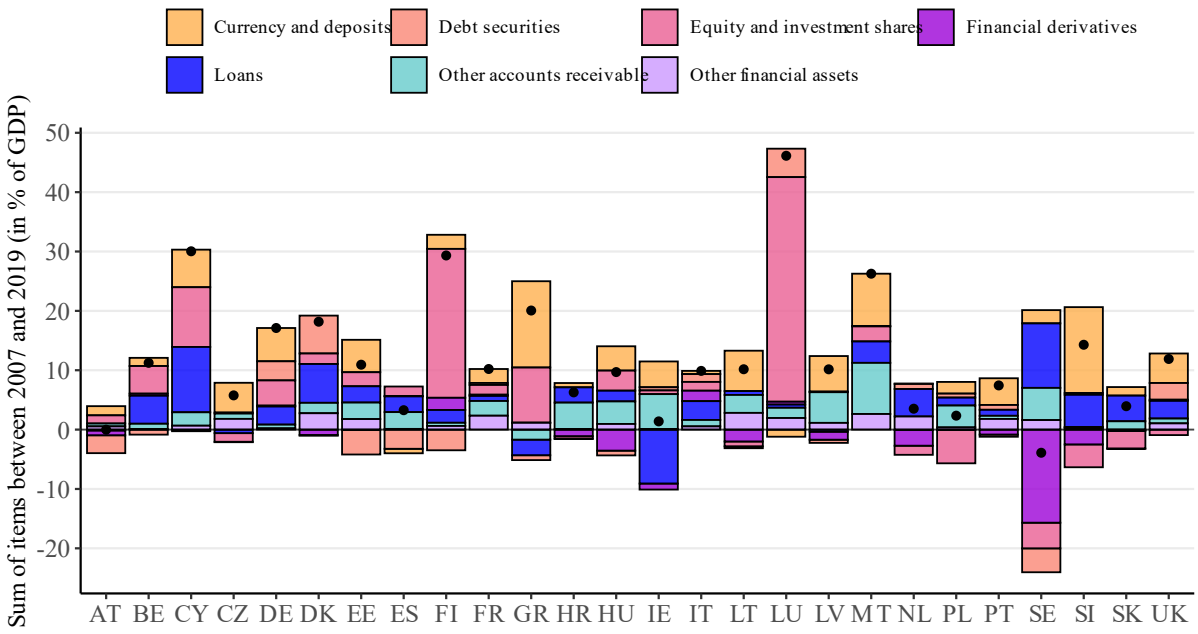
The Equity and investment fund shares/units (F.5) item reflects government transactions in corporate equity, distinguishing between portfolio and non-portfolio investments. Decreases in this item often correspond to privatization proceeds or reclassifications of excess distributions from public corporations as financial transactions. Increases are typically from equity injections into public corporations or contributions to entities like the European Stability Mechanism, expecting a market return. This item also includes government portfolio investments in marketable shares and mutual funds, representing passive holdings without significant influence over the issuer. These transactions can indirectly affect government debt levels, either increasing them through equity injections or financing debt reduction through privatizations.

Treasuries and other government entities frequently engage in transactions in Financial derivatives (F.71), such as swaps, futures and options. Their main objectives are to reduce the risks associated with their debt instruments and to optimize liquidity management. The financial accounts record the cash flows arising from these operations, but they have no impact on the deficit. Liabilities arising from financial derivatives are not counted as part of government debt, with the exception of off-market swaps, which are categorized as loans.

The category of Other accounts receivable (F.8), which is included in the net acquisition of financial assets in the stock-flow adjustment, consists mainly of tax and social contribution receivables. It also includes amounts related to EU transactions, such as payments made by government on behalf of the EU and awaiting reimbursement, and trade credits and advances (e.g. prepayments for future purchases such as military equipment). Occasionally, it may also include advance payments of wages or benefits.

Other financial assets (F.5, F.6) is the smallest category of net acquisition of financial assets. Monetary gold and SDRs (F.1) refers to gold held as a reserve by monetary authorities and Special Drawing Rights, a type of international reserve asset created by the IMF. Insurance technical reserves (F.6) covers financial products such as insurance, pension schemes and standardized financial guarantees used in various transactions.

Figure 3: Decomposition of net acquisition of financial assets (sum of each item between 2007 and 2019 in % of GDP)



Source: Own calculations based on data obtained from EDP notification tables

4.1.3 Adjustments

Adjustments within stock-flow adjustments (SFAs) serve to bridge the gap between accrual-based accounting used for government deficits and the cash-based approach for debt, as defined by the Maastricht criteria. These adjustments fall into three sub-categories: transactions not included in government debt, such as financial derivatives and various

other liabilities; valuation changes in debt, capturing the differences between issuance price and face value, as well as discrepancies between accrued and paid interest; and the impact of foreign exchange movements on foreign-currency debt. Moreover, SFAs account for the reclassification of entities within the general government sector and other infrequent debt extinguishments that do not affect the deficit or surplus. The essence of these adjustments lies in ensuring consistency between the accrual recording of revenues and expenses at the time of transaction or obligation and the cash recording of government debt at nominal values. Adjustments for early repayments or emissions of debt above or below par value are also included, reflecting the practical differences in managing government finances and the reported fiscal statistics.

The category Issuance above(-)/below(+) nominal value reflects the practice where governments issue bonds at prices different from their face value. When issued above face value (a premium), it's recorded as a negative entry, and when below (a discount), as a positive entry. This accounting treatment aligns with the requirement to record debt at face value, with the issue proceeds recognized under Currency and Deposits (F.2). The differential is treated as an expenditure spread over the bond's lifespan, representing an economic interest cost. Changes in market conditions can shift the trend of issuance towards premiums or discounts, as seen in EU Member States' practices over time.

The Difference between interest (D.41) accrued and paid captures the timing difference between when interest accrues and when it is actually paid, as per the ESA 2010 accrual accounting rules, and is excluded from government debt stock. It also accounts for the time distribution of premiums or discounts from bond issuances. Positive values in this category may indicate the accrual of interest from previously issued bonds at a premium. Generally, this adjustment is more significant for countries with higher debt-to-GDP ratios.

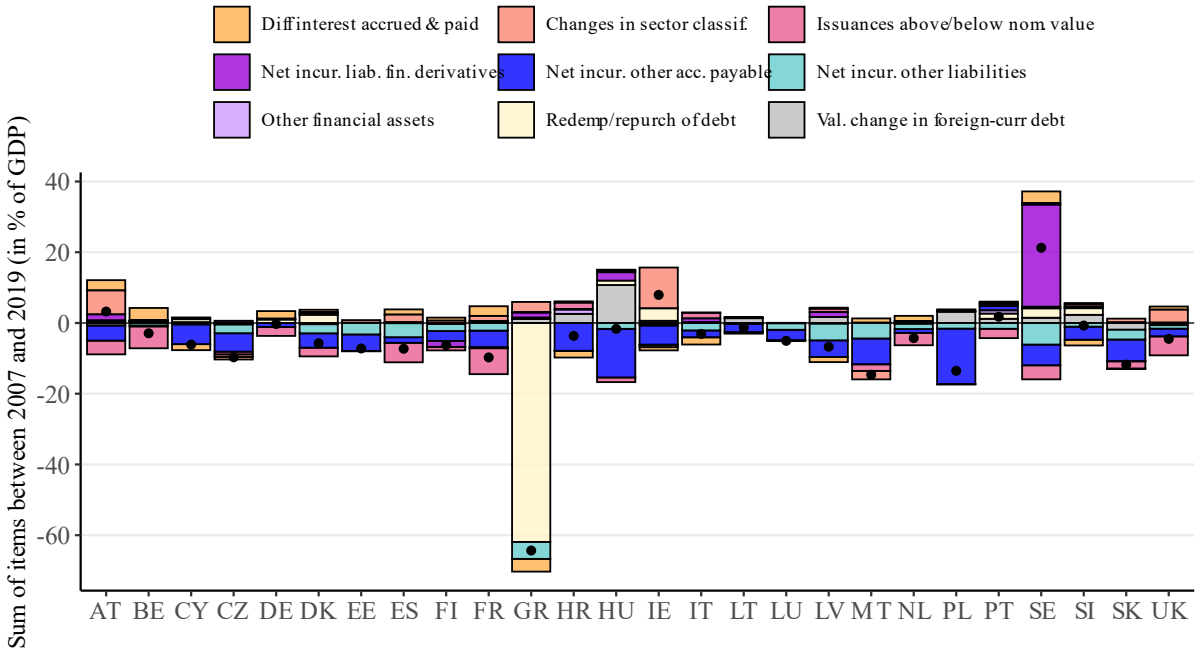
The category Redemptions of debt above/below nominal value addresses the financial adjustments needed when a government either buys back its bonds before maturity or one government unit purchases bonds from another. It represents the difference between the bond's repurchase value and its face value, with this variance recorded in the specified column. This adjustment is crucial in accurately reflecting the government's financial transactions related to its debt instruments.

The appreciation/depreciation of foreign currency debt occurs when governments issue debt in a foreign currency without hedging. Fluctuations in the national currency's

value lead to changes in the debt level, but don't affect the deficit/surplus. An appreciation of the national currency reduces the debt, while a depreciation increases it. Additionally, any final gains or losses from the redemption of hedged debt are also recorded under this adjustment. Notably, some Member States have significant foreign currency debts, primarily in euros (for non-euro area countries), U.S. dollars, or Special Drawing Rights (SDRs).

Changes in sector classification (K.61) occurs when an institutional unit's classification shifts into or out of the government sector, necessitating adjustments to include or exclude its debt and claims against the government. Other volume changes in financial liabilities (K.3, K.4, K.5) covers changes due to catastrophic losses (K.3), uncompensated seizures (K.4), and other unspecified volume changes (K.5). These adjustments ensure the accurate representation of government debt in response to such events and reclassifications.

Figure 4: Decomposition of adjustments category (sum of each item between 2007 and 2019 in % of GDP)



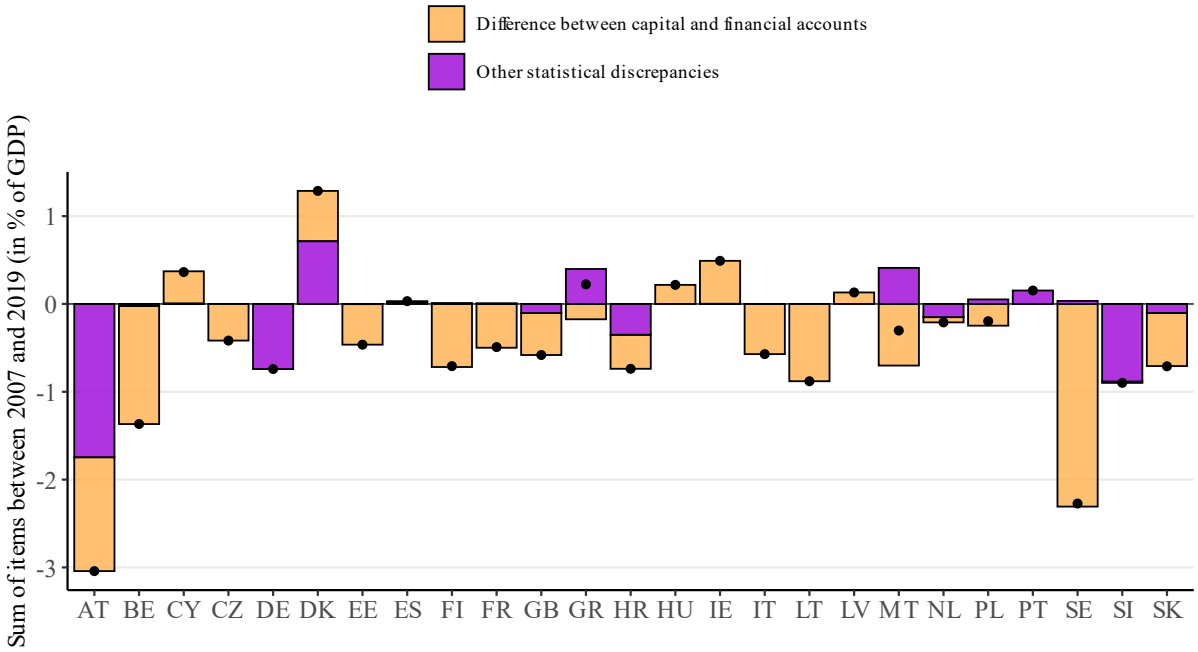
Source: Own calculations based on data obtained from EDP notification tables.

4.1.4 Statistical discrepancies

Statistical discrepancies in stock-flow adjustments represent differences due to varied data sources and can indicate data quality issues. These discrepancies fall into two types: those between balances of non-financial and financial transactions, and those linked to

reconciling transactions in debt instruments with changes in debt at face value. They arise from using diverse, sometimes non-integrated data sources, leading to mismatches between revenue/expenditure and financing data, or between debt transactions and actual debt changes. The discrepancies, monitored by Eurostat, can signal data accuracy issues, especially if consistently positive, suggesting potential underestimation of deficits. Generally, these discrepancies are relatively small for the EU and the euro area.

Figure 5: Decomposition of statistical discrepancies category (sum of each item between 2007 and 2019 in % of GDP)



Source: Own calculations based on data obtained from EDP notification tables.

4.1.5 Construction of the instrument

The strong correlation between the overall stock-flow adjustment (SFA) and changes in government debt is expected, largely due to its mechanical relationship. However, several components within the SFA indicate potential endogeneity. A notable example is the loans category (F.4), in which it is obvious that an increase in credit to the private sector can stimulate economic growth through higher capital accumulation. Another significant category, currency and deposits (F.2), often increases substantially in the period leading up to a crisis, as countries tend to accumulate funds in anticipation. This trend was particularly noticeable at the onset of the Covid-19 pandemic in 2020, when countries stockpiled more cash than necessary. Therefore, while many elements within the SFA are closely correlated with changes in government debt, they do not necessarily meet the exclusion restriction criteria. In our approach to constructing the instrument, we have endeavored to incorporate

parts of the SFA that align as closely as possible with this condition, while also explaining a significant portion of the variation in government debt changes. The instrument was constructed by summing the following SFA categories:

1) valuation change in foreign currency debt;
2) changes in sector classification;
3) other statistical discrepancies.

Valuation change in foreign currency debt has already been used as an instrument for the level of government debt in a study by Panizza & Presbitero (2014), who examined the impact of government debt on economic growth. We follow the argumentation of Panizza & Presbitero (2014) in defending the fulfilment of the exclusion restriction. According to the authors they found two possible channels of impact through error term. The valuation effect is very likely to be correlated with the real effective exchange rate (REER), which several studies have shown to be an important determinant of economic growth (Eichengreen et al. (2005); Rodrik (2008)). Another channel of influence may be the level of foreign currency debt, which on the one hand influences the valuation effect, but according to the literature, its high level may limit a country's ability to implement countercyclical economic policies, increase volatility and reduce economic growth (Eichengreen et al., 2005). Following Panizza & Presbitero (2014), controlling for the REER and the level of foreign currency debt the regressions should close these causal paths.

In the study by Panizza & Presbitero (2014), the valuation effect proved to be a strong instrument, capable of explaining a significant part of the variability in government debt levels. This can likely be attributed to their sample of OECD countries between 1980 and 2005, a period when many countries had their own national currencies, and a larger proportion of their debt was denominated in foreign currency. In contrast, for our sample of EU countries from 2003 to 2019, this single indicator does not serve as an effective instrument for the level of government debt. However, it still can explain a part of the change in debt. Given that several EU countries have only a negligible amount of foreign currency debt, we need to utilize also other components of the SFA to construct a sufficiently robust instrument.

Second component of our instrument is the change in sectoral classification. This refers to the reclassification of institutional units either into or out of the government

sector, which consequently leads to their current debt being included in or excluded from the total government debt. We do not anticipate that a change in classification, such as the reclassification of a state-owned enterprise from the public sector to the general government sector, or vice versa, could have an impact on economic growth through the error term.

The third and final component is other statistical discrepancies which is arising from the use of different, sometimes non-integrated, data sources, leading to mismatches between revenue/expenditure and financing data, or between debt transactions and actual debt changes. In this case, we believe that this component of the SFA could affect growth due to its potential correlation with a country's economic development (more developed economies may have better institutional capacity and more accurate statistics). However, we include the level of GDP per capita in purchasing power parity in all specifications, which leads us to conclude that the inclusion of other statistical discrepancies in our instrument does not violate the exclusion restriction assumption.

We constructed the instrumental variable as the sum of the following three components of the stock-flow adjustment: 1) valuation change in foreign currency debt, 2) changes in sector classification and 3) other statistical discrepancies, all expressed as a share of gross domestic product:

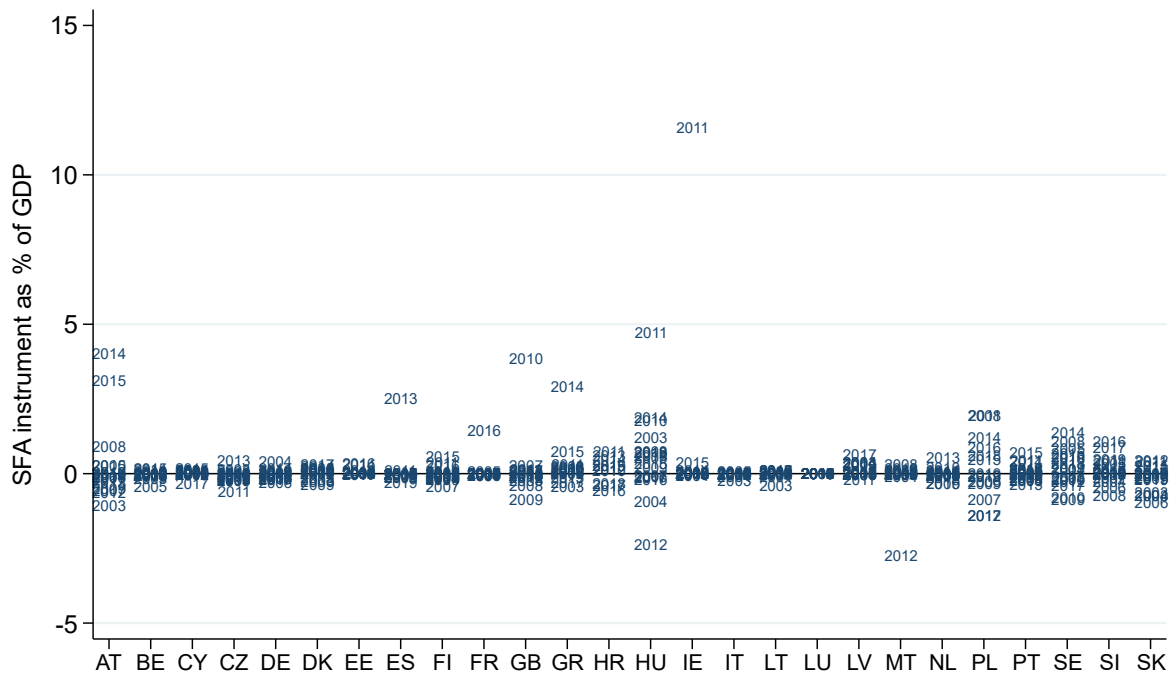
$$SFAIV_{i,t} = \frac{Val.effect_{i,t} + Sector\ class.changes_{i,t} + Stat.discrepancies_{i,t}}{GDP_{i,t}} \quad (6)$$

Data on SFA at a more detailed level of disaggregation are not generally available. However, EU countries regularly send notification tables to the European Commission under the Excessive Deficit Procedure (EDP), in which they also provide data on the detailed structure of the SFA. The data for each SFA category were taken from these tables and divided by the level of GDP at current prices, which was obtained from Eurostat.

