3

UNDERSTANDING THE LINK BETWEEN PUBLIC DEBT AND ECONOMIC GROWTH: THE ROLE OF BAUMOL COSTS

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Abstract: This study empirically explores the influence of public debt on economic growth, through the estimation of a growth model amplified with a debt variable. The model uses a panel for the 19 Euro Area countries between 1995 and 2019, and additionally accounts for possible sources of bias, such as, heterogeneity and endogeneity. The former is tackled through the estimation of a fixed effect model, whereas the latter is handled through an interesting new path, where the influence of Baumol's Cost Disease is considered and used as an instrumental variable. Next, the model is estimated using 2SLS. The results show a negative relationship between public debt and economic growth, where a 1 percentage point increment in the public debt ratio decreases economic growth by 0.02 percentage points, *ceteris paribus*. Finally, there is some evidence of a relatively negative effect on economic growth for public debt levels between 30% to 60% of GDP when compared to lower levels.

JEL codes: C23, H63, O47

Keywords: Economic growth, Public debt, Baumol's Cost Disease

Resumo: Este estudo explora, empiricamente, a influência da dívida pública no crescimento económico através de um modelo de crescimento económico, ao qual é adicionado uma variável da dívida pública. O modelo utiliza dados em painel para os 19 países da Área do Euro entre 1995 e 2019 e, adicionalmente, considera possíveis fontes de enviesamento, como heterogeneidade e endogeneidade. O primeiro problema é confrontado através da estimação de um modelo de efeitos fixos, enquanto o segundo é abordado através de um novo caminho, em que os efeitos da Doença dos Custos de Baumol são introduzidos como uma variável instrumental. Em seguida, o modelo é estimado utilizando o método 2SLS. Os resultados demonstram que um aumento da dívida pública em 1 ponto percentual implica uma diminuição do crescimento económico em 0.02 pontos percentuais, considerando que tudo o resto se mantém constaste. Para finalizar, evidencia-se um relativo decréscimo do crescimento económico para níveis de dívida pública entre os 30% a 60% do PIB quando comparado com níveis inferiores.

Códigos JEL: C23, H63, O47

Palavras-chave: Crescimento económico, Dívida pública, Doença dos Custos de Baumol

Table of contents

List of tables

List of figures

1. Introduction

In the last five decades, the global economy has experienced a sharp increase in debt accumulation involving both developed and emerging economies. A key issue relates to the extent to which these high numbers could impact macroeconomic variables, in particular economic growth, which can happen through multiple channels.

Studying the link between public debt and economic growth became a prominent policy issue after the financial and economic crisis of 2007-2009, when public debt values were greatly increasing and, by contrast, real per capita GDP was decreasing. Recently, a similar pattern has been experienced, intensified by the peculiar times we live in today, amidst the COVID-19 pandemic, in which the current levels of taxes and public spending are unsustainable for most industrialized countries. Consequently, the question arises to the surface again: How can economic growth be affected by the level of public debt?

Multiple authors tried to answer this question in the past, with one of the most influential evidence being provided by Reinhart and Rogoff (2010), who identified a nonlinear relationship between the public debt-to-GDP ratio and economic growth where, once the former surpassed a certain level, called the threshold effect, this variable had a detrimental impact on economic growth. By drawing inspiration from such remarks, this study aims to identify this possible relationship.

Methodologically, this study is based on the book by Barro (1996) on the factors that might influence medium and long run economic growth. Thus, a growth regression, applied to a panel of Euro Area countries is built with the inclusion of such factors alongside a public debt variable to account for the possible causal relationship. Moreover, other methodological concerns, such as heterogeneity and endogeneity, will be addressed.

Particularly, endogeneity bias is a problem thoroughly studied in this dissertation given the multiple claims regarding the endogeneity of the debt variable, and although tackling this problem is nothing new, the way that it is confronted in this study is relatively innovative. That is because, to establish the presence of a causal correlation between public debt and economic growth, the introduction of a new instrumental variable assumed of importance is proposed, given that the so-called Baumol's Cost Disease explains the inevitable unit cost increase in sectors that exhibit only occasional productivity growth (Baumol, 1967). Such sectors are characterized by their labour intensity that helps to explain the low productivity displayed when compared to capital intensive sectors. Examples are the health care and education sectors, which are primarily financed by the government and, consequently, increase public expenditure. These cost increases in the Baumol sector can influence both public debt and economic growth for which this dissertation tries to establish a causal relationship. Thus, the addition of a Baumol variable into the model aims at eliminating the endogeneity problem and, additionally, constitutes the main contribution of this dissertation, given that, to my knowledge, Baumol's variable has not been considered previously.

Henceforth, this study will add to the literature in multiple ways. Firstly, by updating the data used. Secondly, by considering a new instrumental variable that seems to be impactful in reducing biased results. And, finally, since dealing with fiscal imbalance is one of the challenges policymakers face, such results can help policymakers on the appropriate intervention to be applied by providing a clearer idea of what the limit of the debt-to-GDP ratio should be before it becomes unsustainable.

As such, this work will be organized as follows: first, in section 2., a review of the literature will be done, contextualizing the primary concepts, including Baumol's Cost Disease, and debating prior studies done on the topic. In the following section, stylized facts will be considered, followed by the analysis of the relevant input data. After those important bases have been provided, section 4. specifies the empirical model, highlighting the possible sources of bias, such as heterogeneity and endogeneity, and how those caveats can be overcome. To finalize this study, the nonlinear relationship is explored, followed by a brief conclusion to discuss the main findings, limitations, and possible developments.

2. The relevant theoretical and empirical studies

Acknowledging the existing literature regarding the relationship between public debt and economic growth is a crucial step for any study surrounding the topic. First and foremost, it is of most importance to understand the primary concepts, to then explore how theorists argue in favour of a possible relationship between the variables, that will be validated, or not, through the empirical analyses reviewed in subsection 2.2., followed by the evidence on the possible sources of biases that might be present in these studies, acknowledge in subsection 2.3. At last, to conclude this preliminary part, Baumol's Cost Disease needs to be explored as to comprehend, exactly, why such phenomenon leads to the creation of an instrumental variable that might help to explain the relationship between the two main indicators and mitigate the endogeneity problem.

2.1. The theoretical studies

Economic growth is commonly defined as the increase in the production of goods and services from one period to another. Overall, the literature is mostly congruent in supporting the idea that economic growth greatly improves economic agents' standards of living. Specifically, economic growth is directly associated with higher income levels, greater life expectancy, decrease in mortality and higher levels of education (Barro & Sala-i-Martin, 2004). Consequently, multiple structural changes can be driven from it, such as job mobility, since individuals will switch to jobs that require higher levels of education and the consumption of goods beyond their primary needs (Van den Berg, 2017). Moreover, Friedman (2006) argues that economic growth not only stimulates material gains but, additionally, shapes the social and political environment, as well as the moral character of people. Friedman (2006) believes that economic growth can foster better opportunities and diversity amongst individuals, emphasize the commitment to fairness and encourage entrepreneurship and creativity. Thus, even small differences in growth rates, cumulated over time, will have greater consequences on the population, so that it is crucial to understand the determinants of economic growth as to contribute to the optimization of a population's economic prosperity.