The values of our SFA instrument are shown in Figure 6 and the summary statistics by country in Table A.7 in the Appendix. The figure shows some notable outliers such as Ireland or Hungary in 2011. In the case of Ireland, it was due to the transfer of the classification of the Irish Bank Resolution Corporation Limited (IBRC) to the central government as it became a government controlled financial defeasance structure. In Hungary, the forint depreciated significantly in 2011, leading to a large valuation effect. Many of the high values of the SFA instrument are a consequence of the transition to the

new ESA 2010 national accounts methodology and the resulting changes, in particular in the sectoral classification.

Figure 6: SFA instrument by year and country (% of GDP)



Source: Own calculations based on EDP data**.**

4.2 Data

In this chapter we work with data for 26 EU countries, including the UK, between 2003 and 2019. The sample used reflects the availability of data for each component of the stock-flow adjustment. The list of countries in our dataset can be found in the appendix. Despite good availability, we avoided including observations from 2020 onwards, which were significantly affected by the global pandemic.

When examining the impact of government debt on economic growth in EU countries, the main variable used is the change in general government debt as a share of GDP. Specifically, the year-on-year difference in the nominal value of general government debt in national currency divided by nominal GDP:

$$\Delta Debt_{i,t} = \frac{Gen.gov.debt_{i,t} - Gen.gov.debt_{i,t-1}}{GDP_{i,t}} \quad (7)$$

Data on this variable are taken from the Excessive Deficit Procedure (EDP) tables. Data on GDP at current prices were obtained from Eurostat. The construction of our main instrumental variable (SFAIV) has been described in detail in the previous section.

The dependent variable is economic growth. In the specification of the variable, we follow a similar approach to the study by Panizza and Presbitero (2014), who defined growth as the average 5-year difference in the natural logarithms of real GDP per capita at purchasing power parity. However, in our case, since we work with fewer observations over time, we choose to shorten the time window and work with an overlapping three-year average growth:

$$Growth_{i,t+1,t+4} = [\ln(rGDP^{PC}_{t+4}) - \ln(rGDP^{PC}_{t+1})]/3 \times 100 \quad (8)$$

The use of average multi-year growth as the dependent variable is common in growth regressions (Arčabić et al. (2018); C. Checherita-Westphal & Rother (2012)). Data on real GDP per capita are taken from the Penn World Table database.

We follow the literature (Panizza & Presbitero (2014) and Cecchetti et al. (2011)) in the choice of control variables. We control for the level of GDP per capita (PPP) at current prices to adjust for the beta convergence effect, where poorer countries tend to grow faster than richer ones (Mankiw et al. (1992); Patel et al. (2021)). Data are taken from the Penn World Table. Another traditional variable in growth regressions is the savings-to-GDP ratio, which is used as a proxy for the rate of investment and capital accumulation in the economy. Data are obtained from the IMF's World Economic Outlook database. Population growth, based on the Solow growth model, is also a commonly used control variable and a proxy for human capital has also been included. In our case, we have used the average number of years spent in secondary education. Data on population growth were taken from the World Bank database and data on average school enrolment from the Barro-Lee dataset (Barro & Lee, 2013). Openness of the economy should also increase economic growth (Sakyi et al. (2015); Jamel & Maktouf (2017)) and this variable was included in the regressions as the sum of exports and imports relative to GDP. Data were taken from the World Bank's World Development Indicators database. Consumer inflation was included in the regressions as an indicator of macroeconomic stability (Cecchetti et al., 2011) and is calculated as the year-on-year percentage increase in the Consumer Price Index (CPI) and data were obtained from the World Bank database. The last control variable included in the baseline regressions is the dependency ratio, which is defined as the ratio of the population aged 0-15 and over 64 to the population of working age (15-64). This variable captures the

structure of the population, where a significantly higher dependency ratio implies a greater need to reallocate resources in the economy towards the economically inactive population (C. Checherita-Westphal & Rother, 2012). The source is the World Bank database. In an alternative specification, the real effective exchange rate (REER), which measures the change in the competitiveness of a country by taking into account the change in prices relative to other countries, was included as a control variable and was obtained from Eurostat. In an alternative specification, we included foreign currency general government debt as a percentage of GDP as a control variable, using data from the Bank for International Settlements. This inclusion, which follows the approach of Panizza & Presbitero (2014), addresses a potential channel through which SFA may affect growth, namely the constraint on countercyclical fiscal policy due to high foreign currency debt (Hausmann & Panizza, 2011).

Table 9: Summary statistics

Variable	Unit	Obs	Mean	St. Dev.	Min	Max
Real GDP (PPP) per capita 3-year growth	% YoY	337	2.52	2.98	-7.82	15.38
GDP (PPP) per capita in current prices	PPP, USD	441	10.48	0.38	9.49	11.62
National gross savings	% of GDP	441	22.00	5.53	3.88	35.16
Population growth	% YoY	441	0.34	0.81	-2.23	4.01
Average years of secondary schooling	Years	337	4.67	0.94	2.46	7.92
Trade openness	% of GDP	441	121.06	64.72	45.42	380.10
Consumer CPI inflation	% YoY	441	1.99	1.87	-4.48	15.40
Dependency ratio	% of working age population	441	49.62	4.87	38.46	61.80
Real effective exchange rate REER	Index	424	98.82	5.28	67.66	112.42
General government debt	% of GDP	417	62.51	35.00	3.77	186.41
General gov. debt in foreign currency	% of GDP	408	5.76	10.88	0.00	68.30
General government debt change	% of GDP	434	3.01	4.03	-6.13	26.71
SFA instrument	% of GDP	423	0.11	0.81	-2.74	11.57
Change in val. of foreign currency debt (SFA)	% of GDP	430	0.04	0.43	-2.36	4.73
Other statistical discrepancies (SFA)	% of GDP	430	-0.01	0.10	-0.60	0.45
Changes in sector classification (SFA)	% of GDP	428	0.07	0.68	-2.72	11.56

Table 9 provides summary statistics for all the variables used in this chapter. The real GDP (PPP) per capita exhibited an average three-year growth rate of 2.52% with a standard deviation of 2.98%, indicating considerable fluctuations. In terms of wealth measurement, the logarithm of GDP per capita in current prices stood at an average of

10.48, with a relatively low standard deviation of 0.38, suggesting less variability in the size of economies within the sample. National gross savings averaged 22% of GDP, with a standard deviation of 5.53%, spanning a range from 3.88% to a substantial 35.16%, reflecting differing national propensities to save. Population growth had a mean of 0.34%, yet experienced significant variations, suggesting diverse demographic dynamics across the EU. The average years of secondary schooling stood at 4.67 years, reflecting differences in education levels. Trade openness was notably high, with an average of 121% of GDP and a broad range, highlighting the varied extent of economic integration among EU countries. Consumer CPI inflation maintained a modest average of 1.99% but with considerable fluctuations, ranging from deflation to inflation peaks of 15.40%. The dependency ratio, indicative of the population reliant on the working-age group, stood at an average of 49.62% with a tight standard deviation, suggesting a relatively consistent burden across the sample. General government debt as a percentage of GDP had a higher average of 62.51% with a broad range from a low of 3.77% to a high of 186.41%, reflecting varying degrees of fiscal pressures.

4.3 Results

We follow Panizza & Presbitero (2014) in the specification of our baseline model. The dependent variable in is the growth of real GDP per capita in purchasing parity terms ($Growth_{i,t+1,t+4}$). We use 3-year overlapping periods, which are shorter than those used by Panizza and Presbitero (2014) but were chosen due to our smaller number of observations for the instrumental variable. The 3-year averages partially mitigate short-term fluctuations in GDP growth. In our regression, we control for initial income level (GDP per capita in purchasing power parity, $GDPpc_{it}$), which reflects the convergence hypothesis that countries with lower initial income should grow faster than richer countries. Gross national savings ($Savings_{it}$) is used as a proxy for investment in the economy, which follows the classical growth theory that savings lead to investment and hence growth. Population growth ($PopGrowth_{it}$) is incorporated to account for the labor force growth, which can have both positive effects on the economy by providing labor and negative effects through the dilution of capital and resources. The average years of secondary schooling ($School_{it}$) is a measure of human capital, which is a critical component of growth as it enhances the productivity of the workforce. The model also includes trade openness ($Openness_{it}$), reflecting the hypothesis that economic liberalization fosters growth through comparative advantage and technology transfer.

Consumer CPI inflation ($Inflation_{it}$) is used as an indicator of macroeconomic stability, with the expectation that higher inflation rates can have a detrimental effect on economic growth by creating uncertainty and discouraging investment and the dependency ratio ($Dependency_{it}$) is included to gauge the potential burden on the productive segment of the population. Country fixed effects (λ_i) and time dummies (δ_t) are also incorporated to control for unobserved heterogeneity, thus ensuring that the coefficients accurately reflect the impact of the variables on economic growth.

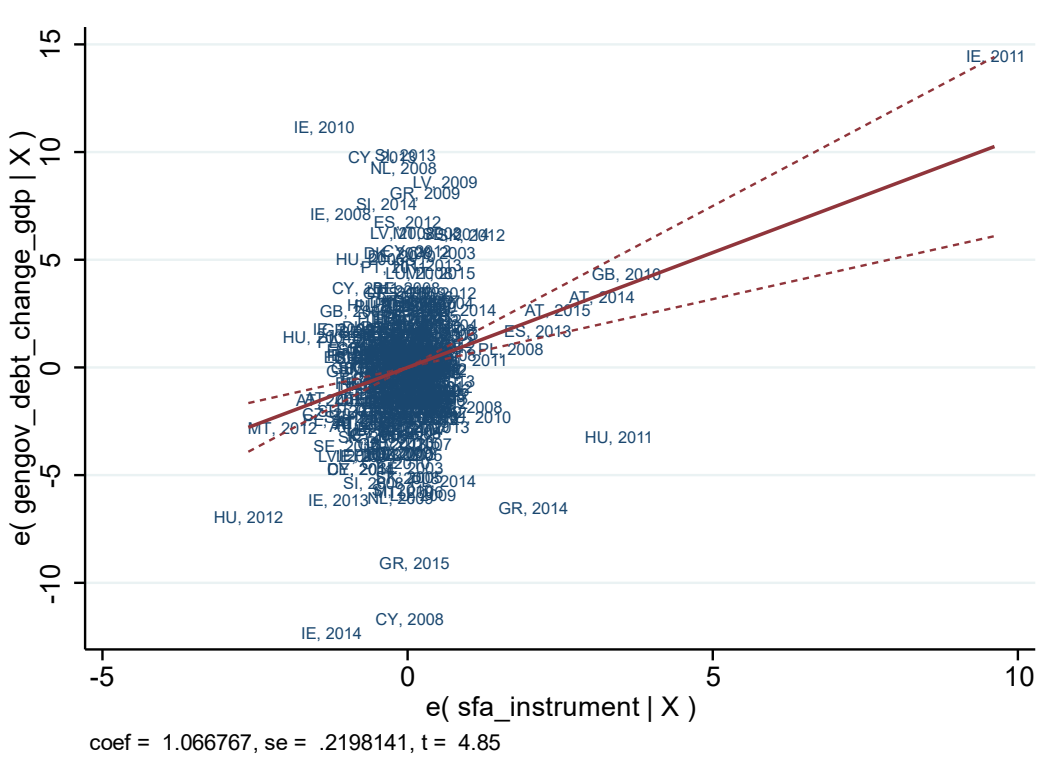
$$Growth_{i,t+1,t+4} = \beta_0 + \beta_1 \Delta\widehat{Debt}_{i,t} + \beta_2 GDPpc_{it} + \beta_3 Savings_{it} + \beta_4 PopGrowth_{it} + \beta_5 School_{it} + \beta_6 Openness_{it} + \beta_7 Inflation_{it} + \beta_8 Dependency_{it} + \lambda_i + \delta_t + \epsilon_{i,t} \quad (9)$$

The resulting basic model estimates are shown in Table 10. In the first column, we estimate the standard fixed effects model on an all-country sample. We find a significant and positive effect of debt change on growth, controlling for other covariates. For example, the positive correlation may be due to higher spending by government that is not covered by additional revenues. These may then affect future real GDP in the current and subsequent years through a multiplier process. Statistically significant effects were also found for the initial level of GDP per capita, population growth, openness of the economy, inflation and the dependency ratio. The observed large coefficients for GDP per capita are due to the fact that the dependent variable is multiplied by 100, as shown in Table 9, and to the small variations in log(GDP per capita) across countries, e.g. a one point difference in log(GDP per capita) corresponds to the difference between Slovakia in 2003 and Germany in 2019. The variables included were able to capture about 60% of the variability in average 3-year economic growth.

In models (2) and (3), we try to estimate the causal effect of the change in government debt on growth using an instrumental variable approach on the full sample of 26 countries between 2003 and 2019. In a first step, we explain the change in government debt using our SFA instrument described above and other control variables. The instrument can explain a significant part of the variability in the endogenous variable. We also conduct tests for under-identification and weak instruments. The Anderson LM chi-squared statistic with a value of 23.27 rejects the null hypothesis of underidentification. The Cragg-Donald F-statistic is also sufficiently high at 23.55, which is above the Stock & Yogo (2005) critical value for 10 per cent maximum bias (upper critical value = 16.38), implying that the maximum bias associated with the possible occurrence of a weak

instrument is less than 10 per cent. However, in the second stage regression on the full sample of countries, we find a significant effect of debt accumulation on growth. Based on a sensitivity analysis using an added-variable plot (Figure 7), we find that Ireland significantly dragged the relationship between the instrument and debt accumulation in the first stage regression. We also identified Greece and Cyprus as countries that have a strong impact on this relationship. Therefore, based on this finding, we estimate models in the same specification on a sample of countries excluding Ireland, Greece, and Cyprus.

Figure 7: Added-variable plot from 1st stage regression (column 2 from Table 10), full sample

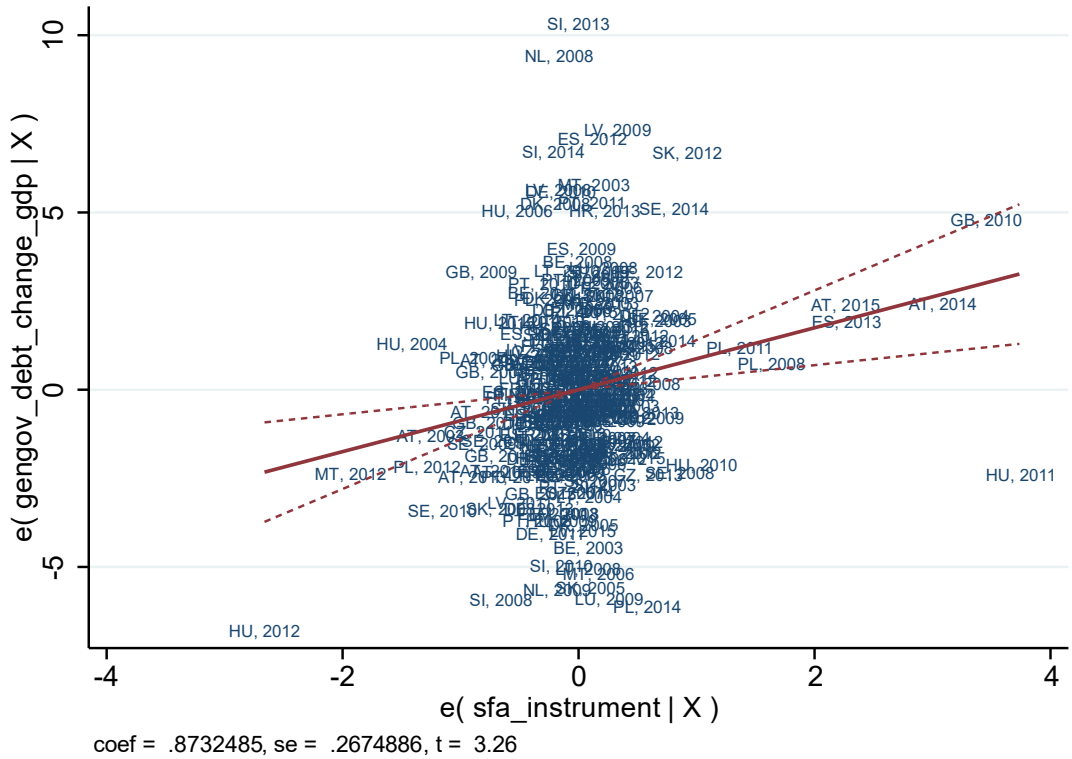


After omitting Ireland, Greece and Cyprus from our sample of countries, the estimates from the baseline model (4) of the impact of debt accumulation on growth are nonsignificant, confirming that the relationship in the full sample was driven by only a few observations and therefore cannot be generalized. The results of the 1st stage regression (column 5 in Table 10) show that, despite the omission of the countries mentioned above, we are able to explain a statistically significant part of the change in government debt with our instrument. However, the strength of the instrument, as measured by the Cragg-Donald F statistic, has declined significantly, but has remained above 10 and thus falls between the first and second bounds of the Stock & Yogo (2005) critical value (16.38 > 10.66 > 8.96), implying that weak instrument bias should be in the range of 10-15%. In Figure 8, we plot

the relationship between our instrument and the change in government debt, controlling for other variables, on a sample of countries excluding Ireland, Greece and Cyprus using an added-variable plot.

In the IV regression, after removing outliers from the sample, we fail to find a significant effect of debt change on future economic growth. This result confirms that the estimated significant effect (column 3 in Table 10) was driven by several outliers. The absence of a significant effect of debt is consistent with the study by Panizza & Presbitero (2014), who used a similar design and also failed to find a significant effect, in their case of debt levels, on growth.

Figure 8: Added-variable plot from 1st stage regression (column 5 from table 10), sample without Ireland, Greece and Cyprus



coef = .8732485, se = .2674886, t = 3.26

As a robustness check, we also estimated the same model specification but with a disaggregated instrument, where instead of a single instrument we used three separate instruments: valuation change of foreign currency debt, changes in sector classification and other statistical discrepancies, each expressed as a share of GDP. However, key diagnostic tests, such as the Cragg-Donald F-statistic for weak instruments, indicated a deterioration in the model's performance. The resulting estimates were consistent with our previous findings, showing no significant effect of the debt change on growth in the sample without

outliers. Details of these estimates with the three separate instruments are given in Table A.8 in the Appendix.