In this regard, to isolate the determinants of growth, Barro (1996) collected data for a panel of more than 30 countries and observed a strong correlation between economic growth and "*higher schooling and life expectancy, lower fertility, lower government consumption, better maintenance of the rule of law, lower inflation, and improvements in terms of trade*" (p. 2). Additionally, given some initial value of these variables, the author concluded that economic growth is negatively related to the initial level of real per capita GDP. By contrast, fiscal deficits and banking crises are estimated to have a significant negative correlation with economic growth (Easterly & Schmidt-Hebbel, 1993; Reinhart & Rogoff, 2009).

Particularly, a widely used fiscal strategy to stimulate short run economic growth is the issuance of public debt. Public debt is, necessarily, issued every time there is a discrepancy between public revenue and spending, thus representing, in the presence of negligible stock-flow adjustments, the net accumulation of budget deficits. As such, if we assume a budget deficit generated by increasing public spending and/or decreasing public revenue, current disposable income increases and, consequently, so does the demand for output, assuming short run Keynesian effects. Thus, in the short run, higher public debt can be beneficial to the economy, particularly because it may allow the government to smooth taxes while obtaining funds to finance their expenditure and, as a result, increase output (Cecchetti, Mohanty & Zampolli, 2011).

Before the twentieth century, the accumulation of debt occurred mainly during wars, whereas in posterior periods, fiscal and economic crises have been a common factor amongst debt accumulation. Moreover, according to Yared (2019), another possible reason for this phenomenon are its short-term political benefits and the fact that governments are short-sighted. As a result, governments tend to increase public debt without any regards for its long-term impact or burden for future generations. And, although there is a consensus that public debt might be beneficial in the short run, the literature is mostly divided in what the long-term consequences are.

Arguably, public debt can be beneficial to economic growth in the long run, if the long-term benefits outweigh the shortcomings, specifically, if it is productively allocated to the determinants of growth, such as, important infrastructures or public education that cannot be financed through taxation. Following the Keynesian view, the increase in public spending can stimulate the economy and "crowd-in" private investment, assuming that it is issued alongside a decrease in the tax rate or an increase in the accumulation of public capital investments, while being contained to certain levels (Elmendorf & Mankiw, 1998).

Still, when debt reaches higher levels, the traditional view is that, in the long run, it may raise some concerns about its sustainability and create a climate of mistrust among economic agents, lending to governments starts being perceived by investors as carrying a higher level of risk, which hampers the lending capacity of the economy, and consequently real interest rates rise. In turn, higher interest rates tend to crowd out capital and reduce output given the decrease in public savings (Elmendorf & Mankiw, 1998). Moreover, given a greater level of mistrust on government's capacity to meet their repayment obligations, higher levels of public debt tend to reduce capital inflows to the affected country or even increase capital outflows to other countries (Bilan & Ihnatov, 2015).

In this regard, Krugman (1988) theorized an existent nonlinear relationship between public debt and economic growth where, for lower levels of the former, the crowding-in effect outweighs the crowding-out effect and, consequently, private investment must increase followed by a rise in economic growth. However, the author argued that, beyond a certain level of public debt, the crowding-out effect is dominant and such high level would be negatively impactful towards economic growth. Hence, debt increases can be detrimental to future generations despite the benefits that can be drawn for current generations (Modigliani, 1961).

Furthermore, the context in which debt builds up seems to be crucial for its long-term impact. For instance, war debts may be less problematic for future generations since it is assumed that spending will come to a halt once peace returns (Reinhart & Rogoff, 2012), but once again, only if debt is restrained to certain low levels. Moreover, accumulating debt during times of inflation could be beneficial for borrowers (in the case of public debt, the government) since they will pay lenders with money that is worth less than when debt was issued.

Additionally, the channels through which public debt may adversely affect economic growth were studied in the literature with detail. Specifically, Kumar and Woo (2010) identified three possible transmission channels: high long-term interest rates, high distortionary taxation, and inflation. The long-term interest rates channel could be explained by the neoclassical model, in which, high public debt, resulting from an accumulation of fiscal deficits, crowds out investment given the reduction in national savings and increases aggregate demand, *ceteris paribus*. Furthermore, high distortionary taxation can be a result of current high public debt, if we assume the Ricardian Equivalence theorem as a valid firstorder proposition since it helps to explain how the present value of the tax revenue is directly correlated with the initial debt level (Barro, 1979). Consequently, current high debt will increase future taxation and thus deter economic growth. At last, high debt levels can additionally lead to inflation, since, besides expanding aggregate demand, increasing government indebtedness may eventually force the central bank to issue money to guarantee solvency (Sargent & Wallace, 1981). As a result, higher public debt levels may cause fiscal disturbances that can affect the price level and, consequently, private consumption. Thus, inflation consists of another possible transmission mechanism by which public debt may affect economic growth.

2.2. Empirical evidence on the debt threshold

One of the most significant contributions on the long-term link between public debt and economic growth was the study conducted by Reinhart and Rogoff (2010), in which the authors used simple statistics to explore a dataset on public debt that incorporated 44 countries covering around 200 years. They categorized the annual observations into four groups, given the levels of the debt-to-GDP ratio, and verified a weak correlation between public debt and economic growth for "normal" debt levels, with a similar relationship across emerging and advanced economies. However, for levels above 90% of GDP, public debt appeared to negatively impact economic growth, observing a nonlinear, concave relationship, in which, once public debt surpasses 90%, economic growth rates are, on average, 1% lower when compared to lower debt levels. They defined such phenomenon as the "threshold effect", i.e., after public debt reaches a specific turning point – the threshold – the relationship between public debt and economic growth changes from positive to negative. In the case of Reinhart and Rogoff (2010), the threshold was identified at 90%.

Other studies on the threshold effect corroborate Reinhart and Rogoff (2010)'s results. Checherita-Westphal and Rother (2010) performed a basic empirical study on the average relationship between public debt-to-GDP ratio and economic growth for a sample of 12 Euro Area countries from 1970 to 2010. Their results confirm the presence of a nonlinear, concave relationship, with the threshold being between 90 and 100% on average. The same was concluded by Bilan and Ihnatov (2015) in their study for a panel of 33 European countries over the 1990-2011 period, where they pointed out a maximum debt threshold around the 94% of GDP, after which "*public debt is expected to negatively affect the* *economic growth rate, due to higher interest rates, fear of public debt unsustainability and severe budgetary consolidation measures*" (p. 24). Similarly, Cecchetti et al. (2011) gathered data for a panel of 18 OECD countries between 1980 and 2010 and supported the existence of a threshold; however, in their case, this would be at around 85% of GDP and, thus the authors emphasized the paramount importance of fiscal policy to keep debt levels under control as to not retard economic growth. Likewise, Kumar and Woo (2010) found a similar result through panel data for 38 advanced and developing economies over more than four decades. By analysing the impact of public debt-to-GDP ratio on subsequent growth, they were able to identify that a 10% increase in initial values of debt was linked with a decrease in the annual real per capita GDP of around 0.2%, concluding for an adverse relationship. Moreover, unlike previous studies, Gómez-Puig and Sosvilla-Rivero (2015) conducted an empirical analysis of 11 member states from 1961 to 2013 using time series to account for country divergences across time horizons, based on a Cobb-Douglas production function for each country augmented with a debt variable. Their results displayed a negative link between public debt and economic growth, due to future distortionary taxation and real interest rates as possible transmission channels.