As described above, the instrument we use also includes the change in the value of government debt denominated in foreign currency. However, this variable may be correlated with the error term in the growth regression and therefore our initial estimates may be biased. Therefore, following Panizza & Presbitero (2014), we also control for the real effective exchange rate in the following specification, which should close the potential channel of the impact on growth through the change in price competitiveness. Our instrument includes a valuation effect that could be related to foreign currency debt and exchange rates, both of which may affect growth through other channels. For example, higher foreign currency debt may limit a country's ability to take countercyclical measures, potentially leading to lower growth (Hausmann & Panizza, 2011). Meanwhile, exchange rate fluctuations may affect growth through the price competitiveness channel. To address these channels, we follow the approach of Panizza & Presbitero (2014) by controlling for the real effective exchange rate (REER) and the foreign currency debt as % of the GDP. Specification of the estimated model:

$$Growth_{i,t+1,t+4} = \beta_0 + \beta_1 \Delta\widehat{Debt}_{\iota,t} + \beta_2 GDPpc_{it} + \beta_3 Savings_{it} + \beta_4 PopGrowth_{it} + \beta_5 School_{it} + \beta_6 Openness_{it} + + \beta_7 Inflation_{it} + \beta_8 Dependency_{it} + \beta_9 REER_{it} + \beta_9 FXDebt_{it} + \lambda_i + \delta_t + \epsilon_{i,t} \quad (10)$$

We report the estimates of this model, including IV estimates and comparisons of the sample of all countries and the sample without outliers (Ireland, Greece and Cyprus) in Table 11. The inclusion of the real effective exchange rate and foreign currency debt changed the estimates of the impact of debt very little. The REER variable did not turn out to be significant in any regressions, and the change in sign or statistical significance was not found in any models for the impact of debt accumulation. The variables for the REER and foreign government debt were found to be statistically significant, especially in the subset excluding Ireland, Greece and Cyprus. Nevertheless, the inclusion of additional control variables did not affect either the direction or the statistical significance of changes in government debt on real GDP growth compared with the baseline model estimates presented in Table 10. The values of the underidentification and weak instrument tests are also not significantly different from the baseline estimates.

In this chapter, we address the endogeneity issue in the relationship between government debt accumulation and economic growth using the instrumental variable

method. While applying instrumental variables methodology to the debt-growth nexus is quite common, the instrument often chosen is the previous level of debt (Cecchetti et al., 2011). However, due to the persistent nature of debt, this method of dealing with endogeneity may not be entirely satisfactory. Panizza & Presbitero (2014), who use the valuation effect, is the only study we are aware of that addresses the challenge of finding an appropriate instrument. In this chapter, we have proposed a new instrument for debt accumulation from components of the stock-flow adjustment. This instrument should not affect economic growth through channels other than debt accumulation and is also suitable for advanced economies, which is not the case in Panizza & Presbitero (2014). Using annual data for 26 EU countries between 2003 and 2019, we then estimate the effect of debt accumulation on economic growth using the instrumental variables method. The estimates suggest that, after the removal of outliers such as Greece, Ireland and Cyprus, the accumulation of government debt does not have a significant impact on economic growth.

Table 10: Effects of government debt change on real economic growth – baseline specification.

Dep.: 3-year real GDP per capita growth	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Without Ireland, Greece & Cyprus		
	Fixed Effects	IV estimates		Fixed Effects	IV estimates	
VARIABLES	OLS	1st Stage	IV	OLS	1st Stage	IV
Gov. Debt Change/GDP	0.0706**		0.315***	0.0123		0.0069
	(0.0315)		(0.115)	(0.0308)		(0.141)
Log Initial GDP per Capita	-10.67***	0.0171	-12.37***	-12.06***	-0.8189	-12.97***
	(1.599)	(3.0204)	(1.691)	(1.371)	(2.879)	(1.331)
National Gross Savings	0.0397	-0.3301***	0.148**	0.131***	-0.1754*	0.142***
	(0.0513)	(0.0949)	(0.0680)	(0.0451)	(0.0948)	(0.0506)
Population growth	-0.962***	-0.5977	-0.614*	-0.218	-0.7001	-0.132
	(0.301)	(0.5636)	(0.326)	(0.248)	(0.5129)	(0.254)
Schooling	-0.370	1.9041	-0.626	0.389	1.2374	0.483
	(0.683)	(1.2473)	(0.735)	(0.512)	(1.041)	(0.517)
Trade openness	0.0494***	-0.0158	0.0554***	0.0149*	-0.0206	0.0207**
	(0.0104)	(0.02)	(0.0114)	(0.00868)	(0.0185)	(0.00935)
CPI inflation rate	0.140*	-0.002	0.124	0.0477	0.064	0.0465
	(0.0767)	(0.1408)	(0.0788)	(0.0605)	(0.1239)	(0.0571)
Dependency ratio	0.197**	0.129	0.284***	0.0794	0.2663	0.165*
	(0.0845)	(0.1715)	(0.0967)	(0.0748)	(0.1779)	(0.0858)
SFA instrument		1.0668***			0.8732***	
		(0.2198)			(0.2675)	
Observations	330	319	319	292	284	284
Number of countries	26	26	26	23	23	23
R-squared	0.593	0.413	0.522	0.666	0.393	0.678
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Underidentification and weak instrument tests						
Anderson LM χ^2 stat.		23.270			11.053	
p-value		0.000			0.001	
Cragg-Donald F stat.		23.552			10.658	

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Effects of government debt change on real economic growth with addition of REER and government debt in foreign currency as control variables.

Dep.: 3-year real GDP per capita growth	(7)	(8)	(9)	(10)	(11)	(12)
	Full sample			Without Ireland, Greece & Cyprus		
	Fixed Effects OLS	IV estimates		Fixed Effects OLS	IV estimates	
VARIABLES		1st Stage	IV		1st Stage	IV
Gov. Debt Change/GDP	0.0512*		0.248**	0.0324		0.0526
	(0.0289)		(0.104)	(0.0272)		(0.107)
Log Initial GDP per Capita	-12.57***	-0.964	-14.47***	-13.19***	-0.226	-15.53***
	(1.869)	(4.315)	(1.990)	(1.720)	(4.733)	(1.680)
National Gross Savings	0.133**	-0.442***	0.213***	0.127***	-0.433***	0.143**
	(0.0518)	(0.114)	(0.0709)	(0.0428)	(0.109)	(0.0604)
Population growth	-0.354	0.229	-0.251	-0.250	0.176	-0.0626
	(0.303)	(0.681)	(0.314)	(0.218)	(0.562)	(0.201)
Schooling	-0.0129	1.670	-0.132	0.308	0.985	0.402
	(0.584)	(1.276)	(0.614)	(0.408)	(1.021)	(0.379)
Trade openness	0.0110	0.00493	0.0219*	0.00286	0.0360*	0.0118
	(0.0107)	(0.0248)	(0.0114)	(0.00775)	(0.0208)	(0.00787)
CPI inflation rate	0.218**	-0.214	0.185*	0.0538	-0.226	-0.0164
	(0.0954)	(0.212)	(0.0998)	(0.0732)	(0.189)	(0.0724)
Dependency ratio	-0.0563	0.246	0.0873	-0.0887	0.728***	0.00603
	(0.0860)	(0.214)	(0.0996)	(0.0726)	(0.212)	(0.102)
REER	-0.0453	0.0226	-0.0592**	-0.0436**	-0.0124	-0.0523***
	(0.0279)	(0.0622)	(0.0288)	(0.0205)	(0.0523)	(0.0185)
Foreign. curr. gov. debt	0.0685**	0.0695	0.0399	0.0762***	0.0353	0.0635***
	(0.0306)	(0.0670)	(0.0321)	(0.0212)	(0.0533)	(0.0195)
SFA instrument		0.9976***			0.8667***	
		(0.2260)			(0.2621)	
Observations	286	276	276	255	247	247
Number of countries	25	25	25	22	22	22
R-squared	0.626	0.420	0.575	0.732	0.450	0.757
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Underidentification and weak instrument tests						
Anderson LM χ^2 stat.		19.678			11.499	
p-value		0.000			0.001	
Cragg-Donald F stat.		19.481			10.933	

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

5 The debt-growth nexus: Exploring channels of economic impact through credit ratings and risk premia

In the previous chapters, our analysis has not provided conclusive evidence of a significant impact of government debt on economic growth. However, the lack of evidence linking higher government debt to slower growth does not mean that government debt levels have no impact on growth. The relationship between debt and growth may be more complex than can be captured by the conventional growth regression models. In this chapter, we shift our focus to exploring how higher government debt can increase country-level risk and thereby raise the risk premium on government bonds. This increase in bond yields can feed through to the economy, making credit more expensive for the private sector, which in turn could dampen economic growth. Our approach is to first assess the impact of government debt on sovereign credit ratings. We then use an event study methodology to examine the impact of sovereign credit rating downgrades on the 10-year government bond risk premia across EU countries.

5.1 Methodology and data

This section presents the methodology and data used in the chapter and is divided into two parts. The first part is devoted to the estimation of the impact of government debt on the level of sovereign credit ratings and the second to the impact of a rating downgrade on the risk premium of sovereign bonds.

5.1.1 Effects of government debt on sovereign rating

In this study, we estimate a fixed-effects panel ordered logit model using Blow-Up and Cluster (BUC) estimator developed by Baetschmann et al. (2015) to analyze the determinants of sovereign credit ratings, with a particular focus on the impact of government debt. This approach is chosen for its robustness in dealing with individual-specific unobserved heterogeneity, and its suitability for the ordinal nature of credit ratings. The BUC estimator is specifically chosen for its ability to provide consistent and reliable estimates in models with correlated unobserved heterogeneity, which is crucial for accurately identifying the effects of observed variables. This methodological choice ensures that our analysis of the importance of government debt in influencing sovereign credit ratings is both insightful and based on robust econometric practice. In addition, as part of our robustness tests, we also used a standard OLS fixed effects regression. This

additional step allowed us to compare the results across different estimation techniques, thereby enhancing the reliability and validity of our findings by confirming the consistency of the impact of government debt across different methodological frameworks.

We estimate the effect of government debt on a country's sovereign rating in a fixed effects ordered logit model using the Blow-up and Cluster (BUC) estimator introduced by Baetschmann et al. (2015) in following specification:

$$Score_{i,t} = \beta GovDebt_{i,t} + \gamma' X_{i,t} + \alpha_i + \mu_{i,t} \quad (11)$$

where the dependent variable represents the sovereign credit ratings of country *i* in quarter *t*, taking on categorical values from 1 to 22, where 1 corresponds to default and 22 to an AAA rating (for a detailed explanation of the rating transformation, see Table 12). We estimate the model using identical right-hand side variables while employing $Score$ as the dependent variable, which are derived from the ratings provided by the three leading rating agencies: Standard & Poor's, Moody's, and Fitch. This approach enables us to consistently analyze the impact of our variables of interest across the diverse rating systems employed by these agencies. Our primary variable of interest is general government debt as a percentage of GDP, under the assumption that higher debt signifies increased risk for the country, thereby increasing the likelihood of a lower rating. Control variables in the regression are captured by $X_{i,t}$, fixed effects by country are denoted by α_i, and $\mu_{i,t}$ represents a time-varying error.

In selecting the control variables, we aligned our approach with the prevailing literature (Afonso et al. (2011); Proença et al. (2022)), with a particular focus on the comprehensive methodology[3] used by Moody's to construct ratings. Moody's methodology assesses the risk profile of countries based on four key factors: economic strength, institutional and governance strength, fiscal strength, and susceptibility to event risk. A set of proxies is used to capture these dimensions. Economic strength is represented by GDP per capita at current prices and the annual real GDP growth rate. For fiscal strength, we chose government debt as proxy. The strength of institutions and governance is measured by regulatory quality index, while the political risk indicator serves as our proxy for vulnerability to event risk. Due to collinearity issues, we have tried to keep the number of variables, especially the institutional ones, reasonable.

[3] Available at: https://ratings.moodys.com/api/rmc-documents/395819

We report the results of the panel ordered logit model estimations in Table 15 for the full sample of countries and in Table 16 for the sample of countries excluding the PIIGS group (Portugal, Italy, Ireland, Greece and Spain), which experienced severe problems during the euro area debt crisis. As a robustness test, we estimate a panel fixed effects regression on the full sample using a standard OLS estimator. The results are presented in Table A.9 in the appendix.

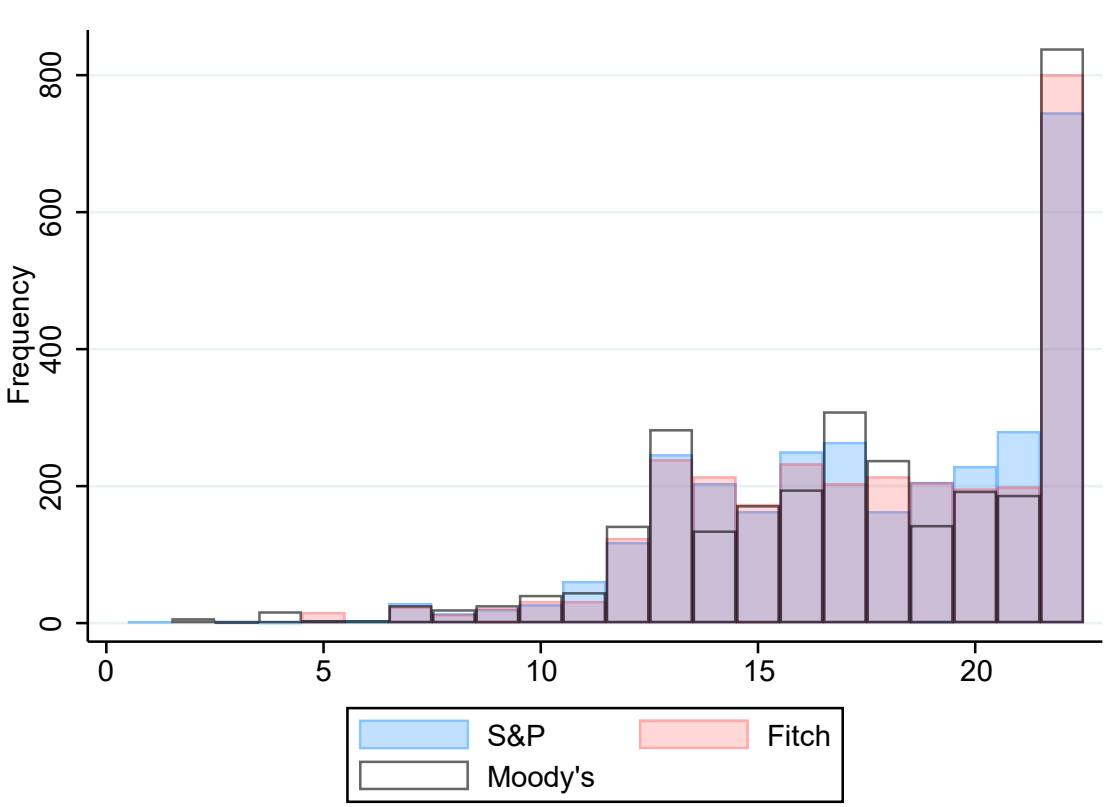
Data on sovereign credit ratings, provided on a daily frequency by the three main agencies (S&P, Moody's, Fitch), were obtained from Bloomberg databases. These ratings were converted to a quarterly frequency by selecting the most recent rating of each quarter, a method similar to that used by Afonso et al. (2011). The ratings were then converted into numerical scores, as shown in Table 12. This table also includes a color scale that differentiates the rating categories according to the level of risk: ratings with scores from 13 to 22 are classified as "investment grade", indicating lower risk, while scores from 2 to 12 are classified as "speculative grade", reflecting higher risk.

Table 12: Overview of sovereign credit ratings, numerical conversions, and distribution frequencies by S&P, Fitch, and Moody's.

S&P	Fitch	Moody's	Score	S&P	Fitch	Moody's
				Frequencies		
AAA	AAA	Aaa	**22**	745	801	839
AA+	AA+	Aa1	**21**	280	199	187
AA	AA	Aa2	**20**	229	196	193
AA-	AA-	Aa3	**19**	206	205	143
A+	A+	A1	**18**	163	214	238
A	A	A2	**17**	264	204	309
A-	A-	A3	**16**	250	233	195
BBB+	BBB+	Baa1	**15**	163	174	172
BBB	BBB	Baa2	**14**	204	214	135
BBB-	BBB-	Baa3	**13**	246	239	283
BB+	BB+	Ba1	**12**	118	124	142
BB	BB	Ba2	**11**	61	32	45
BB-	BB-	Ba3	**10**	27	32	41
B+	B+	B1	**9**	20	22	26
B	B	B2	**8**	14	13	20
B-	B-	B3	**7**	29	24	26
CCC+	CCC+	Caa1	**6**	4	0	4
CCC	CCC	Caa2	**5**	4	16	4
CCC-	CCC-	Caa3	**4**	1	0	17
CC	CC	Ca	**3**	2	0	2
C	C	C	**2**	0	0	7
default	default	default	**1**	2	0	0

The distribution of individual ratings by agency is shown in Table 12 and Figure 9, where we can see in particular the high incidence of AAA ratings, which are consistently assigned to the so-called safe havens in the EU, such as Germany, Sweden, Netherlands and Denmark. The relatively low number of ratings at CCC+ and below is mainly due to the years of the debt crisis, when the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain) in particular had major problems financing their debt.

Figure 9: Distribution of credit ratings based on full sample quarterly data.



The macro-economic and fiscal variables on the right-hand side: general government debt, GDP per capita and real GDP growth have been obtained from Eurostat at the quarterly level. Seasonally and calendar adjusted data were downloaded. The index of regulatory quality were obtained from the World Bank databases at an annual frequency, and quarterly data were obtained by linear interpolation. Political risk indicator data were obtained from the International Country Risk Guide database and also interpolated at quarterly frequency. Summary statistics for the variables used are shown in Table 13.

Table 13: Summary statistics.

Variable	Unit	Obs	Mean	St. Dev.	Min	Max
Score S&P	Index	3 032	17.68	3.87	1.00	22.00
Score Moody's	Index	3 028	17.53	4.11	2.00	22.00
Score Fitch	Index	2 942	17.70	3.88	5.00	22.00
General government debt	% of GDP	2 619	60.21	35.59	3.40	210.30
GDP per capita in curr. prices	EUR	2 997	6 034	4 536	140	31 460
Real GDP growth	% YoY	2 958	2.54	4.19	-21.70	26.20
Regulatory quality	Index	2 798	1.14	0.46	-0.18	2.04
Political risk	Index	1 951	79.35	7.15	64.25	96.08

5.1.2 Credit rating downgrades and risk premium

We used an event study methodology to examine the effect of sovereign credit rating downgrades on sovereign bond risk premium. We followed Afonso et al. (2012) in estimating the instantaneous effects. Using daily data for 27 EU countries, we identified episodes of credit rating downgrades and examined how this event affected the risk premium (relative to Germany) on 10-year sovereign bonds. To avoid possible contamination by other events, we compared the risk premium over a relatively short time window (change in periods t, t+1 and t+2 compared to t-1). To ensure clarity in our analysis of credit rating downgrades, we excluded data points associated with other rating or outlook announcements around the downgrade event. Our study is based on two datasets: the first isolates downgrades within a 3-day window around the event and the second, using stricter criteria, uses a 7-day window. Furthermore, given that spreads are typically highly correlated across countries, as noted by Longstaff et al. (2011), our methodology includes an adjustment for EU market conditions in line with Afonso et al. (2012). This is achieved by calculating an adjusted sovereign yield spread measure. This adjusted measure represents the difference between the sovereign yield spread of the individual country and the average spread of the EU countries (excluding Germany) in our sample.