Still, not satisfied with the previous studies, multiple authors tried to verify the validity of such conclusions. Égert (2012) collected the same data as Reinhart and Rogoff (2010) and put the dataset to formal econometric tests by using bi-variate time series. He did find some evidence for a nonlinear relationship between the two variables; however, Égert (2012) identified the threshold, for advanced countries, at a level of public debt-to-GDP ratio much lower than the one identified by Reinhart and Rogoff (2010). In the author's results, the threshold is within the range of 20% to 60%.

A year later, Herndon, Ash and Pollin (2013) replicated Reinhart and Rogoff (2010)'s study and furiously criticized it. The authors argued that, after correcting the study for certain coding errors, such as selective exclusion and unconventional weighting summary statistics, such relationship could no longer be observed. According to their results, the threshold previously detected did not exist and, consequently, a level after which public debt has a negative effect on GDP could not be identified.

Moreover, even though the data gathered by researchers is mostly focused on advanced countries, this potential relationship is not exclusive to them. In fact, strong evidence for an adverse relationship between public debt and economic growth was provided by Pattillo, Poirson and Ricci (2002), who observed a 1% fall in per capita GDP growth once public debt levels were doubled, for 93 developing countries between 1969 and 1998. Additionally, according to the authors, the harmful consequences only kicked in when public debt was around 35 to 40% of GDP, thus identifying the threshold at such level. Their results suggested that such impact was transmitted through a significant negative effect on physical capital accumulation and productivity growth. While the former is a consequence of the decrease in expectations of return due to higher distortionary taxes mentioned above, the latter argues that countries with higher debt are less prone to undertake costly policy reforms, and thus investment and productivity will be affected. Years later, Checherita-Westphal and Rother (2010) would provide empirical evidence that these constitute two of the transmission channels through which debt impacts growth alongside the real long-term interest rate channel, also considered by Kumar and Woo (2010).

To add to these results, Asteriou, Pilbeam and Pratiwi (2021) examined the same possible relationship for a panel of Asian countries between 1980 and 2012, in the short and long run. However, because debt levels in these Asian countries were relatively low, the authors were not looking for a threshold, but they could conclude a 0.012 p.p. decrease in economic growth given a marginal increase in public debt, in the short run, and a 0.013 p.p. decrease in the long run.

Taking all these studies into account and, as it is evident in Table 1, the results regarding the estimation of the threshold range between different debt levels in accordance with the sample and method of estimation considered (Égert, 2012; Panizza & Presbitero, 2014).

Table 1: Results from different studies regarding the threshold effect

Author(s)	Sample	Threshold (% of GDP)
Reinhart & Rogoff (2010)	40 advanced and developing countries. 1946-2009	90%
Checherita-Westphal & Rother (2010)	12-Euro Area countries, 1970-2010	90 – 100%
Bilan & Ihnatov (2015)	33 European countries, 1990-2011	94%
Cecchetti, Mohanty & Zampolli (2011)	18 OECD countries, 1980-2010	85%
Égert (2012)	16 advanced countries. 1946-2009	20 – 60%
Herndon, Ash & Pollin (2013)	20 advanced economies, 1946-2009	*Cannot be identified*
Pattillo, Poirson & Ricci (2002)	93 developing countries, 1969-1998	35 – 40%

Source: Own elaboration.

2.3. Empirical evidence on the causal relationship

It could be argued that a causal relationship between public debt and economic growth is hard to establish, and that none of the mentioned authors seem to have a rigorous argument for it. In fact, the possible causal relationship between public debt and economic growth could be due to an endogenous variable – a third component that has a combined influence on public debt and on economic growth – or it could be that public debt levels have an impact on economic growth but that the other way around is also valid, in contrast with what is continuously assumed – reverse causality (Panizza & Presbitero, 2014).

The existing literature has tried to mitigate the endogeneity problem by either using a lagged endogenous variable as an instrument (Cecchetti et al., 2011), estimating the model through a GMM dynamic panel regression (Kumar & Woo, 2010) or by instrumenting the debt variable with the average of other countries in the sample (Checherita-Westphal & Rother, 2010). In particular, the former is a method commonly used in the literature surrounding this topic, although there is a surprising lack of formal analysis that proclaim if this is, in fact, an appropriate route. In theoretical terms, Bellemare, Masaki and Pepinsky (2017) addressed this issue and demonstrated that lagged explanatory variables can, indeed, be used as instruments to mitigate the endogeneity problem but only when these neither have a direct causal effect with the dependent variable nor with unobserved factors, and even then, the likelihood of a Type 1[1] error is still large. In practice, this may lead one to wrongly conclude for a causal relationship between two.

When it comes to the GMM estimation alternative, which relies on the first differences of the endogenous variable and lagged values of the regressors as instruments to, respectively, correct for unobserved confounders and simultaneity, Blundell and Bond (1998) have highlighted the unsatisfactory results of such method due to a weak correlation between the lagged explanatory variables and first difference of the endogenous variable. Finally, instrumenting the debt variable with the average of other countries in the sample might be problematic if global shocks and spill overs are at play, since a shock in a specific country's GDP growth will influence its neighbour country's growth, the evolution of public debt in the first country cannot be used as an instrument for the public debt in the second one (Panizza & Presbitero, 2014).

As such, Panizza and Presbitero (2014) tried to tackle this issue with a different approach. The authors used an instrumental variable that "*captures the valuation effects brought about by the interaction between foreign currency debt and exchange rate volatility*" (p.25). Their results, for a sample of 17 OECD countries, showed a negative correlation between public debt and economic growth that disappeared once the instrumental variable was introduced, hence emphasizing how the prior results could have been influenced by the endogeneity bias that, when considered, could alter the results. Following a similar route, an instrumental variable is introduced in this study as explored in the next subsection.

On the other hand, reverse causality is a methodological issue that has not been strongly considered in the literature. A good exception is the study conducted by Donayre and Taivan (2015), in which the direction of causality between public debt and economic growth was analysed for a sample of 20 OECD countries between 1970 and 2010. The authors conducted inferences through Granger and Var-based tests and, additionally, acknowledged the individual characteristics of countries by performing the tests for each individual country. They found evidence for both types of unidirectional causality, bidirectional causality and of no-causality between the two variables for the countries

[1] Type 1 errors can occur during hypothesis testing representing "false positives", that is, a null hypothesis might be wrongly rejected despite its accuracy.

analysed. This suggests that, if the evidence is for unidirectional causality going from public debt to economic growth, it supports the traditional idea that high levels of public debt have a detrimental effect on economic growth, as priorly mentioned. However, by contrast, if there is evidence for unidirectional causality going from economic growth to public debt, it opposes to what has been considered until here, and it could be explained by the reduction in taxes and increases in government transfer payments following recessions, which, in turn, would augment the fiscal deficit and, consequently, public debt. Thus, economic contractions could, arguably, affect public debt, which would explain the feedback unidirectional causality (Tica, Lee, Sonora & Vladimir, 2018). Evidence for bidirectional causality indicates that, not only high levels of public debt might retard growth but, additionally, economic growth might influence the dynamics of debt. Similarly, Dube (2013) used a lag model containing Reinhart and Rogoff (2010)'s data for developed countries, to test the possibility of reverse causality. The author concluded that the impact of the lags on public debt were smaller than the effects of the leads on economic growth which did not seem to make logical sense. Thus, it would have to be past economic growth that influenced current public debt and, not the other way around, hence suggesting that the causality would be unidirectional but going from economic growth to public debt. Therefore, given such results, even if there is evidence for a negative correlation between public debt and economic growth, it cannot be inferred that it is public debt that deters growth.

Furthermore, in addition to studying the direction of the causality, Donayre and Taivan (2015) followed a different route regarding the heterogeneity bias. Whereas prior studies have dealt with such issue by estimating a fixed effect model (Kumar & Woo, 2010; Cecchetti et al., 2011), Donayre and Taivan (2015) opted to estimate their model for each individual country and asserted that the casual link between the variables varies according to the country and, hence, it cannot be guaranteed that higher public debt always means lower economic growth. Eberhardt and Presbitero (2015) followed the same route by collecting data for 118 countries from 1960 to 2012 and, although they found some support for a negative relationship between public debt and economic growth, once the authors estimated the same model for each individual country, their results changed, and they could no longer find evidence for a parallel threshold within countries. This conclusion emphasizes the importance of overcoming the heterogeneity bias that, when unresolved, could alter the results. Nevertheless, this dissertation aims to solve such problem in a similar way to most of the literature, by adopting the most appropriate estimation technique through the introduction of country and time specific effects, as explored in section 4.

To summarize, part of the literature shows evidence of a nonlinear relationship between public debt and economic growth, while the remaining part demonstrates opposite results. For those who agree with a negative link between the two variables, the transmission mechanisms were specified, and it was mostly demonstrated that the negative correlation is only observed after debt levels surpass a certain turning point, whereas for lower levels the relationship observed is positive, i.e., we are in the presence of a threshold effect, although some authors could not identify such threshold. Endogeneity and heterogeneity can help to explain the divergent conclusions, highlighting the importance to not disregard such issues. As such, first and foremost this study will focus on the relationship between public debt and economic growth, and to provide more accurate results and relying on the literature, heterogeneity and endogeneity biases will also be explored. As it was briefly mentioned, heterogeneity will be accounted for through the introduction of country and time specific effects, whereas endogeneity will be resolved through the addition of an instrumental variable, a third factor that has a joint effect on both public debt, and economic growth. In this regard, a strong case for the addition of a Baumol variable as an instrument is done in the subsection that follows.

2.4. Baumol's Cost Disease

As stated, the main contribution of this dissertation is the new pathway created by considering an instrumental variable, that has not been considered before, and that has a conjoint effect on public debt and economic growth – Baumol's Variable – which represents the ever-increasing per unit costs of the services provided by the public sector relative to those of the private sector, commonly known as Baumol's Cost Disease. Hence, firstly, it is necessary to understand this concept to then explain its influence on the two variables for which this dissertation intends to establish a causal relationship and, lastly, comprehend how to possibly create a variable for such phenomenon.

Regarding the continuous cost increases in the public sector, Baumol (1967) offers a detailed justification for this. According to the author, the economy can be distinguished into two sectors – the progressive sector and stagnant sector, with divergent productivity growth between the two. While the former is characterized by technologically progressive activities, capital accumulation and automatization, the latter is labour intensive and cannot be automatized to increase productivity, and thus being known as the "stagnant sector" given the low or inexistent productivity by which it is characterized. Furthermore, the author identified the role played by labour as the primary differentiation between the two sectors: while in the progressive sector, labour is mainly an instrument to attain the final product, in the stagnant sector, labour is a vital component, to the point where the quality of the final product itself will be valued based on the amount and/or quality of labour. Obvious examples of activities present in the stagnant sector are education, health services and the performing arts, which have not shown any relevant evolution in their practices throughout the years, specially, when compared to activities included in the progressive sector that have resorted to significant technological progress.

Moreover, an important assumption of this model is that wages must increase proportionally in both sectors to prevent labour mobility, in the long run, to the highest paid sector, a reasonable hypothesis considering the governmental competences in the scope of income redistribution, such as the national minimum wage legislation and progressive taxes in accordance with individual income. As a result, unit labour costs and prices in the stagnant sector rise relatively more than those in the opposite sector given the differences between wages and productivity, with such occurrence being frequently labelled as Baumol's Cost Disease.

To testify the validity of the Cost Disease, multiple empirical studies have been conducted. Nordhaus (2008) used data for 67 industries ranging from 1948 to 2001 to investigate the impact of this phenomenon in the overall economy. His results proved that divergent productivity growth between industries is responsible for an increase in relative prices of the "stagnant industries", and hence confirmed that such sectors are affected by Baumol's Cost Disease. Likewise, Hartwig (2008) relied on data for 19 OECD countries and found robust evidence in favour of this hypothesis, and specifically that health expenditure, which has been identified has the main factor responsible for the increase in government consumption, is determined by the excess increase in wages compared to productivity growth. However, as mentioned, the relevance of this concept occurs due to the correlation between Baumol's Cost Disease and the two variables of interest in this dissertation. But how is Baumol's Cost Disease correlated with both economic growth and public debt?

Once again, an important assumption of Baumol's (1967) thesis is that wages in both sectors of the economy must rise in accordance with productivity in the progressive sector and, hence, the costs per unit of the output in the stagnant sector will increase limitless. Consequently, it would be expected that the demand for the activities of this sector would decline and, ultimately, vanish. However, that is not what has been observed. In fact, given the importance of such services, like education and health, the demand is not highly elastic and thus demand will continue to prosper despite the high prices that might be practiced. Additionally, there is a tendency for the government to finance part of these services, decreasing the final price for the consumers and creating incentives for the demand to not decline. As such, despite the divergences in relative costs and prices of both sectors, the difference between the output growth of both sectors is expected to be maintained. However, to achieve this goal, given unbalanced productivity, a transference of the labour force to the stagnant sector is necessary whereas, in the progressive sector, the labour force will tend to become less relevant. Subsequently, the overall output growth of an economy, measured as a weighted average of the output of the two sectors, will decline. Quoting Baumol (1967), "*An attempt to achieve balanced growth in a world of unbalanced productivity must lead to a declining rate of growth relative to the rate of growth of the labour force*" (p.419), which explains the link between Baumol's Cost Disease and economic growth.