A fixed effects regression model is used to estimate the immediate impact of sovereign rating downgrades on bond spreads. By examining spreads immediately before and after the downgrade within a 3-day (7-day) isolation window, the model captures the short-term market reaction to rating changes. The model is estimated with the following specification:

$$Spread_{i,t} = \alpha_i + \beta Downgrade_{i,t} + \epsilon_{i,t} \quad (12)$$

where we regress yield spreads against time dummy $Downgrade_{i,t}$, which take value of 0 one day before downgrade event and value 1 after the event. The inclusion of country-specific fixed effects α_i ensures that the estimated impact of rating downgrades on bond spreads is specific to the downgrade event, rather than being influenced by enduring national characteristics.

Table 14: Downgrade occurrences in full sample by year and country. Only instances where a single downgrade occurred within a +- 3-day window were counted.

Country	1998	2004	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2020	2023	Total
Austria							1			1	1					3
Belgium	1					1	1				1					4
Estonia			1	2												3
Spain				1	3	4	7									15
Finland									1		2					3
France							2	2	1	1						6
Greece				3	4	7	6			4						24
Croatia											1					1
Hungary			1		2	2	2								1	8
Ireland				5	5	2										12
Italy		1				1	4	2	1			1	1	1		12
Netherlands								1								1
Poland											1					1
Portugal				1	3	3	2									9
Slovenia						4	4	3								11
Slovakia							2							1		3
Total	1	1	2	12	17	24	31	8	3	6	6	1	1	2	1	**116**

We examined the differences in risk premia following the downgrade announcements in several samples. First, we split our dataset by rating agency and estimated whether, for example, a downgrade by S&P has a different impact than a downgrade by Fitch. We report these results in Table 17. In the next step, we examined whether the effect of a rating downgrade would be statistically significant if we removed

troubled countries from the sample, or periods that could significantly depress the overall average effect. Specifically, we used three different data samples: excluding Greece, excluding the PIIGS countries (Portugal, Ireland, Italy, Greece, Spain), and a sample excluding the debt crisis period, where we excluded all episodes that occurred between 2010 and 2012. In addition to these factors, the impact of rating deterioration may also depend on the rating level itself. We expect that a move from investment grade (e.g. BBB-) to speculative grade (e.g. BB+) will increase the risk premium more than a move within investment grade (e.g. from A to A-). Therefore, we split our dataset into three subsamples: a) downgrade episodes within the investment grade band (score 22-13); b) downgrade episodes within the speculative grade band (score 0-12); c) downgrade episodes when a country moves from investment grade to speculative grade. The results according to this breakdown are shown in Table 19.

In this section we use daily data for 27 EU countries on sovereign credit ratings by S&P, Moody's and Fitch and data on 10-year government bond yields. These data are obtained from Bloomberg databases on a daily basis. The risk premium is calculated as the difference between the bond yield of a given country and the yield on 10-year German government bonds. The evolution of ratings and risk premium vis-à-vis German bonds are shown in the Appendix.

5.2 Results

This section presents the results of our findings and is divided into two parts. In the first, we describe estimates of the impact of government debt on sovereign credit ratings, and in the second, we describe estimates of the impact of rating downgrades on the 10-year sovereign risk premium.

5.2.1 Effects of government debt on sovereign rating

We conducted an analysis of the relationship between government debt and sovereign credit ratings by applying ordered logit models with fixed effects to quarterly panel data from EU countries, covering the period from 1998 to 2023. To obtain our estimates, we used the Blow-Up and Cluster (BUC) estimator, a method introduced by Baetschmann et al. (2015). This method was chosen for its robustness in dealing with unobserved heterogeneity specific to individuals, and for its appropriateness in dealing with the ordinal characteristics of credit ratings.

Table 15 presents our main findings on how different factors affect credit ratings. These are the ratings assigned by S&P, Moody's and Fitch, which serve as our dependent variables. Our analysis starts with models 1 to 3, which include macroeconomic and government debt as controls. In models 4 to 6, we include regulatory quality in addition to macroeconomic and fiscal variables, and in specifications 7 to 9, we add a variable reflecting the degree of political risk. The dataset includes quarterly data from 23 to 25 countries, depending on the availability of data. In particular, certain countries, such as Germany, Luxembourg and the Netherlands, have been omitted due to a lack of variation in the dependent variable. Our analysis shows that GDP per capita is a strong and statistically significant predictor of a country's credit rating, suggesting that higher economic output per capita is associated with better ratings. However, short-term economic performance, as measured by the real GDP growth rate, does not have a consistent impact on credit ratings across models. On the fiscal side, general government debt is negatively correlated with credit ratings, underlining that higher debt levels reduce the likelihood of a high rating, a trend that is consistent across models. The indicator of regulatory quality was statistically significant and the high coefficients observed are due to the low variance of this variable. A one-point difference in regulatory quality is as significant as the contrast between Hungary and Denmark in regulatory quality index.. In the later models (7 to 9), which also included political risk (with higher values indicating lower risk), we found that a lower level of risk is correlated with a higher chance of obtaining a better rating. This relationship was statistically significant for S&P and Moody's ratings, but not for Fitch ratings.

We then refined our analysis by estimating models with the same specifications on a dataset excluding Portugal, Ireland, Italy, Greece and Spain (PIIGS). This exclusion was aimed at countries that experienced significant difficulties in their debt financing during the debt crisis in the euro area, which may have biased the initial estimates presented in Table 15. The results of this adjusted analysis, excluding the PIIGS countries, are detailed in Table 16. Notably, the exclusion does not alter the central findings regarding government debt, which continues to have a strong and statistically significant impact in all model specifications. Similarly, the GDP per capita variable retained its significance in all models. Moreover, with the PIIGS countries removed from the data set, real GDP growth now shows a statistically significant positive effect, showing that economic performance matters for non-troubled countries. The results for the other control variables remain

broadly consistent with those observed in the full sample analysis. To further validate our findings, we conducted a robustness check using Ordinary Least Squares (OLS) within standard panel fixed effects models. These results are documented in Table A.9 in the Appendix. Our supplementary analysis confirms the initial findings and reinforces the conclusion that an increase in government debt is correlated with a lower credit rating.

Table 15: Estimates of panel ordinal logit model with fixed effects, full sample. Rating score as dependent variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	S&P	Moody's	Fitch	S&P	Moody's	Fitch	S&P	Moody's	Fitch
Log GDP per capita	3.337***	2.944***	3.930***	2.714***	2.369***	3.393***	3.615***	4.114***	5.001***
	(0.867)	(0.986)	(1.032)	(0.785)	(0.907)	(0.941)	(1.012)	(1.132)	(1.216)
Real GDP YoY growth	0.0508	0.0361	0.0428	0.0765**	0.0658	0.0734*	0.0872*	0.0383	0.0894
	(0.0347)	(0.0439)	(0.0404)	(0.0374)	(0.0455)	(0.0437)	(0.0529)	(0.0608)	(0.0664)
Government debt as % of GDP	-0.109***	-0.133***	-0.139***	-0.0947***	-0.118***	-0.124***	-0.118***	-0.146***	-0.167***
	(0.0185)	(0.0260)	(0.0230)	(0.0201)	(0.0276)	(0.0240)	(0.0247)	(0.0277)	(0.0195)
Regulatory quality				5.699***	7.022***	7.224***	4.578***	7.760***	8.130***
				(0.737)	(1.079)	(0.795)	(1.451)	(2.069)	(1.919)
Political risk							0.290***	0.315***	0.151*
							(0.0903)	(0.103)	(0.0803)
Fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time effects	NO	NO	NO	NO	NO	NO	NO	NO	NO
Observations	2427	2228	2283	2341	2148	2204	1782	1629	1685
Number of countries	25	23	24	25	23	24	25	23	24
Pseudo R-squared	0.383	0.453	0.470	0.444	0.532	0.547	0.584	0.696	0.684

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

Table 16: Estimates of panel ordinal logit model with fixed effects, sample without PIIGS countries.

VARIABLES	(10) S&P	(11) Moody's	(12) Fitch	(13) S&P	(14) Moody's	(15) Fitch	(16) S&P	(17) Moody's	(18) Fitch
Log GDP per capita	3.686***	3.710***	4.797***	3.200***	3.322***	4.451***	3.662***	4.715***	5.652***
	(1.001)	(1.147)	(1.172)	(0.921)	(1.043)	(0.955)	(1.022)	(1.105)	(1.114)
Real GDP YoY growth	0.0477	0.0359	0.0666**	0.0720*	0.0692*	0.102***	0.0927	0.0798	0.156***
	(0.0354)	(0.0378)	(0.0327)	(0.0399)	(0.0405)	(0.0339)	(0.0564)	(0.0612)	(0.0504)
Government debt as % of GDP	-0.0969***	-0.141***	-0.137***	-0.0940***	-0.139***	-0.136***	-0.103***	-0.152***	-0.156***
	(0.0199)	(0.0283)	(0.0219)	(0.0229)	(0.0307)	(0.0205)	(0.0292)	(0.0360)	(0.0268)
Regulatory quality				5.096***	6.566***	6.576***	4.580**	9.146***	8.155***
				(0.881)	(1.472)	(1.011)	(1.843)	(2.190)	(2.373)
Political risk							0.269**	0.332***	0.177**
							(0.109)	(0.111)	(0.0878)
Fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time effects	NO	NO	NO	NO	NO	NO	NO	NO	NO
Observations	1955	1765	1811	1887	1703	1750	1440	1296	1343
Number of countries	20	18	19	20	18	19	20	18	19
Pseudo R-squared	0.299	0.393	0.414	0.359	0.483	0.493	0.453	0.632	0.595

Robust standard errors in parentheses

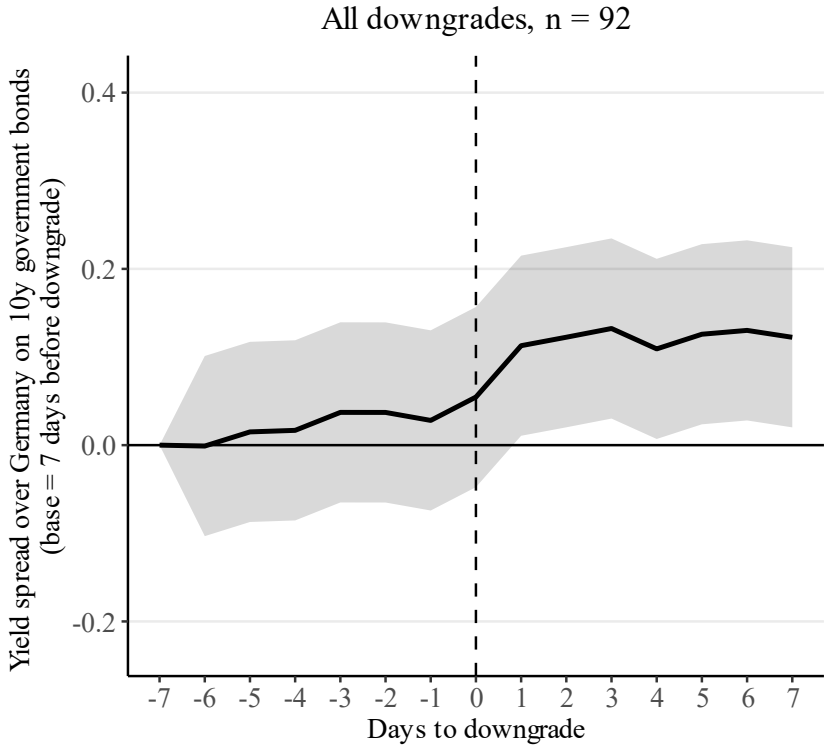
*** p<0.01, ** p<0.05, *p<0.1

5.2.2 Credit rating downgrades and risk premium

In the previous section we found that, on average, higher levels of debt are associated with higher probability of lower credit ratings. In this section, we examine how the announcement of a downgrade affects the risk premium (yield spread over Germany) on 10-year government bonds. We use an event study methodology to analyze this relationship and examine the impact on the risk premium around the time window in which the downgrade announcement occurred.

Moreover, we examine the impact of ratings downgrades on the risk premium, defined by Afonso et al. (2012) as the difference between a country's sovereign yield spread over Germany and the average spread across EU countries. Figure 10 shows the average response of the risk premium to the announcement of ratings downgrades, obtained by regressing yield spreads against time dummies over a seven-day period around the downgrade announcement. The average effect at time t+1 of 0.11 then tells us that the risk

Figure 10: Change in yield spread in the event of rating downgrade (difference in average yield spread over t-7), full sample.



premium is 11 basis points higher relative to period t-7. We also plot the confidence intervals, which tell us whether the average premium is significantly different from the value at t-7. This analysis covers all downgrades from 1998 to 2023 that were not

accompanied by other rating or outlook announcements between t-7 and t+7, a total of 92 episodes. The general reaction to downgrades shows an approximate increase in the risk premium of 11 to 13 basis points from t+1 to t+3 relative to t-7. Separate analyses for downgrades by each agency - S&P, Moody's and Fitch - are documented in the Appendix (Figures A.7 to A.9). While the impact of downgrades is consistent with the aggregate sample, Fitch downgrades uniquely show a more pronounced pre-announcement anticipation effect.

In order to examine the effect of rating downgrades on the risk premium without contamination, we carefully selected cases where no other announcements occurred. This approach minimizes contamination by unrelated events. Nevertheless, the use of longer observation periods increases the possibility that the release of other macroeconomic data, such as inflation or industrial production figures, could coincide with our window and potentially influence the risk premium. To mitigate this risk as much as possible, we have

Table 17: Change in yield spreads in the event of rating downgrade, full sample and by agencies.

	All	S&P	Moody's	Fitch
	3-day isolation window			
[-1, 1]	0.082***	0.097***	0.122**	0.027
	(3.90)	(3.95)	(2.18)	(1.08)
[-1, 2]	0.090***	0.097***	0.128**	0.045*
	(4.10)	(3.13)	(2.32)	(1.84)
[-1, 0]	0.036**	0.047***	0.046	0.014
	(2.49)	(2.87)	(1.61)	(0.45)
Episodes	116	43	36	37
	7-day isolation window			
[-1, 1]	0.085***	0.099***	0.147*	0.014
	(3.41)	(3.50)	(1.99)	(0.57)
[-1, 2]	0.094***	0.115***	0.143*	0.028
	(3.69)	(3.47)	(1.95)	(1.13)
[-1, 0]	0.026*	0.046**	0.033	-0.003
	(1.94)	(2.62)	(1.22)	(-0.10)
Episodes	92	36	26	30

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

opted for very short windows. Our main results, presented in Table 17, show the average change in the risk premium following a downgrade announcement. The changes are

reported for different time intervals around the announcement day. Specifically, the row labelled [-1,1] indicates the change in the average premium at t+1 relative to t-1. In addition, we conducted analyses within so-called "isolation windows". For the "3-day isolation window", we excluded observations where there were other announcements by the rating agencies between t-3 and t+3. A same exclusion criterion was applied to define the "7-day isolation window". The data show that the risk premium typically increases by about 8 basis points the day after a downgrade, which is a statistically significant response. A relatively small observed increase of 3 basis points on the announcement day itself can also be attributed to the daily averaging of bond yield data, implying that afternoon announcements have less of an impact on the daily average yield than morning announcements. The impact of downgrades by S&P and Moody's was somewhat more pronounced, with an increase of around 10-12 basis points for S&P and 12-14 basis points for Moody's, both of which are statistically significant. Changes following Fitch downgrades were smaller and not statistically significant, a phenomenon that can be attributed to a strong anticipation effect, as shown in Figure A.9 in the Appendix.

A significant proportion of rating downgrades occurred between 2010 and 2012, in the midst of the euro area debt crisis, which particularly affected the PIIGS countries (Portugal, Ireland, Italy, Greece and Spain). Consequently, to refine our understanding of the changes in risk premia, we conducted our analysis using three different samples: one excluding Greece, another excluding all PIIGS countries, and a third excluding the entire debt crisis period (2010 to 2012). This segmentation is critical as these specific observations could significantly influence the average effect of downgrades. The analysis includes downgrades by all rating agencies and the results are presented in Table 18, following a similar presentation format as before. Excluding Greece from the analysis removes 24 observations in the 3-day isolation window and 15 in the 7-day window. This exclusion slightly reduces the average change in the risk premium one and two days after the announcement by about 2-3 basis points compared to the full sample, but these differences remain statistically significant. The impact diminishes further when the PIIGS countries are excluded entirely, which significantly reduces the sample size by more than half. In such cases, the average increase in the risk premium at t+1 and t+2 drops to around 2 to 3 basis points, about a third of the effect observed in the full sample. Removing all observations from the debt crisis period further reduces the immediate impact of rating downgrades to a statistically insignificant level. These results underline the

disproportionate impact of rating downgrades on the risk premium, especially during crisis periods when market volatility is high and for countries facing significant debt financing problems.

Table 18: Change in yield spreads in the event of rating downgrade, samples without problematic countries and debt crisis.

	wo Greece	wo PIIGS	wo Debt crisis
	3-day isolation window		
[-1, 1]	0.060***	0.026*	0.007
	(2.90)	(1.87)	(0.32)
[-1, 2]	0.063***	0.029**	0.026
	(3.15)	(2.09)	(1.11)
[-1, 0]	0.010	0.005	0.006
	(0.88)	(0.51)	(0.51)
Episodes	92	44	44
	7-day isolation window		
[-1, 1]	0.067***	0.018	0.017
	(2.76)	(1.17)	(0.66)
[-1, 2]	0.067***	0.021	0.036
	(2.88)	(1.39)	(1.37)
[-1, 0]	0.009	-0.003	0.019
	(0.73)	(-0.29)	(1.66)
Episodes	77	39	38

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The final aspect of our analysis of the immediate impact of rating changes on the risk premium is to differentiate the type of downgrade. In particular, a downgrade from AA to AA- is expected to have a less pronounced effect than a downgrade from A to BB, which represents a move into speculative grade. To account for this, we have structured our analysis around three different sample groups: the first includes only downgrades within the investment grade range (referred to as "down in inv." for grades AAA to BBB-), the second captures episodes where a country's rating moves from investment grade to speculative grade ("down to junk"), and the third consists of downgrades within the speculative grade itself ("down in junk" for grades BB+ and below). We observed the largest number of downgrades within the investment grade category. For downgrades that remained within this category, the risk premium on the day of and the day after the event is

around 3 to 4 basis points higher. In contrast, for speculative grade downgrades, the risk premium increased dramatically by up to 43 bps on the day after the announcement and 35 bps two days after (relative to one day before announcement). It's important to note, however, that this particular analysis is based on a smaller sample of only 10 observations. For speculative grade downgrades, the premium was higher on average by 25 basis points the day after the announcement and by 17 basis points two days later. These findings highlight the significant challenges and market perceptions associated with a country's descent into the speculative grade.

Table 19: Change in yield spreads in the event of rating downgrade, different types of downgrades.

	Down in inv.	Down to junk	Down in junk
	3-day isolation window		
[-1, 1]	0.030**	0.434***	0.251***
	(2.44)	(2.90)	(2.94)
[-1, 2]	0.037***	0.346**	0.169*
	(3.17)	(2.13)	(2.04)
[-1, 0]	0.015	0.021	0.144**
	(1.16)	(0.53)	(2.16)
Episodes	87	10	16

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results in the first part of this chapter show that higher government debt is correlated with an increased probability of a lower rating. Then, in the second part, we find that such downgrades increase the risk premium on 10-year government bonds. In particular, this effect is pronounced during the euro area debt crisis and for countries facing debt financing problems. Moreover, risk premiums escalate significantly when a country's rating falls into the speculative category, while shifts within the investment grade range have little impact on premiums.