Empirically, Nordhaus (2008) gathered data for the growth rate of total factor productivity and the composition of output between 1948 and 2001. Not only did the author observe a shift in output towards those industries with lower productivity growth, but confidently affirmed that the demand for such industries was, typically, price inelastic and, thus, the output share in this sector was deemed to increase. Additionally, his data permitted to conclude for a more than 0.5 percentage points lowering of the overall productivity growth per year, once again, justifying the negative link between Baumol's Cost Disease and economic growth.

On the other hand, the literature regarding the correlation between Baumol's Cost Disease and public debt is quite scarce. Nevertheless, the connection between the two seems clear cut. That is because, clearly, there is a considerable number of services present in the non-progressive sector that depend upon government's financing. Hence, recalling that public debt is issued every time there is a negative incongruity between public revenue and spending, assuming constant public revenue, the existence of Baumol's Cost Disease deepens government's expenditure and, consequently, influences public debt.

Colombier (2017) demonstrated empirical evidence for such argument. The author gathered data for a sample of 24 OECD countries within a time span ranging from 1990 to 2010 to test the impact of Baumol's Cost Disease on government's total expenditure as a percentage of GDP. By doing so, he concluded that the public sector suffers from Baumol's Cost Disease, particularly, the healthcare and education sectors, resulting in a relative increase of public expenditure if governments are to continue to supply these services. Moreover, Köppl-Turyna and Lorenz (2016) relied on data for Austria ranging from 1940 to 2016 and verified a positive correlation between government's expenditure in intermediate consumption and compensation of public employees which, according to the evidence, suffered from Baumol's Cost Disease, and public debt as a percentage of GDP. Hence, the previous argument regarding the impact of Baumol's Cost Disease on public debt can be emphasized through these empirical findings.

As such, these logical claims motivate an innovative new path regarding the methodological estimation of the relationship between public debt and economic growth granted by the conjoint effect of Baumol's Cost Disease on the two variables of interest in this study. Specifically, it inspires the creation of an instrumental variable that accounts for the effects of the Baumol's Cost Disease in the endogenous growth model described in section 4, which I believe to have not been considered before. Thus, a final issue to discuss is how the prior studies have created this variable that translates into data the mentioned thesis. In this regard, Hartwig (2008) and Colombier (2017) developed an innovative approach by creating an Adjusted Baumol Variable. Both authors considered that the difference, for the public sector, between the growth rate of real wages and of productivity per employee divided by the employment share of the public sector was majorly affected by Baumol's Cost Disease. Hence, by considering the correlation priorly explained between Baumol's Costs, public debt, and economic growth, it seems likely that the adjusted Baumol's variables, as the one proposed by the two authors, could be used as an instrumental variable to control for the endogeneity bias that may be present in the data.

3. Public debt and some stylized facts

Comprehending public debt data is a crucial starting point to understand the motivation behind this study. Henceforth, the data for gross public debt as a percentage of GDP was extracted from the macroeconomic database of the European Commission for Economic and Financial Affairs – AMECO database – and includes the 19 Euro Area countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. The period to be examined ranges from the year of the introduction of the compatible European accounting framework – the European System of National and Reginal Accounts (ESA) – in 1995 to 2019, excluding data for the pandemic period since it constitutes an abnormal shock that might furiously impact this study's conclusions.

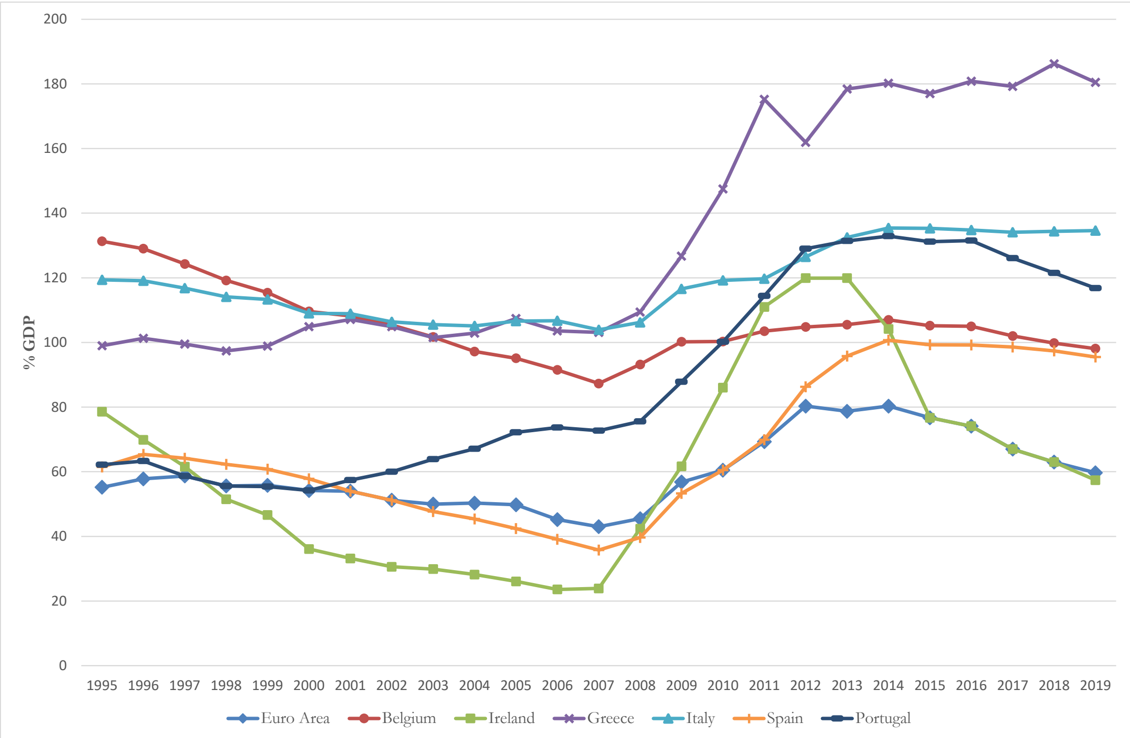
Thus, considering the countries in question, several debt spikes can be identified prior to 1995. The first prominent one can be explained by World War I and the fiscal and economic crisis that followed and although, throughout the 1920s, debt reductions were implemented, these were followed by two additional debt spikes associated to the Great Depression and World War II, accounting for unprecedent debt levels that only stabilized by the following decade due to rapid economic growth and inflation. Hence, public debt as a percentage of GDP strongly decreased and continued in this downward trend until the end of the Bretton Wood system, in 1971, when debt began to accumulate, once again (Abbas, Belhocine, El-Ganainy & Horton, 2010).

Overall, it seems that public debt levels have always been volatile and sensitive to shocks. Consequently, the Maastricht Treaty and the Stability and Growth Pact, that were created in 1992 and 1997, respectively, implemented a limit on public debt as 60% of GDP, even though not all member states have been effective in attaining this fiscal threshold. Thus, the excessive deficit procedure (EDP) was launched in 2013 by the European Commission to prevent members states to exceed fiscal ceilings and in case countries do violate the public debt rule, the EDP implies that the gap between public debt and the 60% mark must be reduced by 1/20th annually, otherwise countries will be fined. Moreover, this action demands countries to provide a strategy on how they plan to correct this gap, as well as a deadline for such achievement.