As we have linked higher debt levels to higher bond risk premia in this chapter, it is important to outline the link between this channel and economic growth. The prevailing theoretical framework suggests a predominantly negative relationship between interest rates and economic growth, mainly through the investment and consumption channels. This view is supported by various economic theories that show how rising interest rates

negatively affect economic growth by increasing the cost of capital and reducing the incentive to invest. For example, Tobin's monetary growth model posits that higher real yields on money reduce the demand for capital in the medium term, thereby reducing investment (Tobin, 1965). Similarly, neo-Keynesian (Wickens, 2008) and neoclassical theories (Haavelmo (1960); Jorgenson (1963)) argue that higher real interest rates increase the cost of capital for firms, thereby negatively affecting output. Reinhart et al. (2012) also contribute to this debate in the context of the debt overhang hypothesis. They argue that when public debt reaches levels that raise concerns about repayment, a risk premium is added to interest rates, which in turn adversely affects investment and consumption of durable goods and ultimately hampers economic growth. Given the robust theoretical underpinnings linking long-term interest rates to economic growth, we recommend that future research should more focus on empirically establishing this link from bond yields and long-term interest rates to economic growth.

Conclusion and policy implications

Examining the relationship between government debt and economic growth has become increasingly important due to the economic challenges of the last two decades. The global financial crisis, the European debt crisis and the Covid-19 pandemic have all necessitated major fiscal interventions by governments, leading to significant increases in debt. These events, coupled with the geopolitical tensions in 2022 arising from Russia's invasion of Ukraine, have further strained economies, leading to increased spending on subsidies and financial support to mitigate the effects of rising prices and economic downturns. These developments suggest that government debt is likely to continue to rise, driven by the need to address long-term challenges such as ageing populations, security threats and climate change. Understanding how rising debt affects economic growth is critical to navigating the complex global economic landscape.

The dissertation begins by reviewing and discussing the current literature on the relationship between government debt and economic growth. The influential study by Reinhart & Rogoff (2010) introduced the concept of a possible debt threshold, suggesting a certain point of debt relative to GDP (90% in their study), beyond which economic growth slows down significantly. This notion of a debt threshold has been supported by subsequent studies (e.g. Caner et al. (2010); Cecchetti et al. (2011); Baum et al. (2013)), but there is still no consensus on a universal debt threshold applicable across countries. Further research using advanced econometric techniques has argued against the existence of a universal debt threshold, suggesting instead that such a threshold is likely to be varying, dependent on numerous factors and specific to each country (e.g. Arčabić et al. (2018); Égert (2015); Bentour (2021)). In addition to exploring the concept of a debt threshold, we also review topics such as the endogeneity (Panizza & Presbitero, 2014), reverse causality (Amann & Middleditch, 2020), and the mechanisms through which government debt may affects growth (C. Checherita-Westphal & Rother, 2012). Our review shows that there is no uniform agreement on the impact of government debt on economic growth, with results varying depending on the countries, time periods, econometric techniques and model specifications chosen. As highlighted in the meta-study by Heimberger (2023), it is crucial to address the endogeneity of the relationship, as it could largely explain the negative correlation often observed in the literature. Heimberger (2023) also recommends a closer examination of the conditional effects of debt and the

channels through which it may affect growth. Following these suggestions, our dissertation examines the conditional effects of debt in chapter 3, tackles endogeneity with an instrumental variables approach in chapter 4 and assesses the transmission channel of debt through increased perceived risk in chapter 5.

Our first partial objective was to analyse the relationship between government debt and economic growth in advanced economies on a quarterly basis, using a panel cointegration approach. The use of quarterly data for this analysis is relatively rare in the debt-growth nexus literature and has only been used in a few studies (Lim (2019); Amann & Middleditch (2020)). Similarly, only a handful of studies have applied the panel ARDL methodology to estimate the impact of debt on growth (Asteriou et al. (2021); Ibrahim (2021)). To the best of our knowledge, no existing research has used panel ARDL models to produce estimates using quarterly data. In the third chapter, we estimated the long-run effect of government debt on real GDP for 37 advanced economies from 1990 to 2019. We used panel ARDL models estimated with the PMG estimator, distinguishing between short-run and long-run effects, assuming uniform long-run coefficients and allowing for short-run heterogeneity. This approach revealed a significant non-linear relationship between government debt and real GDP, identifying a debt threshold ranging from 95% to 110%. In addition, we examined the conditional effects of government debt by analyzing how its relationship with GDP might be affected by other variables. Our results showed that an increase in government consumption reduced the positive impact of government debt and lowered the debt threshold. A similar effect was observed for private debt, which also adjusted the debt threshold downwards. Subsequently, models with non-linear and conditional debt effects were estimated using the Common Correlated Effects (CCE) estimator, which adjusts the PMG estimator for cross-sectional dependence, a common problem in panel data analysis. However, once this issue was taken into account, all significant non-linear and conditional debt effects disappeared in the long-run equations. This highlights the critical influence of global economic interdependencies, suggesting that external conditions may affect national economies more than domestic factors. This is particularly relevant in an interconnected economic club with common currency and strong contagion effects. It also underlines the need for advanced econometric techniques to deal with such complexities and to ensure accurate economic modelling. Furthermore, our results show a significant and negative impact of changes in government debt on economic

growth in short-run equation, an effect that persisted even when we used the common correlated effects estimator.

Another partial objective of our research was to identify a suitable instrument for the accumulation of government debt (debt change) and then to estimate its causal effect on economic growth. While the application of instrumental variables methodology in the debt-growth nexus is quite common, the instrument often chosen is the previous level of debt (Cecchetti et al., 2011). However, this method of dealing with endogeneity may not be fully satisfactory due to the persistent nature of debt. The only study we're aware of that addresses the challenge of finding an appropriate instrument is Panizza & Presbitero (2014), who use the valuation effect. This effect accounts for changes in the value of debt denominated in foreign currency due to exchange rate fluctuations and is suitable for countries with a significant portion of their debt in foreign currency, a scenario that is less common in advanced economies, which typically issue debt in domestic currency. Since our work focuses on the relationship between debt and growth in advanced economies, our instrument had to capture the variability of debt within this group. In our study, we constructed an appropriate instrument for debt accumulation from components of the stock-flow adjustment, which should not affect economic growth through channels other than debt accumulation. We then estimated the effect of debt accumulation on economic growth on annual data for 26 EU countries between 2003 and 2019 using the instrumental variables method. The estimates suggest that, after removing outliers such as Greece, Ireland and Cyprus, government debt accumulation does not have a significant impact on economic growth. This result is consistent with Panizza & Presbitero (2014), who also find no significant effect of the level of government debt on growth. To the best of our knowledge, the literature on the debt-growth nexus has not focused on the impact of changes in debt on growth, with the exception of the study by Gómez-Puig & Sosvilla-Rivero (2018). The estimation of the causal effect of debt changes on growth is largely absent from the literature, a gap that this thesis aims to fill.

Another partial goal of our thesis was to explore the potential channel through which government debt affects growth. Specifically, in chapter 5 we examine the impact of government debt on perceived country risk and its subsequent effect on sovereign bond yields. While much of the current literature on the debt-growth nexus focuses primarily on growth regressions, there is a significant gap in the empirical investigation of how government debt might affect growth through different channels (C. Checherita-Westphal

& Rother, 2012). We address this gap by first assessing how government debt affects sovereign credit ratings and then estimating how rating downgrades translate into changes in the risk premium on government bonds. Our results, detailed in chapter 5, start by modelling the level of sovereign credit ratings for EU countries on a quarterly basis using panel ordered logit models estimated with the Blow-Up and Cluster (BUC) estimator of Baetschmann et al. (2015). We found that higher government debt increases the probability that a country has a lower credit rating, a result that was significant across different model specifications. In the next step, we estimated the impact of a rating downgrade on 10-year sovereign risk premiums using an event study methodology. This involved examining the evolution of the risk premium around the time a rating downgrade was announced. Our approach, similar to Afonso et al. (2012), focuses exclusively on rating downgrades and examines their differential impact on the risk premium, taking into account the timing of the episode and the rating grade of the country. The results show that in 116 episodes, a rating downgrade is associated with an increase in the risk premium of around 8 basis points the day after the downgrade. However, the effect of the downgrade was significantly larger and more pronounced during the euro area debt crisis and in cases where the rating fell into the speculative band. These estimates suggest that rating downgrades have a particularly strong impact during periods of economic downturn or financial instability.

In chapter 3 we found that, after accounting for cross-sectional dependence, we did not find a significant long-run impact of government debt on real GDP in advanced economies. Nor did we find significant non-linear or conditional relationships with other variables, notably government consumption, private credit, private debt and long-term interest rates. However, even after accounting for cross-sectional dependence, we found a significant impact of debt changes on economic growth. Given the significant effect of debt changes identified in chapter 3, in the following chapter we estimated the causal effect of debt changes on growth using the instrumental variables method. As an instrument, we used components of the stock-flow adjustment, which, to our knowledge, should not affect growth through channels other than changes in government debt. Using this instrument, we estimated the effect of debt accumulation on economic growth across EU countries, but could not robustly demonstrate a significant effect. Although we were unable to demonstrate a direct effect of government debt on growth from growth regressions, this does not mean that government debt has no effect on growth and the economy. The relationship between government debt and growth may operate through more complex

channels, which have not been sufficiently reflected in the empirical literature. Therefore, in this thesis we investigate the impact of government debt on perceived country risk and its subsequent effect on government bond yields. Using panel data for EU countries, we find that higher government debt increases the probability of a lower sovereign credit rating and that a subsequent downgrade increases the risk premium on 10-year government bonds. The effect of a rating downgrade is particularly strong during periods of economic downturn or financial instability. Higher bond yields then have economic consequences, including rising debt servicing costs and the negative effects of more expensive credit financing leading to lower growth. Although we have not been able to demonstrate a direct effect of government debt on growth, this does not mean that high levels of debt have no effect, as the relationship between debt and growth can operate through several channels, as we have shown, for example, through the channel of increased risk and more expensive debt financing. Future research in the debt-growth nexus literature should focus on better understanding the functioning of the transmission channels through which debt might affect economic growth, literature - a new research frontier that is largely neglected in the current literature. The dissertation also shows that cross-sectional dependence is important in the debt-growth nexus. Therefore, future research should also take into account cross-sectional dependence and its related complexities. These findings underscore the need for advanced econometric techniques and the importance for policymakers to consider global economic dynamics, as domestic debt management may fall short if global interdependencies are overlooked.

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Appendix

Table A.1: Correlation matrix.

	Real GDP index	Gov. debt	Gross fixed inv.	GDP in PPP p.c.	Trade openness	CPI QoQ	REER	Policy rate	Years of schooling	Gov. cons.	Gov. size	Political risk	Private credit	Private debt	Long-term interest
Real GDP index	1.00														
Gov. debt	-0.43	1.00													
Gross fixed inv.	0.16	-0.44	1.00												
GDP in PPP	0.01	-0.01	0.09	1.00											
Trade openness	-0.03	-0.22	0.05	0.04	1.00										
CPI QoQ	0.06	-0.12	0.10	-0.16	0.06	1.00									
REER	0.00	-0.05	-0.21	0.15	-0.04	-0.03	1.00								
Policy rate	0.05	-0.37	0.15	-0.49	0.00	0.30	-0.01	1.00							
Years of school	0.24	-0.16	0.12	0.44	0.11	-0.10	-0.06	-0.12	1.00						
Gov. cons.	-0.06	0.12	-0.28	0.12	0.15	-0.01	0.04	-0.08	0.01	1.00					
Gov. size	0.21	-0.12	0.35	-0.06	-0.27	0.03	-0.04	0.07	0.10	-0.83	1.00				
Political risk	-0.07	-0.35	0.26	0.45	0.03	0.01	0.10	0.05	0.20	-0.08	-0.07	1.00			
Private credit	-0.02	-0.08	-0.08	0.47	-0.23	-0.11	0.19	-0.28	-0.10	0.07	-0.02	0.24	1.00		
Private debt	0.02	-0.05	-0.05	0.70	0.07	-0.13	0.16	-0.37	0.05	0.26	-0.21	0.35	0.78	1.00	
Long-term interest	-0.09	-0.05	-0.22	-0.56	-0.07	0.23	-0.01	0.62	-0.32	-0.02	0.01	-0.24	-0.17	-0.36	1.00

Note: PPP p.c. stands for purchasing power parity per capita, CPI stands for consumer price index, QoQ stands for quarter-on-quarter growth, REER stands for real effective exchange rate. Real GDP index, GDP in PPP p.c. and years of schooling are defined as natural logarithms.

Figure A.1: Real GDP index by country.

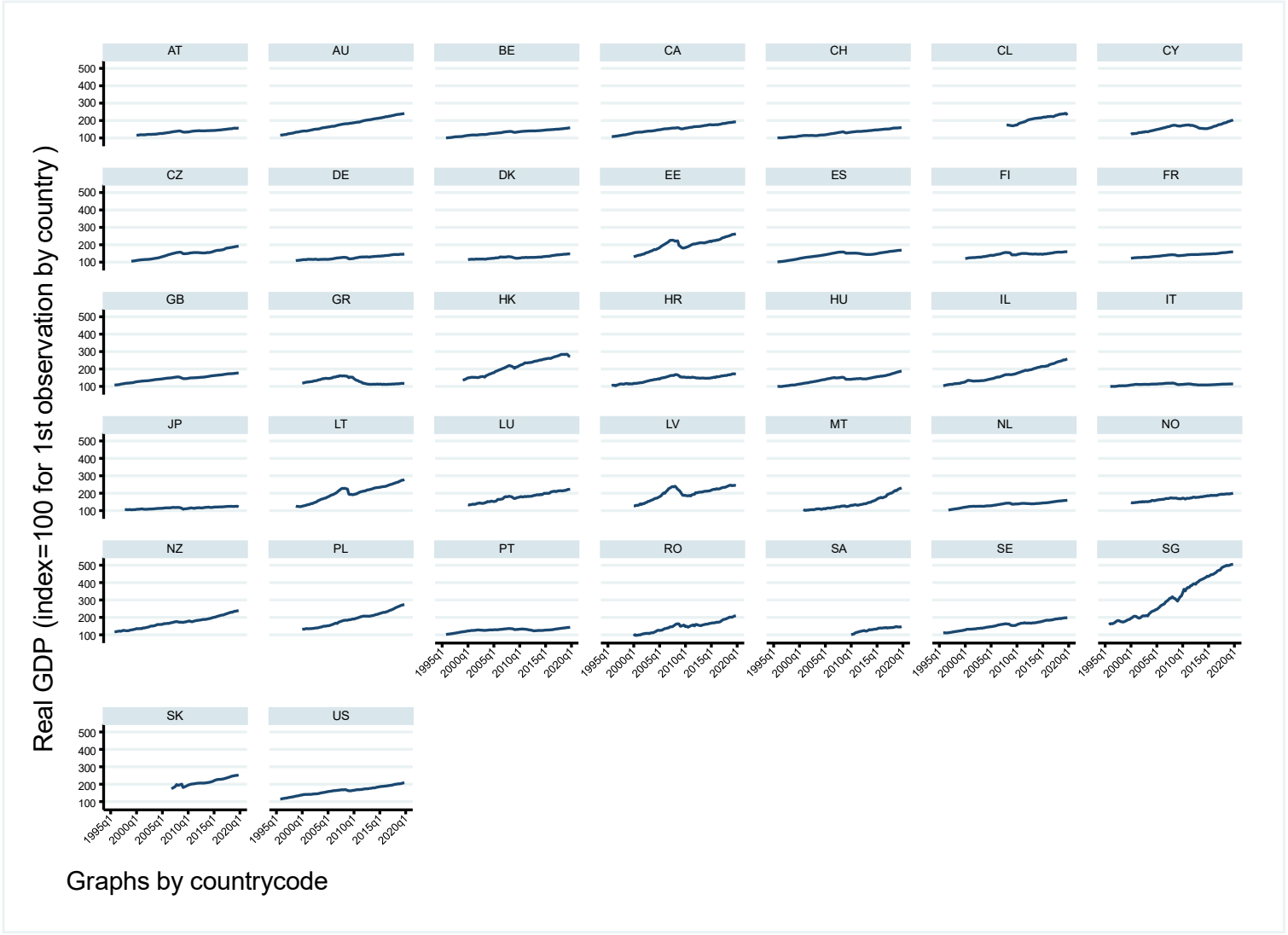


Figure A.2: General government debt as % of GDP by country.

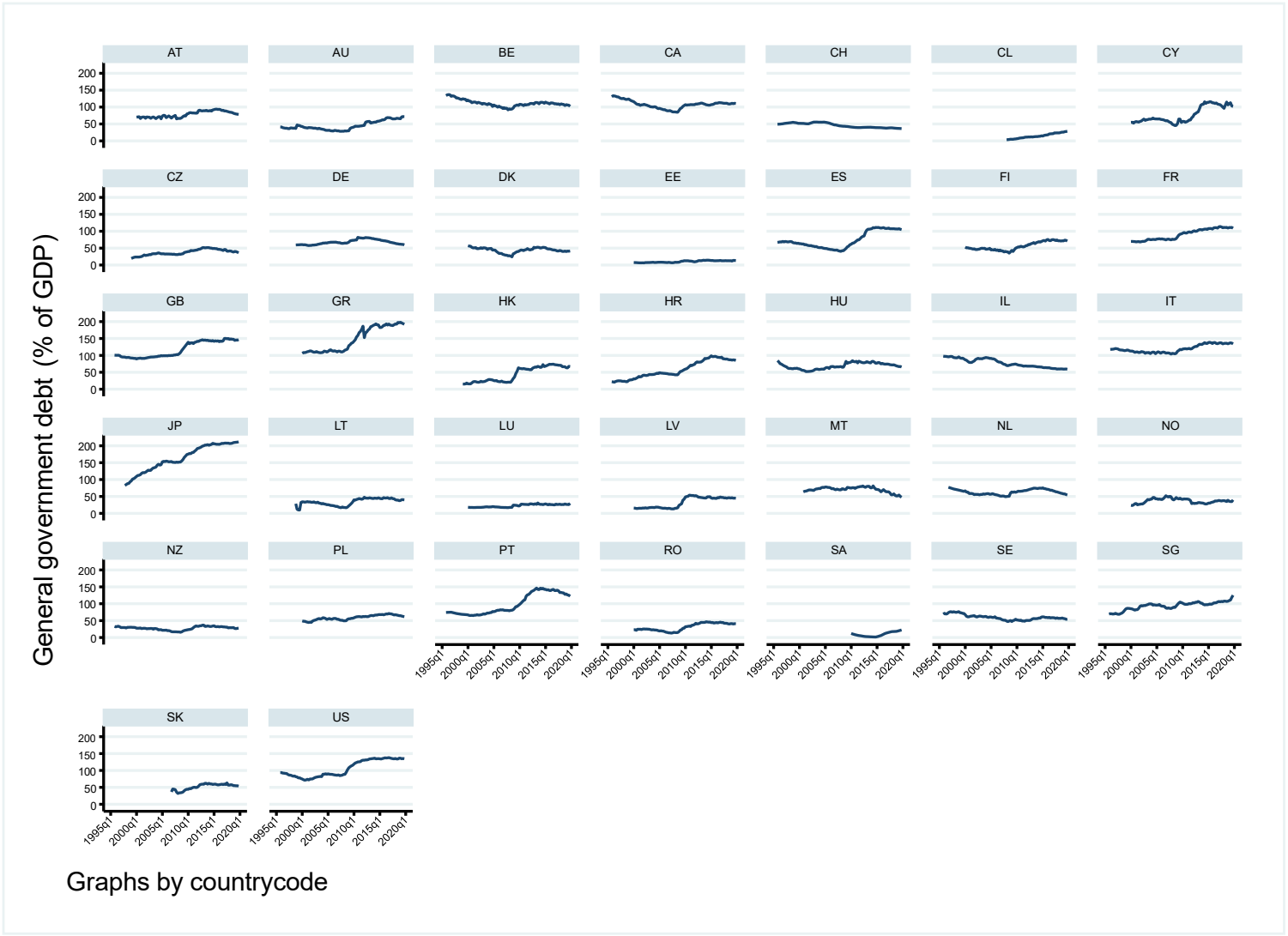


Figure A.3: General government debt as % of GDP and real GDP growth (% YoY growth).

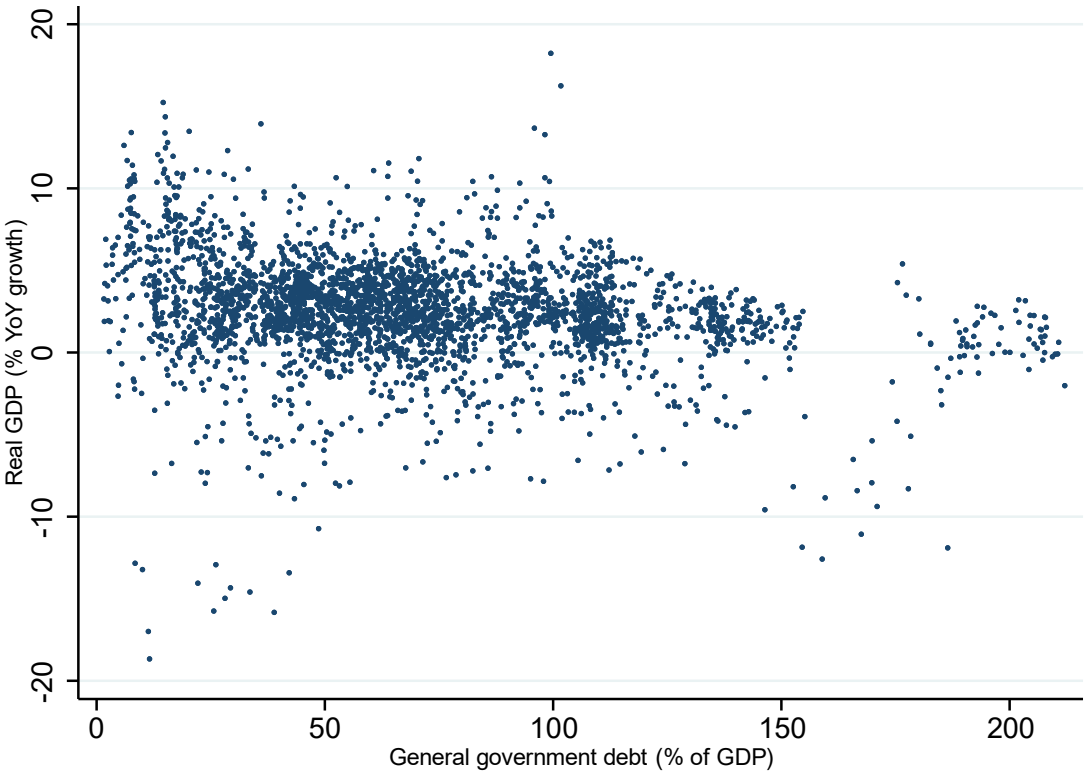


Table A.2: Panel unit root tests I – level of variables.

		Real GDP	Gov. debt	Gross fixed inv.	GDP in PPP p.c.	Trade openness	CPI QoQ	REER	Policy rate
	Number of panels	37	37	37	37	37	37	37	35
	Average number of periods	85	85	85	85	85	85	85	81
Im-Pesaran-Shin	P-value	0.93	1.00	0.00	0.30	0.16	0.00	0.01	0.00
Dickey-Fuller	Inverse chi-squared, p-value	0.05	1.00	0.00	0.00	0.80	0.00	0.02	0.00
	Inverse normal, p-value	0.63	1.00	0.00	0.00	0.50	0.00	0.01	0.08
	Inverse logit, p-value	0.56	1.00	0.00	0.00	0.49	0.00	0.01	0.00
	Mod. inv chi-squared, p-value	0.04	0.99	0.00	0.00	0.80	0.00	0.01	0.00
Phillips-Perron	Inverse chi-squared, p-value	0.05	1.00	0.00	0.00	0.80	0.00	0.02	0.00
	Inverse normal, p-value	0.63	1.00	0.00	0.00	0.50	0.00	0.01	0.08
	Inverse logit, p-value	0.56	1.00	0.00	0.00	0.49	0.00	0.01	0.00
	Mod. inv chi-squared, p-value	0.04	0.99	0.00	0.00	0.80	0.00	0.01	0.00

Table A.3: Panel unit root tests II – level of variables.

		Years of school	Gov. cons.	Gov. size	Political risk	Private credit	Private debt	Long-term interest
	Number of panels	37	36	37	37	29	29	31
	Avg. Number of periods	85	84	75	70	86	86	83
Im-Pesaran-Shin	P-value	1.00	0.01	0.00	0.00	0.99	0.90	0.73
Dickey-Fuller	Inverse chi-squared, p-value	0.00	0.00	0.12	0.91	0.27	0.01	0.95
	Inverse normal, p-value	0.00	0.00	0.99	0.99	0.98	0.51	1.00
	Inverse logit, p-value	0.00	0.00	0.95	0.99	0.97	0.58	0.99
	Mod. inv chi-squared, p-value	0.00	0.00	0.11	0.90	0.28	0.00	0.94
Phillips-Perron	Inverse chi-squared, p-value	0.00	0.00	0.12	0.91	0.27	0.01	0.95
	Inverse normal, p-value	0.00	0.00	0.99	0.99	0.98	0.51	1.00
	Inverse logit, p-value	0.00	0.00	0.95	0.99	0.97	0.58	0.99
	Mod. inv chi-squared, p-value	0.00	0.00	0.11	0.90	0.28	0.00	0.94

Note: P-values are provided for each panel unit root test. In these tests, the null hypothesis (H0) asserts the existence of a unit root across all panels. The alternative hypothesis (Ha) of the Im-Pesaran-Shin test indicates stationarity in some panels, whereas for the Dickey-Fuller and Phillips-Perron tests, the Ha suggests that there is stationarity in a minimum of one panel.

Table A.4: Panel unit root tests I – first differences of variables.

		Real GDP	Gov. debt	Gross fixed inv.	GDP in PPP p.c.	Trade openness	CPI QoQ	REER	Policy rate
	Number of panels	37	37	37	37	37	37	37	35
	Avg. number of periods	85	85	85	85	85	85	85	81
Im-Pesaran-Shin	P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dickey-Fuller	Inverse chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse normal, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse logit, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mod. inv chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phillips-Perron	Inverse chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse normal, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse logit, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mod. inv chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A.5: Panel unit root tests II – first differences of variables.

		Years of school	Gov. cons.	Gov. size	Political risk	Private credit	Private debt	Long-term interest
	Number of panels	37	36	37	37	29	29	31
	Avg. number of periods	85	84	75	70	86	86	83
Im-Pesaran-Shin	P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dickey-Fuller	Inverse chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse normal, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse logit, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mod. inv chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phillips-Perron	Inverse chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse normal, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inverse logit, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mod. inv chi-squared, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: P-values are provided for each panel unit root test. In these tests, the null hypothesis (H0) asserts the existence of a unit root across all panels. The alternative hypothesis (Ha) of the Im-Pesaran-Shin test indicates stationarity in some panels, whereas for the Dickey-Fuller and Phillips-Perron tests, the Ha suggests that there is stationarity in a minimum of one panel

Table A.6: Dumitrescu and Hurlin (2012) Granger panel causality test, first differences of variables.

	Lag order	W-bar statistics	Z-bar statistics	P-value
Debt -> Real GDP[a]	1	1.987	4.246	0.000
Real GDP -> Debt[b]	1	7.791	29.207	0.000
Debt -> Real GDP	AIC = 1	1.987	4.246	0.000
Real GDP -> Debt	AIC = 12	28.770	20.822	0.000
Debt -> Real GDP	BIC = 1	1.987	4.246	0.000
Real GDP -> Debt	BIC = 4	19.885	34.161	0.000
Debt -> Real GDP	HQIC = 1	1.987	4.246	0.000
Real GDP -> Debt	HQIC = 4	19.885	34.161	0.000

[a]H0: government debt does not Granger-cause real GDP. H1: government debt does Granger-cause real GDP for at least one panel.
[b]H0: real GDP does not Granger-cause government debt. H1: real GDP does Granger-cause government debt for at least one panel.

Figure A.4: Marginal effects of government debt on real GDP (estimates from regressions in table 5)

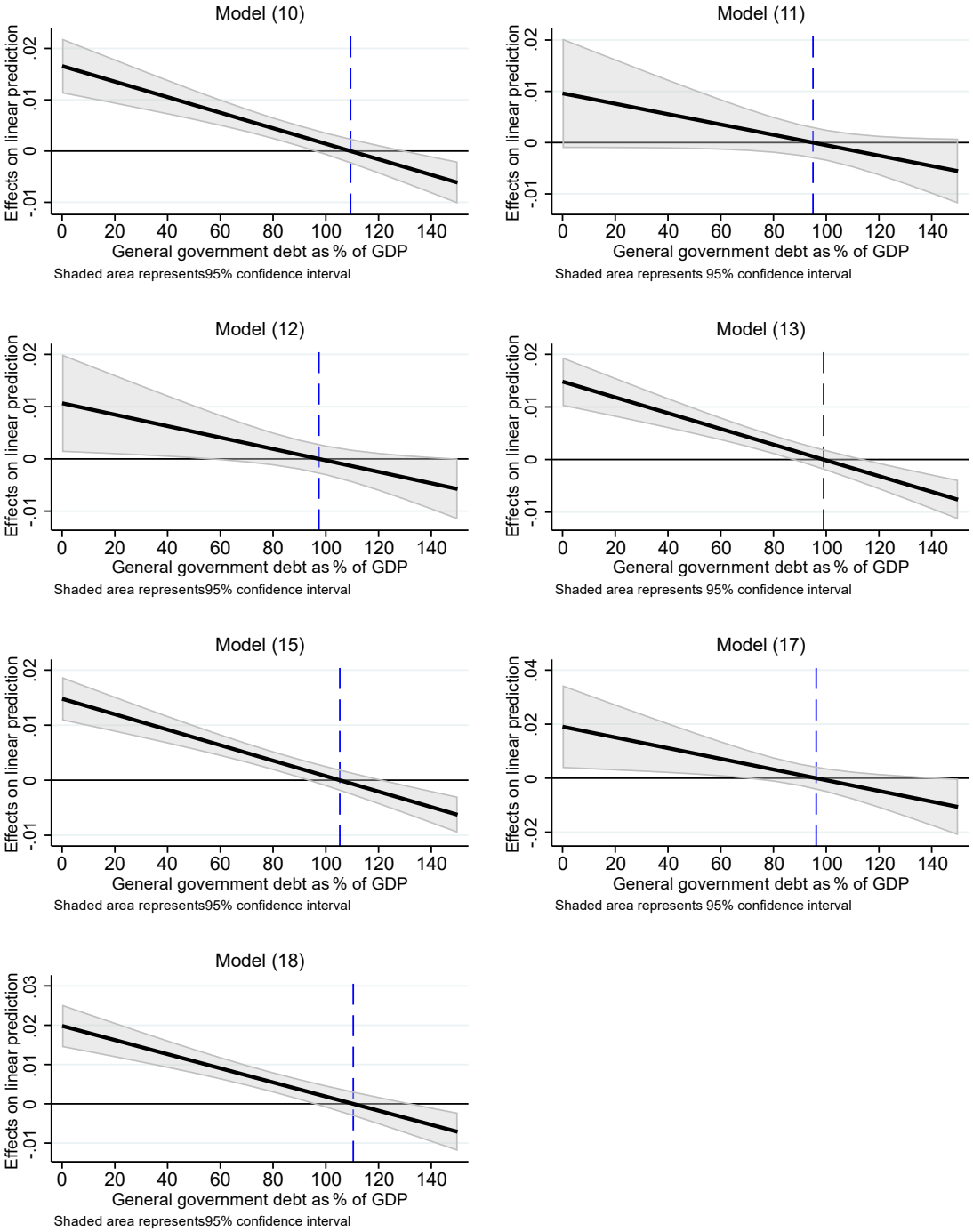


Table A.7: Summary statistics of SFA instrument by countries.

Country	Obs	Mean	St. Dev.	Min	Max
Austria	17	0.308	1.316	-1.058	4.032
Belgium	17	-0.020	0.133	-0.433	0.170
Cyprus	17	0.029	0.112	-0.330	0.195
Czech Republic	17	-0.062	0.209	-0.587	0.453
Germany	17	-0.022	0.166	-0.288	0.420
Denmark	17	0.036	0.178	-0.341	0.307
Estonia	17	0.046	0.108	-0.013	0.336
Spain	17	0.118	0.622	-0.286	2.511
Finland	17	0.014	0.232	-0.426	0.580
France	17	0.083	0.350	-0.055	1.436
United Kingdom	17	0.169	0.986	-0.863	3.864
Greece	14	0.301	0.802	-0.430	2.909
Croatia	10	0.139	0.440	-0.557	0.764
Hungary	17	0.577	1.457	-2.362	4.732
Ireland	16	0.760	2.885	-0.045	11.572
Italy	17	-0.007	0.067	-0.236	0.066
Lithuania	17	-0.002	0.114	-0.404	0.105
Luxembourg	12	0.000	0.000	0.000	0.000
Latvia	17	0.142	0.215	-0.173	0.664
Malta	17	-0.115	0.683	-2.743	0.306
Netherlands	17	0.005	0.194	-0.317	0.564
Poland	14	0.201	1.064	-1.385	1.972
Portugal	17	0.071	0.267	-0.355	0.732
Sweden	17	0.188	0.613	-0.840	1.380
Slovenia	17	0.125	0.438	-0.706	1.088
Slovakia	17	-0.124	0.409	-0.966	0.466
Total	423	0.111	0.809	-2.743	11.572

Table A.8: Effects of government debt change on real economic growth – baseline specification with 3 separate instruments.

Dep.: 3-year overlapping real GDP per capita growth	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample			Without Ireland, Greece & Cyprus		
		IV estimates			IV estimates	
VARIABLES	Fixed Effects OLS	1st Stage	IV	Fixed Effects OLS	1st Stage	IV
Gov. Debt Change / GDP	0.0706**		0.301***	0.0123		0.0397
	(0.0315)		(0.105)	(0.0308)		(0.123)
Log Initial GDP per Capita	-10.67***	-0.0428	-12.37***	-12.06***	-0.753	-12.94***
	(1.599)	(3.0143)	(1.672)	(1.371)	(2.872)	(1.330)
National Gross Savings	0.0397	-0.3107***	0.143**	0.131***	-0.169*	0.148***
	(0.0513)	(0.0951)	(0.0652)	(0.0451)	(0.0946)	(0.0490)
Population growth	-0.962***	-0.5389	-0.624*	-0.218	-0.679	-0.111
	(0.301)	(0.5627)	(0.321)	(0.248)	(0.512)	(0.250)
Schooling	-0.370	1.7746	-0.598	0.389	1.126	0.437
	(0.683)	(1.2454)	(0.722)	(0.512)	(1.040)	(0.508)
Trade openness	0.0494***	-0.0175	0.0552***	0.0149*	-0.0206	0.0216**
	(0.0104)	(0.0199)	(0.0112)	(0.00868)	(0.0185)	(0.00914)
CPI inflation rate	0.140*	-0.0248	0.123	0.0477	0.0546	0.0452
	(0.0767)	(0.1415)	(0.0780)	(0.0605)	(0.124)	(0.0571)
Dependency ratio	0.197**	0.1241	0.285***	0.0794	0.267	0.159*
	(0.0845)	(0.171)	(0.0955)	(0.0748)	(0.178)	(0.0847)
Valuation effect (instrument)		0.3438			0.500	
		(0.4528)			(0.375)	
Statistical discrepancies (instrument)		2.888			2.939*	
		(1.7781)			(1.513)	
Changes in sector class. (instrument)		1.2303***			1.093***	
		(0.2472)			(0.382)	
Observations	330	319	319	292	284	284
Number of countries	26	26	26	23	23	23
R-squared	0.593	0.4219	0.532	0.666	0.402	0.678
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Underidentification and weak instrument tests						
Anderson LM χ^2 stat.		27.411			14.586	
p-value		0.000			0.002	
Cragg-Donald F stat.		9.323			4.716	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure A.5: Rating score by time and country.