Nevertheless, since 1995 and until the end of the first decade of the current millennium, most countries reduced and stabilized their debt levels and, particularly, Ireland

and Belgium demonstrated a great effort in reducing their public debt, even if Greece and Italy still registered very high levels of indebtedness (Figure 1). However, this composure changed once the 2007-2009 global economic and financial crisis hit, and countries were forced to react by increasing their public spending, and thus debt levels exploded from a Euro Area average of 43% of GDP, in 2007, to 80%, in 2012, once the macroeconomic consequences of the crisis started to be felt, according to the AMECO data.

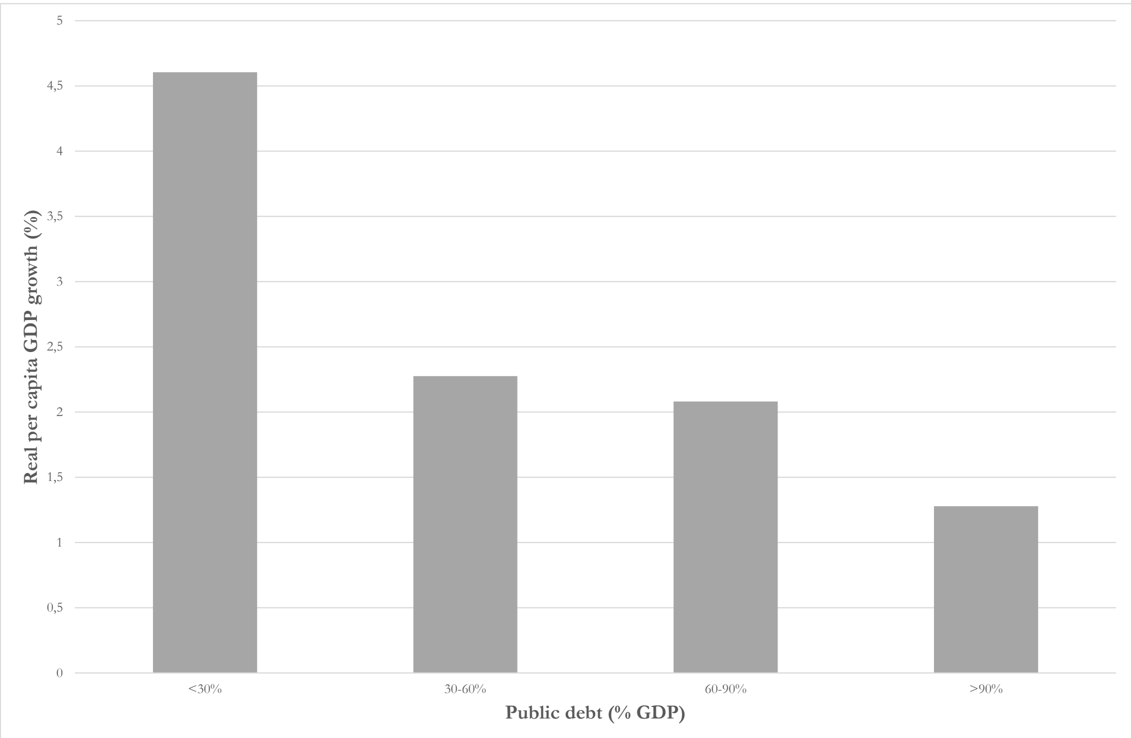
Figure 1: Public debt ratio for Euro Area countries, 1995-2019



Source: AMECO database.

Not long after the outbreak of the 2007-2009 global economic and financial crisis, macroeconomists started to wonder about the potential effects of such unprecedented levels of public indebtedness on economic activity, and it all started to gain some prevalence on the literature after the previously mentioned study by Reinhart and Rogoff (2010). As stated, the authors examined the average economic growth for four different levels of the public debt ratio, not accounting for any other determinants of growth, and concluded, through simple statistics, that for high debt-to-GDP ratios, of 90% and above, economic growth was notably lower than it was when compared to lower levels of debt. Following the same approach, for the Euro Area countries ranging from 1995 to 2019, a similar pattern is observed in Figure 2, where, given a debt level below 30% of GDP, real per capita GDP growth is around 4.6%, on average. However, when debt levels reach a level above 90% of GDP, real per capita GDP growth is around 1.3%, on average. Henceforth, the first stylized fact verifies that the real growth of per capita GDP for high levels of debt-to-GDP ratio is lower than for low debt to GDP ratio levels, not accounting for other growth determinants and ignoring the possible endogeneity problem. Specifically, for debt-to-GDP ratios above 90%, economic growth is 0.38% lower than it is at debt levels between 60 to 90% of GDP, according to the countries and time analysed, and 0.72%. lower than it is when compared to economic growth at levels of public debt-to-GDP ratio below 30%.

Figure 2: Real per capita GDP growth according to the public debt ratio level for Euro Area countries, 1995-2019



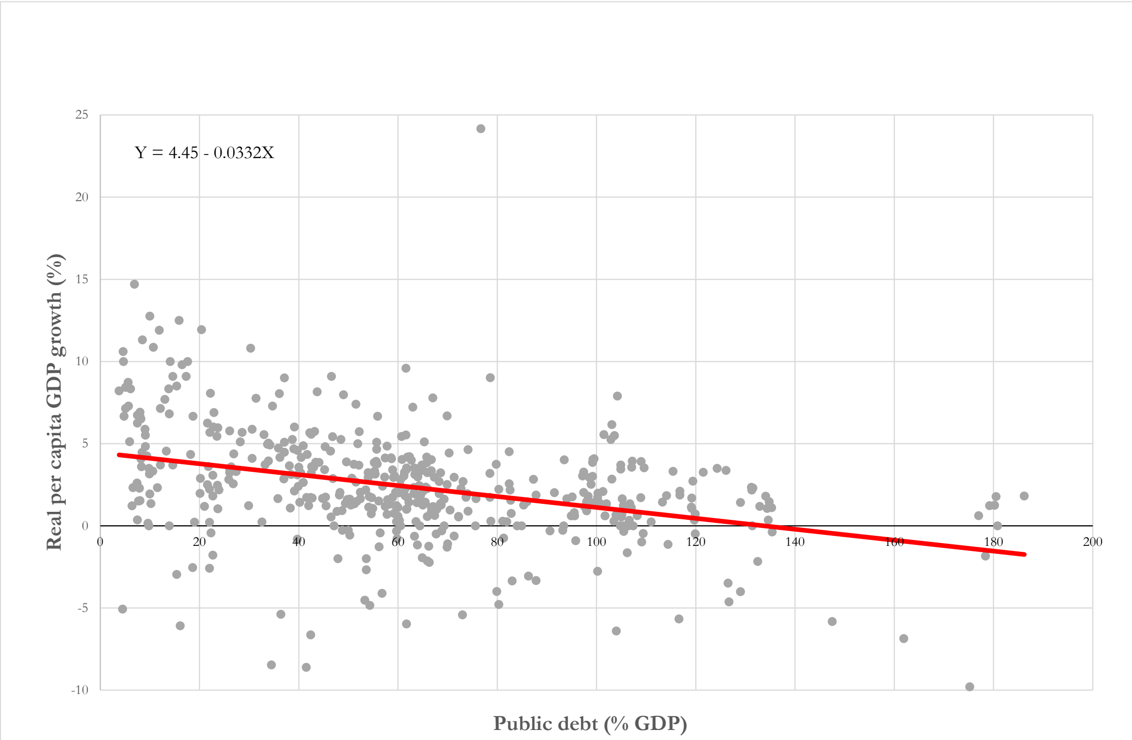
Source: AMECO database.

Note: The levels of public debt-to-GDP ratio were divided into 4 groups – below 30% of GDP; between 30 and 60% of GDP; between 60 and 90% of GDP; and above 90% of GDP. Henceforth, a simple average of real per capita GDP growth was calculated for each individual country in accordance with its public debt-to-GDP ratio group, between 1995 and 2019. At last, the average of real per capita GDP growth for each country within a certain group was aggregated, again by average, to construct the graph above.

Furthermore, an additional stylized fact may be introduced through the creation of a scatter plot between the public debt ratio and economic growth. Accordingly, a negative correlation between the two variables is observed, given the OLS fitted line, once again, not controlling for other growth determinants, and ignoring the possible endogeneity problem (Figure 3).

Through this simple descriptive analysis, Reinhart and Rogoff's (2010) conclusions are reinforced, but a deeper and more complex understanding of the link between public debt and economic growth is motivated, which this dissertation aims to do.

Figure 3: Real per capita GDP growth and public debt ratio for Euro Area countries, 1995-2019



Source: AMECO database.

Note: An outlier can be identified well above the OLS fitted line, justified by Ireland's real GDP growth (25.2%) and debt level (76.7%) in 2015 – GDP rose sharply, and public debt was relatively high.

4. An empirical assessment of the causal relationship

The empirical strategy regarding the link between public debt and economic growth focuses on the long-term relationship between the two variables. To study this relationship, firstly, a growth equation is specified relying on the empirical growth literature by Barro (1996), properly disclosed in section 2, where the author identifies the determinants of growth that will be added to the model as explanatory variables.

However, prior to anything else, it is important to account for any sources of bias that might be present, such as heterogeneity and endogeneity biases. As specified in section 2, a heterogeneity bias occurs whenever individual specific effects, that may be hidden from the model, and that are constant throughout countries or period considered, are correlated with the explanatory variables, whereas an endogeneity bias arises whenever the regressors are correlated with the error term.

As such, to analyse the possible causal relationship between the variables, a panel data technique is used, instead of cross-section or time-series methods. In a panel data technique, the same cross-sectional unit is evaluated over a certain period, meaning that the data has a spatial as well as a time dimension. Such path seems more appropriate due to its inherent advantages: 1) permits more accurate measurements due to the availability of cross-sectional data overtime; 2) allows for an increased capacity to model the complexity of the macroeconomic variables; and 3) emphasises individual features across both sections and periods, with the latter being the main motivation of relying on this technique (Hsiao, 2005). Thereby, panel data can explicitly account for the heterogeneity problem, and thus it may allow for a greater efficiency of the results when, as in this case, one suspects that non-observable countries and time specific effects are correlated with the regressors, i.e., a heterogeneity bias is present.

Next, a test for endogeneity will be performed to confirm the suspicion that public debt may be influenced by a third factor hidden from the model. If confirmed, such problem will be tackled through the introduction of an instrumental variable into the model which will be estimated using the Two-Stage Least Squares (2SLS) method. To understand this line of thinking, we must recall what was presented in subsection 2.4. regarding the joint correlation between Baumol's Cost Disease and the two main variables of interest for this study – public debt and economic growth.

Therefore, this section is divided in multiple subsections, each identifying the proper steps that must be followed before estimating the model. Starting with subsection 4.1., the growth regression is presented, and the variables are properly described; secondly, subsection 4.2. emphasises the data gathered and its descriptive statistics. As a next step, subsection 4.3. confronts the heterogeneity bias, followed by subsection 4.4. in which the endogeneity bias is tackled through an innovative new path that will be suitably described. In subsection 4.5., the results are presented and discussed, and in subsection 4.6. robustness checks are provided to understand the validity of this path. Moreover, the possible nonlinear relationship is explored in subsection 4.7., and at last, some of the main limitations that have been encountered throughout this study will be specified.

4.1. The model

To empirically explore whether public debt has a causal influence on economic growth, a growth regression is constructed. To do so, the explanatory variables introduced represent the multiple determinants of growth inspired by Barro (1996) augmented with a public debt as a percentage of GDP variable that complies with the main goal at hand. Hence, he economic growth regression can be represented by equation (I).

$$g_{i,t+k} = \beta_0 + \beta_1 Y_{i1} + \beta_2 X_{it} + \beta_3 Debt_{it} + \nu_i + \lambda_t + \varepsilon_{it}, \quad t=1,\dots,T; i=1,\dots,N \qquad (I)$$

Where *i* and *t* symbolize country and period, respectively, $g_{i,t+k}$ represents the real k-year forward annual per capita GDP growth in which k=5, in accordance with the path followed by similar studies, to represent the long run effect of the explanatory variables on subsequent growth, $Debt_{it}$ is a variable for public debt as a percentage of GDP, ν_i and λ_t are, respectively, country and time specific effects, and ε_{it} is the error term. The variable Y_{i1} specifies the level of per capita GDP in each country for 1995, to account for the catching-up process and, at last, X_{it} constitutes a vector of relevant control variables that, according to the literature, might affect economic growth.

The explanatory variables considered in vector X_{it} embody determinants of growth (Barro, 1996) and are replicate the ones used by Kumar and Woo's (2010) study regarding this topic: 1) years of secondary schooling and returns to education, as a proxy for human capital to reflect the idea that the abundance of this input attracts investors and promotes innovation and the absorption of ideas that positively influence growth (Grossman and

Helpman, 1991); 2) government size, measured by government consumption as a percentage of GDP, which is negatively correlated with the dependent variable through the disturbing taxation channel; 3) openness to trade, calculated as the sum of imports and exports as a percentage of GDP, justified by its potential to enhance growth due to the increased efficiency in the allocation of resources and the improvement in total factor productivity as a consequence of the diffusion of knowledge (Barro & Sala-i-Martin, 2004); 4) CPI inflation explained by the decline in purchasing power that discourages savings, and by contrast increases the propensity to spend and invest, incrementing aggregate demand, and consequently economic growth, 5) and a dummy variable for banking crises incidence, inspired by Reinhart and Rogoff's (2009) additional conclusions that this phenomenon is usually followed by large increases of public debt.

With that in mind, a logical next step is to acquire the appropriate data that will allow for the estimation of the regression above.