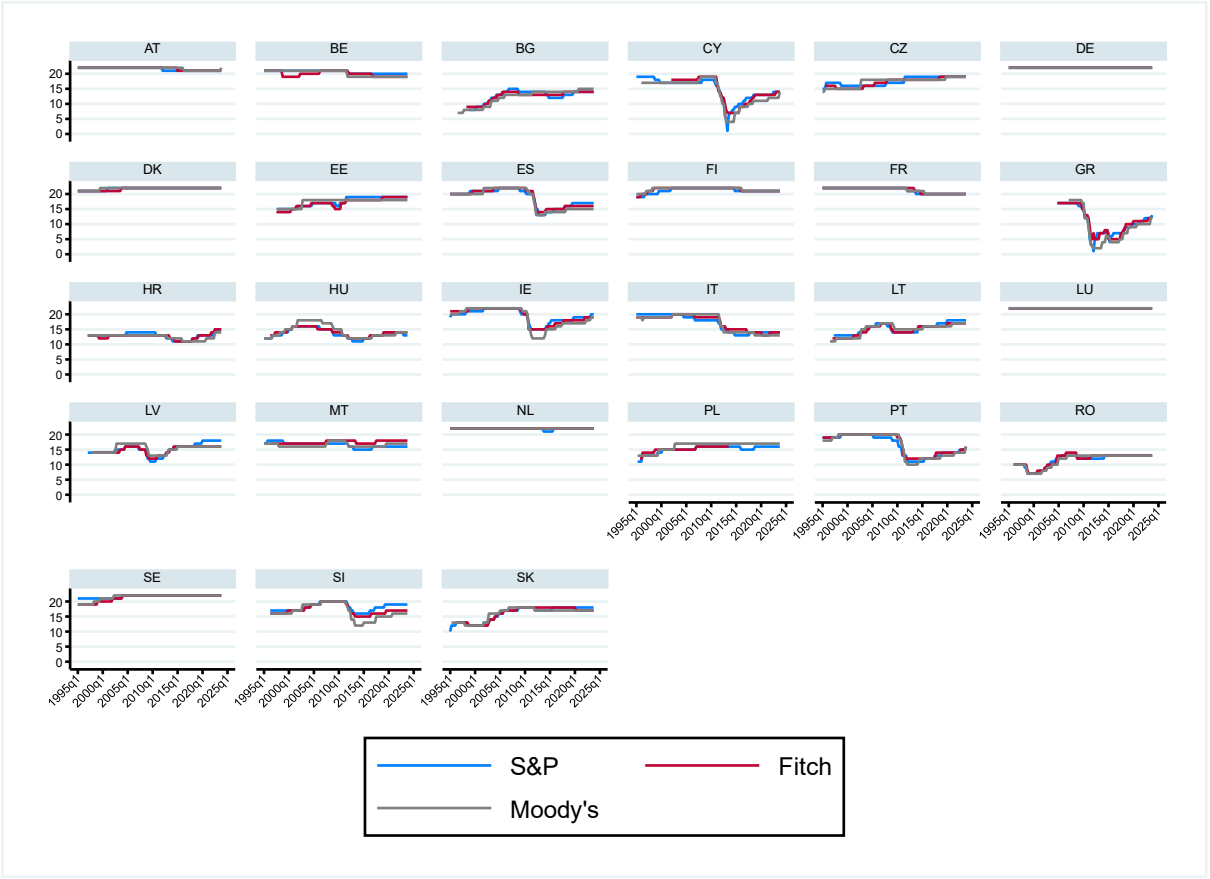


Table A.9: Robustness test, estimates of panel OLS with fixed effects, full sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	S&P	Moody's	Fitch	S&P	Moody's	Fitch	S&P	Moody's	Fitch
Log GDP per capita	4.151***	4.232***	3.898***	3.263***	3.240***	2.970***	2.787***	3.098***	2.552***
	(0.145)	(0.160)	(0.142)	(0.145)	(0.160)	(0.140)	(0.198)	(0.219)	(0.189)
Real GDP YoY growth	0.0531***	0.0457***	0.0484***	0.0590***	0.0513***	0.0548***	0.0640***	0.0525***	0.0556***
	(0.00922)	(0.0101)	(0.00903)	(0.00858)	(0.00944)	(0.00825)	(0.00972)	(0.0108)	(0.00924)
Government debt as % of GDP	-0.0567***	-0.0782***	-0.0680***	-0.0492***	-0.0700***	-0.0600***	-0.0673***	-0.0851***	-0.0739***
	(0.00198)	(0.00220)	(0.00194)	(0.00191)	(0.00212)	(0.00184)	(0.00244)	(0.00272)	(0.00232)
Regulatory quality				3.701***	4.099***	3.864***	3.026***	3.555***	3.215***
				(0.171)	(0.189)	(0.165)	(0.237)	(0.263)	(0.225)
Political risk							0.101***	0.0890***	0.105***
							(0.0130)	(0.0144)	(0.0126)
Constant	-11.05***	-10.67***	-8.646***	-8.680***	-8.009***	-6.150***	-11.55***	-12.71***	-10.22***
	(1.336)	(1.469)	(1.373)	(1.282)	(1.409)	(1.234)	(1.709)	(1.889)	(1.624)
Observations	2,617	2,608	2,568	2,525	2,516	2,480	1,926	1,917	1,901
Number of countries	0.584	0.639	0.625	0.658	0.702	0.701	0.711	0.742	0.747
R-squared	27	27	27	27	27	27	27	27	27
Country and time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure A.6: 10-year government bond yield spread oved Germany by time and country.

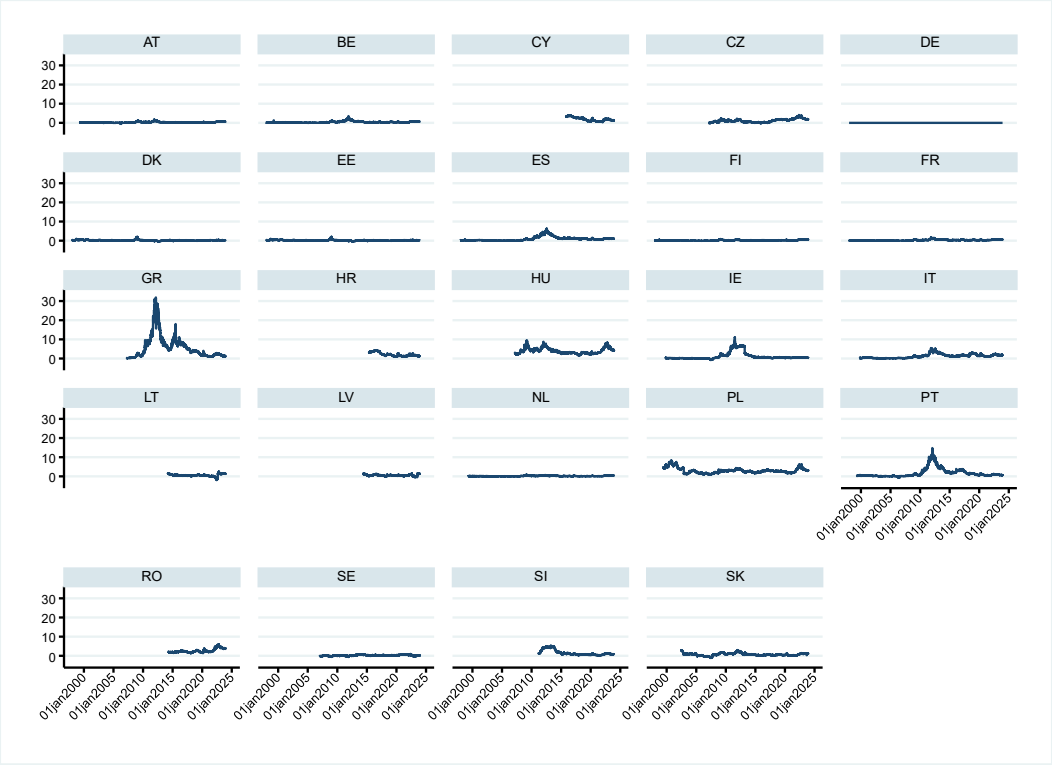


Figure A.7: Change in yield spreads in the event of rating downgrade (difference in average yield spread over t-7), sample of S&P downgrades.

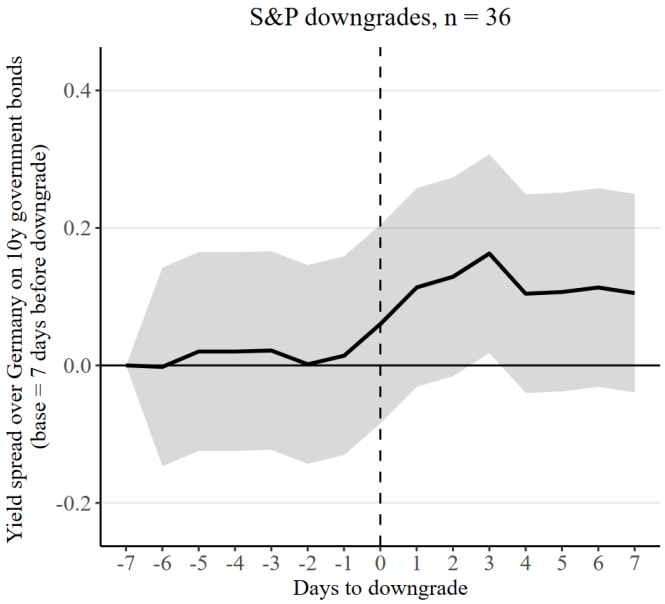


Figure A.8: Change in yield spreads in the event of rating downgrade (difference in average yield spread over t-7), sample of Moody's downgrades.

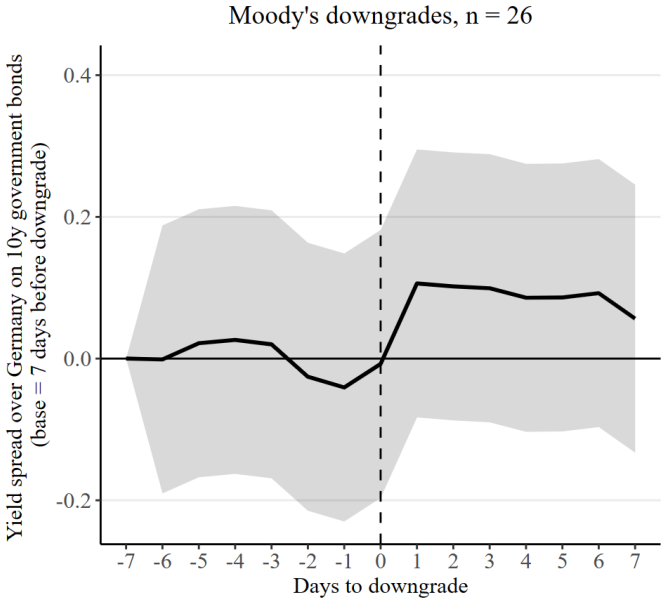


Figure A.9: Change in yield spreads in the event of rating downgrade (difference in average yield spread over t-7), sample of Fitch downgrades.

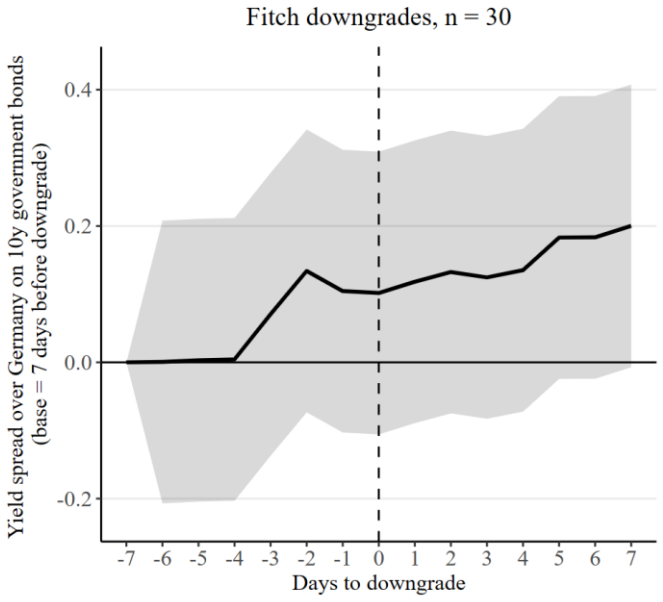
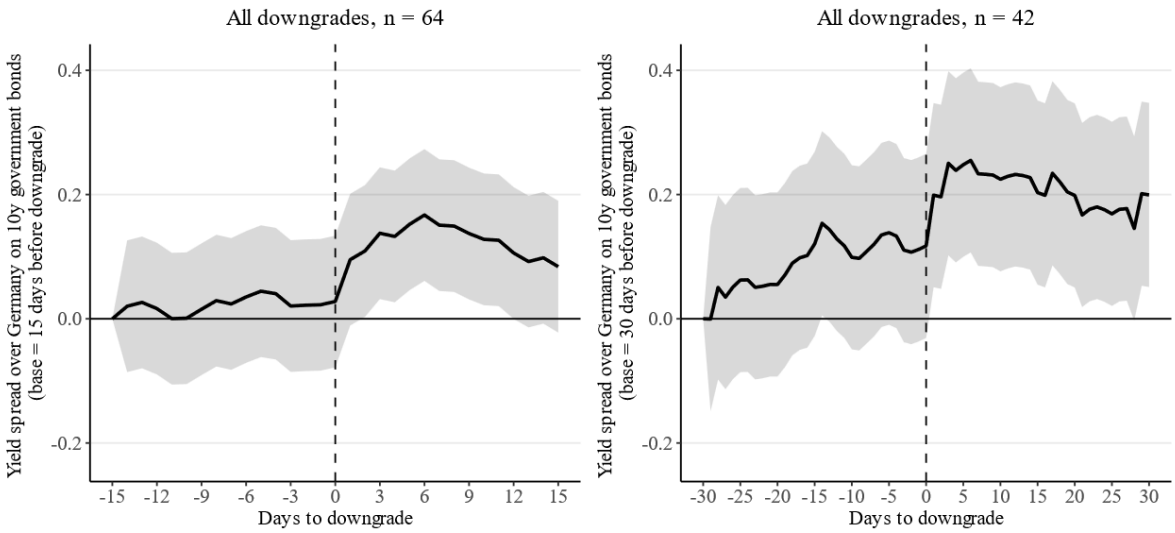


Figure A.10: Change in yield spreads in the event of rating downgrade (difference in average yield spread over t-15/t-30), samples of different time windows.



Resumé

Vzťah medzi vládnym dlhom a rastom nepochybne patrí medzi najviac diskutované a skúmané témy v ekonomickom výskume. Výskum tohto vzťahu sa sústredí na tri kľúčové oblasti: skúmanie príčinného vzťahu medzi vládnym dlhom a hospodárskym rastom, optimálnu úroveň dlhu a jeho dlhodobú udržateľnosť. Štúdium vzťahu medzi vládnym dlhom a rastom je mimoriadne dôležité, najmä vzhľadom na globálne ekonomické turbulencie posledných dvoch desaťročí. Globálna finančná kríza prinútila rozvinuté ekonomiky zaviesť rozsiahle fiškálne intervencie, čo viedlo k výraznému nárastu vládneho dlhu. Tento nárast sa ešte prehĺbil počas európskej dlhovej krízy, keď krajiny ako Portugalsko, Taliansko, Írsko, Grécko a Španielsko čelili vážnym problémom so štátnym financovaním, čo postavilo správu dlhu do centra pozornosti eurozóny. Pandémia Covid-19 v roku 2020 vrhla svet do bezprecedentnej ekonomickej krízy. Na boj proti vážnemu poklesu spôsobenému lockdownom a odstavením kľúčových sektorov boli vlády po celom svete nútené zaviesť masívne fiškálne stimulačné balíčky. Tieto opatrenia boli nevyhnutné na stabilizáciu ekonomík a záchranu pracovných miest, no viedli k významnému nárastu vládneho dlhu. Keď sa ekonomiky začali zotavovať z následkov pandémie, v roku 2022 sa objavila ďalšia výzva - invázia Ruska na Ukrajinu. Tento konflikt narušil globálne trhy s komoditami, najmä s energiou a poľnohospodárskymi plodinami, čo viedlo k prudkému nárastu cien (Arndt et al., 2023). V reakcii na inflačné tlaky vlády zvýšili subvencie a finančné podporné programy na zmiernenie záťaže pre domácnosti a podniky (Sgaravatti et al., 2021). Tento okamžitý nárast výdavkov na riešenie súčasných ekonomických problémov ešte viac zhoršuje mieru vládneho dlhu. Ako mnohí argumentujú (napríklad Mian (2024)), hlavný problém vládneho dlhu počas krízového obdobia spočíva v tom, že väčšina zdrojov je použitá na podporu dopytu a menej na podporu ponukovej strany ekonomiky, čo je dôležitejšie pre dlhodobý rast. S výzvami, ako je starnutie populácie, rastúce bezpečnostné hrozby vyžadujúce väčšie vojenské investície a naliehavá potreba riešiť klimatické zmeny, je veľmi pravdepodobné, že krajiny po celom svete budú čeliť ďalšiemu nárastu vládneho dlhu. Preto je pochopenie krátkodobých aj dlhodobých dôsledkov rastúceho vládneho dlhu na hospodársky rast zásadné v dnešnom neustále sa meniacom globálnom ekonomickom prostredí.

Táto dizertačná práca skúma vzťah medzi vládnym dlhom a hospodárskym rastom, so zameraním na rozvinuté ekonomiky. Cieľom je objasniť zložité interakcie a kanály vplyvu, ktoré sú často zanedbávané alebo prehliadané v predchádzajúcich štúdiách. Dizertačná práca prispieva k existujúcej literatúre tým, že sa zaoberá doteraz málo skúmanými, ale dôležitými otázkami, vrátane, ale nielen, reverznej kauzality a endogenity vo vzťahu vládneho dlhu a hospodárskeho rastu. Táto štúdia prináša nový metodologický rámec, ktorý umožňuje detailnejšie pochopenie komplexných vzťahov medzi vládnym dlhom a hospodárskym rastom a otvára nové perspektívy výskumu v troch kľúčových aspektoch.

Po prvé, táto dizertačná práca na rozdiel od predchádzajúcich štúdií skúma vplyv vládneho dlhu na hospodársky rast v krátkodobom aj dlhodobom horizonte pomocou kvartálnych údajov. Vyššia frekvencia údajov umožňuje presnejšiu analýzu, najmä pri sledovaní zložitých a nestabilných ekonomických období. Predpokladáme, že oddelenie krátkodobých efektov dlhu od dlhodobých je nevyhnutné z viacerých dôvodov. Hlavným dôvodom je, že vládny dlh ovplyvňuje rozhodnutia súkromného sektora vytláčaním súkromných investícií, resp. cez Ricardovskú ekvivalenciu, pričom tieto kanály môžu mať rôzne účinky v závislosti od časového obdobia. Taktiež v krátkom období sú účinky reverznej kauzality a simultánnosti výraznejšie, pretože prípadná recesia okamžite zvýši dlh cez automatické stabilizátory a mechanickým efektom prostredníctvom menovateľa. Dlhodobo, ak vlády efektívne rozdeľujú zdroje a trh sa prispôsobí novým ekonomickým podmienkam, môže vládny dlh podporiť vyšší hospodársky rast.

Po druhé, táto dizertačná práca prispieva k štúdiu vzťahu medzi dlhom a rastom tým, že skúma nelineárne a podmienené vplyvy, pričom rozlišuje medzi dlhodobými a krátkodobými efektami vládneho dlhu na hospodársky rast. To je dôležité, pretože jednou z hlavných obáv pri štúdiu vplyvu vládneho dlhu na hospodársky rast je endogenita a reverzná kauzalita, čo vedie k skresleným odhadom. Mnohé štúdie riešia tento problém použitím metodológie inštrumentálnych premenných. Pri tom sa často spoliehajú iba na predchádzajúcu úroveň dlhu (Cecchetti et al., 2011), čo nie je dostatočné vzhľadom na vysokú zotrvačnosť dlhu. Nájsť vhodný externý inštrument pre vládny dlh je veľmi náročná úloha. Štúdia Panizza & Presbitero (2014) je jediným významným prínosom v tejto oblasti. Hlavným príspevkom tejto dizertačnej práce je návrh nového inštrumentu za zmenu vládneho dlhu, ktorý pozostáva zo zložiek zosúladenia dlhu a deficitu (z angl. stock-flow adjustment) a môže byť použitý pre

rozvinuté ekonomiky. Využitím tohto nového inštrumentu, ktorý pomáha minimalizovať endogenitu, boli odhadnuté kauzálne efekty akumulácie vládneho dlhu na hospodársky rast na vzorke krajín EÚ v období 2003 až 2019. Na rozdiel od väčšiny predchádzajúcich štúdií táto práca považuje prierezovú závislosť (z angl. cross-sectional dependence) vo vzťahu medzi dlhom a rastom za dôležitú otázku. Použitá vzorka krajín pozostáva z vysokopríjmových ekonomík, najmä z Európy, ktoré mnohé zdieľajú spoločnú menu, sú vysoko prepojené a môžu byť ovplyvnené spoločnými faktormi. Táto otázka je obzvlášť dôležitá v kontexte vzťahu medzi dlhom a rastom kvôli spoločným „záchranným“ mechanizmom, ako je Európsky stabilizačný mechanizmus. V dôsledku takéhoto "zdieľania bremena" a prepojenosti sa môže „nákaza“ rýchlejšie šíriť a fiškálna politika v jednej krajine môže ovplyvniť aj iné krajiny. Na základe toho prispieva táto práca použitím techník, ktoré zohľadňujú prierezovú závislosť.

Po tretie, dizertačná práca prispieva k literatúre tým, že skúma, ako vládny dlh formuje vnímanie rizika krajiny a ovplyvňuje výnosy vládnych dlhopisov, čím sa objasňujú širšie ekonomické dôsledky rastúcej úrovne dlhu. Metodicky je podstatným príspevkom v tomto smere použitie nového metodologického prístupu aplikáciou usporiadaného logit modelu s fixnými efektami vyvinutého Baetschmann et al. (2015) na kvartálne údaje pre krajiny EÚ, ktoré zahŕňajú turbulentné obdobia, ako je finančná kríza a následky európskej dlhové krízy. Druhým príspevkom sú odhady efektov zníženia ratingu na rizikové prirážky na 10-ročných štátnych dlhopisoch. V tomto prípade sa analýza líši od predchádzajúcich štúdií použitím tzv. „scenárového“ prístupu, kde zisťujeme, že účinky takýchto znížení ratingu boli výrazné najmä v krajinách so zlou povesťou a počas obdobia dlhových kríz. Práca prispieva aj zistením, že účinky zníženia ratingu sú najvýraznejšie, keď sa krajiny dosiahnu do tzv. špekulatívneho pásma.

Táto dizertačná práca poskytuje detailnú analýzu vzťahu medzi vládnym dlhom a hospodárskym rastom, čím ponúka tvorcom hospodárskych politík hlbšie pochopenie úlohy vládneho dlhu v meniacom sa globálnom ekonomickom prostredí. Tiež prináša nové koncepčné a empirické prístupy, ktoré môžu byť využité na ďalší výskum tohto komplexného vzťahu.

V prvej kapitole poskytuje dizertačná práca prehľad súčasnej literatúry zaoberajúcej sa vzťahom medzi vládnym dlhom a hospodárskym rastom. Vplyvná štúdia Reinhart & Rogoff (2010) predstavila koncept možného dlhového prahu, ktorý naznačuje určitý bod dlhu v pomere k HDP (90 % v ich štúdii), po prekročení ktorého sa hospodársky rast výrazne spomaľuje. Túto myšlienku dlhového prahu podporili aj ďalšie štúdie (napr. Caner et al. (2010); Cecchetti et al. (2011); Baum et al. (2013)), no stále neexistuje konsenzus o univerzálnom dlhovom prahu. Ďalší výskum s využitím pokročilých ekonometrických techník argumentoval proti existencii univerzálneho dlhového prahu a naznačil, že takýto prah sa pravdepodobne mení, závisí od mnohých faktorov a je špecifický pre každú krajinu (napr. Arčabić et al. (2018); Égert (2015); Bentour (2021)). Okrem skúmania konceptu dlhového prahu sa prehľad súčasnej literatúry venuje aj témam ako endogenita (Panizza & Presbitero, 2014), reverzná kauzalita (Amann & Middleditch, 2020) a mechanizmy, ktorými môže vládny dlh ovplyvňovať rast (C. Checherita-Westphal & Rother, 2012). Tento prehľad ukazuje, že neexistuje jednotná zhoda o vplyve vládneho dlhu na hospodársky rast, pričom výsledky sa líšia v závislosti od zvolených krajín, časových období, ekonometrických techník a modelových špecifikácií. Ako zdôrazňuje meta-štúdia Heimberger (2023), je nevyhnutné riešiť endogenitu tohto vzťahu, pretože by mohla do značnej miery vysvetliť negatívnu koreláciu často pozorovanú v literatúre. Heimberger (2023) tiež odporúča dôkladnejšie preskúmať podmienené účinky dlhu a kanály, ktorými môže ovplyvňovať rast. V súlade s týmito odporúčaniami sa táto dizertačná práca okrem iného zaoberá podmienenými efektmi dlhu v kapitole 3, rieši endogenitu pomocou prístupu inštrumentálnych premenných v kapitole 4 a posudzuje transmisný kanál dlhu prostredníctvom zvýšeného rizika v kapitole 5.

Tretia kapitola skúma vzťah medzi vládnym dlhom a reálnym HDP na vzorke kvartálnych údajov z 37 rozvinutých ekonomík za obdobie rokov 1990 až 2019. Metodologicky sa opiera o panelový model autoregresívneho distribuovaného oneskorenia (ARDL), ktorý umožňuje zachytiť krátkodobé aj dlhodobé efekty vládneho dlhu. Tento prístup je podporený teoretickou literatúrou, ktorá predpokladá rôzne efekty dlhu v rôznych časových horizontoch (Elmendorf & Mankiw, 1999). Použitý panelový ARDL model je zvolený pre svoju robustnosť pri zachytávaní viacerých interakcií v čase a svoju flexibilitu pri práci s dátami s rôznymi úrovňami integrácie. Tento model umožňuje simultánne odhadnúť krátkodobé a dlhodobé koeficienty, čo umožňuje komplexnú ekonomickú interpretáciu. Na

odhady vplyvov bol použitý PMG estimátor, vyvinutý Pesaran et al. (1999), ktorý predpokladá homogenitu dlhodobých koeficientov pri zachovaní krátkodobej heterogenity, čo je obzvlášť vhodné pre rozvinuté ekonomiky, ktoré môžu mať podobné dlhodobé ekonomické trendy, ale odlišné krátkodobé výkyvy. Použitý dataset pozostáva z nevyváženého panelu kvartálnych údajov pre 37 rozvinutých ekonomík za obdobie 1990 až 2019. Hlavná premenná záujmu je vládny dlh, vyjadrený ako percento HDP, pričom údaje sú získané z databázy Svetovej banky. Ostatné kontrolné premenné zahŕňajú mieru investícii, otvorenosť ekonomiky, infláciu, ľudský kapitál a ďalšie faktory, ktoré môžu ovplyvňovať hospodársky rast. Výsledky nelineárnych modelov naznačujú, že existuje prah vládneho dlhu, nad ktorým ďalšie hromadenie dlhu vedie k ekonomickému spomaleniu. Tento prah sa pohybuje medzi 95% a 110% HDP v závislosti od modelu. Táto kapitola tiež skúmala, ako interakcie medzi vládnym dlhom a ďalšími premennými, ako sú vládna spotreba, súkromné úvery a súkromný dlh, ovplyvňujú reálny HDP. Výsledky ukázali, že vyššia vládna spotreba znižuje pozitívny efekt vládneho dlhu a tiež znižuje prah dlhu. Podobný efekt bol zaznamenaný aj pre súkromný dlh. V poslednej časti kapitoly boli odhadnuté modely s nelineárnymi a podmienenými efektmi vládneho dlhu pomocou metódy CCEPMG, ktorá upravuje odhady PMG o prierezovú závislosť - bežný problém v panelových dátach. Po zohľadnení prierezovej závislosti sa všetky štatisticky významné nelineárne a podmienené efekty vládneho dlhu v dlhodobých rovniciach stratili. Tieto zistenia podčiarkujú význam globálnych ekonomických prepojení a naznačujú, že externé podmienky môžu mať väčší vplyv na národné ekonomiky než domáce podmienky. To môže byť obzvlášť dôležité v kontexte vysoko prepojeného ekonomického klubu, kde väčšina členov zdieľa spoločnú menu a efekty nákazy sú výraznejšie. Výsledky taktiež naznačujú potrebu pokročilých ekonometrických techník, ktoré dokážu dostatočne zohľadniť prierezovú závislosť. Okrem toho, výsledky zdôrazňujú dôležitosť integrovať globálne ekonomické dynamiky pri formulovaní fiškálnej politiky, keďže samotné riadenie domáceho dlhu nemusí mať očakávaný vplyv na hospodársky rast, ak sa nezohľadnia globálne závislosti. Tieto výsledky tiež otvárajú otázky pre ďalší výskum, ktorý by mohol skúmať, ako globálne ekonomické podmienky interagujú s národnými fiškálnymi politikami, čo predstavuje bohatú oblasť pre hlbšiu analýzu.

Štvrtá kapitola skúma kauzálne efekty akumulácie vládneho dlhu na hospodársky rast na vzorke 26 krajín EÚ v období rokov 2003 až 2019. Predchádzajúca kapitola nedokázala

preukázať robustný dlhodobý vzťah medzi vládnym dlhom a reálnym HDP, ale krátkodobý vplyv zmien dlhu na hospodársky rast bol štatisticky významný. Na minimalizovanie endogenity vo vzťahu používame prístup s inštrumentálnymi premennými, pričom ako inštrument pre zmenu dlhu používame vybrané komponenty zosúladenia dlhu a deficitu (stock-flow adjustment, SFA), ktoré súvisia so zmenou dlhu, ale pravdepodobne neovplyvňujú rast cez iné kanály. Na odhad bola použitá dvojstupňová metóda najmenších štvorcov (2SLS). Tento prístup je vhodný pre riešenie potenciálnej endogenity vládneho dlhu, ktorá predstavuje významný problém pri odvodení kauzálnych záverov. Konvenčné regresné metódy by mohli viesť k skresleným a nekonzistentným odhadom, čo môže súvisieť s problémom reverznej kauzality. Reverzná kauzalita môže napríklad nastať, keď krajina s nedostatočným hospodárskym rastom trpí poklesom daňových príjmov a súčasne sa vlády snažia podporiť ekonomiku vyššími výdavkami, čo urýchľuje akumuláciu dlhu. Ako inštrument pre zmenu vládneho dlhu boli zvolené komponenty zosúladenia dlhu a deficitu (SFA), ktorý zohľadňuje nesúlad medzi variáciou vládneho dlhu a zaznamenaným vládnym deficitom alebo prebytkom počas určitého obdobia. Tento inštrument bol zostavený zo súčtu troch hlavných komponentov: zmena hodnoty dlhu v cudzej mene, zmeny v sektorovej klasifikácii a iných štatistických diskrepancii. Každý z týchto komponentov bol vybraný, pretože ovplyvňuje zmeny dlhu, ale nemá priamy vplyv na hospodársky rast. Výsledky prvej fázy regresie ukázali, že inštrument dokáže vysvetliť významnú časť variability endogénnej premennej a silu inštrumentu potvrdili aj diagnostické testy. V druhej fáze regresie, pri analýze celkovej vzorky krajín, sa zistil významný efekt akumulácie dlhu na rast. Avšak po odstránení extrémnych hodnôt (pozorovania za Írsko, Grécko a Cyprus) bolo zistené, že tento vzťah nie je štatisticky významný, čo naznačuje, že pôvodné výsledky boli ovplyvnené niekoľkými extrémnymi hodnotami a nemôžu byť zovšeobecnené. Ďalšie odhady zahŕňali pridanie kontrolných premenných, ako je reálny efektívny výmenný kurz (REER) a vládny dlh v cudzej mene, aby sa uzatvorili potenciálne kanály vplyvu na rast. Výsledky však nepreukázali zmeny v odhadoch, čo posilňuje závery, že po odstránení extrémnych hodnôt nemá akumulácia vládneho dlhu významný vplyv na hospodársky rast. Táto kapitola prispieva k literatúre tým, že navrhuje nový inštrument pre akumuláciu dlhu, ktorý je vhodný pre rozvinuté ekonomiky a umožňuje lepšie pochopenie kauzálneho vzťahu medzi vládnym dlhom a hospodárskym rastom. Zistenia naznačujú, že po odstránení vplyvu extrémnych hodnôt nemá akumulácia

vládneho dlhu v rozvinutých ekonomikách štatisticky významný vplyv na dlhodobý hospodársky rast. Tento výskum podčiarkuje význam dôkladného skúmania endogenity a používania vhodných inštrumentov pri analýze vzťahu medzi vládnym dlhom a hospodárskym rastom.

Piata kapitola skúma možné dopady vládneho dlhu na kreditné ratingy a rizikových prirážky na štátnych dlhopisoch. Predchádzajúce kapitoly nedokázali poskytnúť robustné dôkazy o významnom vplyve vládneho dlhu na hospodársky rast. Absencia štatisticky významných efektov však neznamená, že vládny dlh nemá žiadny vplyv na rast. Vzťah medzi dlhom a rastom môže byť zložitejší, než čo dokážu zachytiť konvenčné rastové regresie. Táto kapitola je zameraná na to, ako môže vyšší vládny dlh zvýšiť riziko spojené s krajinou a tým aj zvýšiť rizikovú prirážku na vládnych dlhopisoch. Toto zvýšenie výnosov z dlhopisov môže následne ovplyvniť ekonomiku tým, že zdraží úverovanie pre súkromný sektor a tlmiť tak hospodársky rast. V tejto kapitole najprv posudzujeme vplyv vládneho dlhu na kreditné ratingy krajín EÚ. Následne pomocou metódy „event study“ analyzujeme vplyv zníženia kreditného ratingu na rizikovú prirážku 10-ročných vládnych dlhopisov v krajinách EÚ. Na odhady bol použitý panelový usporiadaný logit model s fixnými efektami, využívajúc Blow-Up and Cluster (BUC) estimátor vyvinutý Baetschmann et al. (2015), aby sme analyzovali determinanty kreditných ratingov s dôrazom na vplyv vládneho dlhu. Táto metodológia bola zvolená pre jej robustnosť pri riešení individuálnej nepozorovanej heterogenity a pre jej vhodnosť pre kategorickú povahu kreditných ratingov. Model odhaduje efekt vládneho dlhu na rating krajiny, pričom závislá premenná reprezentuje kreditné ratingy krajín v štvrťročnej frekvencie. Kreditné ratingy sú prevzaté od troch hlavných ratingových agentúr: Standard & Poor's, Moody's a Fitch. Kontrolné premenné zahŕňajú HDP na obyvateľa, ročný rast reálneho HDP, index regulačnej kvality a politické riziko. Vládny dlh je negatívne korelovaný s kreditnými ratingami, čo naznačuje, že vyššie úrovne dlhu znižujú pravdepodobnosť vysokého ratingu. Druhá časť piatej kapitoly analyzuje vplyv oznámenia o znížení ratingu na rizikovú prirážku (rozdiel vo výnosoch oproti Nemecku) na 10-ročné vládne dlhopisy. Na odhad je použitá metóda event study a je analyzovaný vplyv zhoršenia ratingu na rizikovú prirážku okolo času oznámenia zníženia ratingu. V tejto časti používame denné dáta pre 27 krajín EÚ počas rokov 1998 až 2023 o kreditných ratingoch a výnosoch na 10-ročných vládnych dlhopisoch z Bloomberg databáz. Riziková prirážka je vypočítaná ako rozdiel medzi výnosom

dlhopisov danej krajiny a výnosom 10-ročných nemeckých vládnych dlhopisov. Z výsledkov vyplýva, že riziková prémia sa deň po znížení ratingu zvyčajne zvýši približne o 8 bázických bodov, čo je štatisticky významná reakcia. Analýza podľa agentúr ukazuje, že zníženie ratingov od Fitch má výrazný anticipačný efekt, zatiaľ čo zníženia ratingov od S&P a Moody's vykazujú konzistentný vplyv na rizikovú rizikovú prirážku. Z analýzy vyplýva, že zníženie kreditného ratingu má významný vplyv na rizikovú prirážku, najmä počas krízových období a pre krajiny so značnými problémami s financovaním dlhu. Rizikové prémie výrazne stúpajú, keď sa rating krajiny dostane do špekulatívnej kategórie. Zvýšenie dlhodobých úrokových sadzieb spôsobené vyššími rizikovými prémiami môže brzdiť hospodársky rast tým, že zvyšuje náklady na kapitál a znižuje investičnú aktivitu. Budúci výskum by sa mal zamerať na empirické prepojenie výnosov z dlhopisov a dlhodobých úrokových sadzieb s hospodárskym rastom.

Záverečná kapitola sumarizuje zistenia tejto dizertačnej práce. Prvým cieľom bolo analyzovať vzťah medzi vládnym dlhom a hospodárskym rastom v rozvinutých ekonomikách pomocou panelových kointegračných metód. Použitím štvrťročných údajov bol odhadnutý dlhodobý efekt vládneho dlhu na reálny HDP pre 37 rozvinutých ekonomík od roku 1990 do roku 2019. Výsledky odhalili významný nelineárny vzťah medzi vládnym dlhom a reálnym HDP, pričom identifikovali dlhový prah v rozmedzí od 95 % do 110 %. Výsledky tiež ukázali, že nárast vládnych výdavkov a súkromného dlhu znižuje pozitívny vplyv vládneho dlhu a znižuje dlhový prah. Následné odhady berúce do úvahy prierezovú závislosť však nepotvrdili nelineárne ani podmienené efekty vládneho dlhu, čo naznačuje, že nie je dostatok dôkazov na definitívne stanovenie robustného dlhového prahu a vzťah medzi dlhom a rastom je v prostredí vyspelých ekonomík pravdepodobne ovplyvňovaný spoločnými faktormi, čo poukazuje na vysokú mieru prepojenosti ekonomík. Ďalším cieľom bolo identifikovať vhodný inštrument pre akumulácie vládneho dlhu a odhad jeho kauzálneho vplyvu na hospodársky rast. Komponenty zosúladenia dlhu a deficitu boli použité ako inštrument, ktoré by nemali ovplyvniť hospodársky rast inak ako prostredníctvom zmien vládneho dlhu. Odhady naznačujú, že po odstránení extrémnych hodnôt ako Grécko, Írsko a Cyprus, akumulácia vládneho dlhu nemá významný vplyv na hospodársky rast. Posledným cieľom bolo preskúmať potenciálny kanál, cez ktorý môže vládny dlh ovplyvniť rast. Piata kapitola preto skúmala vplyv vládneho dlhu na kreditné riziko krajiny a následný efekt na výnosy štátnych dlhopisov.

Výsledky ukázali, že vyšší vládny dlh zvyšuje pravdepodobnosť nižšieho kreditného ratingu, čo následne zvyšuje rizikovú prirážku na vládnych dlhopisoch. Tento efekt je obzvlášť silný počas období ekonomického poklesu alebo finančnej nestability. Vyššie výnosy dlhopisov potom vedú k ekonomickým dôsledkom, vrátane rastúcich nákladov na obsluhu dlhu a negatívnych efektov drahšieho úverového financovania, čo môže viesť k nižšiemu rastu. Aj keď sa nepodarilo demonštrovať priamy efekt vládneho dlhu na rast, neznamená to, že vysoké úrovne dlhu nemajú žiadny efekt. Vzťah medzi dlhom a rastom môže fungovať cez viaceré kanály, ako sme ukázali prostredníctvom kanála zvýšeného rizika a drahšieho dlhového financovania. Budúci výskum by sa mal zamerať na lepšie pochopenie týchto transmisných kanálov a tiež sa hlbšie zaoberať možnou prepojenosťou fiškálnych politík a identifikáciou spoločných faktorov, ktoré môžu ovplyvňovať pôsobenie vzťahu medzi vládnym dlhom a hospodárskym rastom.