4.2. The data

This dissertation resorts to panel data that permits an evaluation throughout countries and time. When it comes to the former, it includes data for the 19 Euro Zone countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. This seems like a relevant set of countries, given the common institutional and political framework. Thereby, the temporal dimension will range from 1995[2] to 2019, excluding data for the pandemic period to prevent the results from being significantly influenced by such an atypical shock that has yet to be absorbed by the economy.

Subsequently, a set of meaningful variables, which are described in Table 2, are introduced to conduct the econometric approach in the most complete possible way. As stated, such variables are inspired by the literature that was properly disclosed in subsection 4.1., and for the most part, the data was collected form Ameco Database – the annual macroeconomic database of the European Commission's Directorate General for Economic and Financial Affairs. However, since not all the necessary data was available, it was necessary

[2] The data collected starts in 1995 given the introduction of the compatible European accounting framework – the European System of National and Reginal Accounts (ESA).

to turn to other alternative credible sources, such as the Penn World Table, the IMF database, and World Bank database.

Table 2: Variables description

Variable	Description	Unit	Source
GROWTH_PC	Real per capita GDP growth	%	Ameco
DEBT	Public debt	% GDP	Ameco
GDP_1ST	Level of per capita GDP for 1995	€	Ameco
H_CAP	Years of secondary schooling and returns to education	-	Penn World Table
P_CONSUMPTION	Government consumption expenditure	% GDP	Ameco
OPENNESS	Sum of imports and exports	% GDP	Ameco
INFLATION	Inflation	%	World Bank
BANK_CRISIS	Dummy variable, 1 if there was a banking crisis, 0 otherwise	-	World Bank

The descriptive statistics of each explanatory variable can be seen in Table 3 where it is important to highlight some facts. Specifically, concerning per capita GDP growth, we can see that while the mean is 2.38%, the minimum and maximum are, respectively, -14.20% observed in Lithuania right after the crisis, and 24.17% coming from Ireland in 2015. Such a discrepancy exhibits how volatile this variable can be; in fact, prior to 2008, all countries were benefiting from relatively high economic growth that dramatically declined once the crisis stroke. By 2009, the entire cross-section dimension was struggling with negative per capita GDP growth that persisted for some time, specifically, in Cyprus, Greece, Ireland, and Portugal, where there were only signs of recovery after the implementation of the IMF, the EC and the ECB's Economic Adjustment Program. At last, the standard deviation of 3.67%, represents the data's dispersions from its mean. For the debt variable, the value for this indicator is 36.98% because while some countries do not seem capable of keeping their debt levels as a percentage of GDP below 100%, such as, Belgium, Greece, Italy, Cyprus and Portugal, others exhibit incredibly low levels, like Estonia, Latvia, and Luxembourg.

Curiously, the mean for this variable is 62.07% which surrounds the 60% of GDP targeted in the Stability and Growth Pact.

An equally interesting value is the mean of the inflation variable at 2.70% which is close to the ideal level defined by the ECB's monetary strategy for the pursuit of price stability that aims at keeping the rate of inflation below, but close to, 2%[3]. Nevertheless, this is another variable that displayed a great level of variability throughout the period considered, with a minimum of -4.48% attained by Ireland in 2009, and a maximum of 39.65% representing Lithuania's inflation in 1995. Finally, another interesting observation concerns the dummy variable that takes the value 1 whenever a banking crisis strikes, and equals 0 otherwise, in which, the mean is closer to the latter. This value indicates that, while there were some struggles within the banking sector, mostly concentrated between the years of 2008 and 2012, for most of the period at hand the environment was favourable, although with some exceptions, namely, Cyprus between 2015 and 2018 and Slovakia between 1998 and 2002.

Table 3: Descriptive statistics

Variable	Mean	Minimum	Maximum	Std. deviation
GROWTH_PC	2.38	-14.29 (Lithuania, 2009)	24.17 (Estonia, 2015)	3.67
DEBT	62.07	3.80 (Estonia, 2007)	186.20 (Greece, 2018)	36.98
GDP_1ST	20.93	4.40 (Latvia, 1995)	63.4 (Luxembourg, 1995)	13.45
H_CAP	3.07	2.07 (Portugal, 1995)	3.85 (Slovakia, 2019)	0.33
INFLATION	2.70	-4.48 (Ireland, 2009)	39.65 (Lithuania, 1995)	3.57
OPENNESS	144.3936	45.26 (Greece, 2009)	421.43 (Luxembourg, 2004)	88.11
P_CONSUMPTION	19.48	11.9 (Ireland, 2019)	26.20 (Netherlands, 2010)	2.62
BANK_CRISIS	0.14	0.00	1.00	0.35

[3] Although this strategy has been recently altered, as of right now the ECB aims at maintaining inflation at a target of 2%, what was pointed out remains true given the period considered for the data.

4.3. Heterogeneity as a source of bias

There are 7 explanatory variables observed in the model that change according to the country (i) and time (t) considered. However, there are also individual effects that are constant throughout those dimensions and that, by contrast, are not observed but affect the regressors either way (heterogeneity). As seen before, a crucial next step must be to find a solution for this problem, which can rely upon one of the two possible variations of panel data estimation: fixed effects model or random effects model. As the names indicate, the former is a statistical model that assumes the unobserved individual effects to be constant or, in other words, to be fixed, whereas the latter assumes that those levels will vary, i.e., are random.

Theoretically, if the period considered is rather large while the number of countries is restricted, little to no differences can be observed from the use of any mentioned approaches. However, if the contrasting situation is at play, the differences are quite significant. In that case, a fixed effects model would be the most suitable method if the study is centred on the behaviour of a non-random sample, whereas if the set of individuals is randomly chosen, the random effects approach is preferable (Gujarati & Porter, 2009). Empirically, according to Wooldridge (2010), the desirable method depends on the correlation between the observed explanatory variables and the unobserved individual effects. Assuming zero correlation between the two, the proper way to estimate the model is through a random effects model while, by contrast, assuming correlation between the variables, a fixed effects model is preferred.

Therefore, to cater for omitted variable bias, the *Hausman test* is applied, according to which, if the null hypothesis is not rejected, there is no correlation between the unobserved effects and the explanatory variables, and hence, a random effects model would be the most efficient solution; however, if rejected, there is evidence regarding a correlation between the unobserved effects and the explanatory variables, and one should choose a fixed effects estimation. The results of the *Hauman test*, conducted for both cross-section and period fixed effects, are depicted in Table 4. According to the results, given the *p-value* below 0.05, the null hypotheses are rejected, and thus both cross-section and period fixed effects are the preferred solution.

Table 4: Hausman test with least squares methods

Test	Statistic (χ^2)	Probability
Cross-section fixed effects	37.4200	0.0014
Period fixed effects	38.9702	0.0000

Moreover, an alternative approach to fixed effects could be to wield a pooled OLS estimator, that will be efficient if and only if the model does not actually contain unobserved individual effects, and consequently, all statistics associated with this approach are asymptotically valid (Wooldridge, 2010). However, even if intuitively heterogeneity among countries can be anticipated, an empirical *redundant test for fixed effects* is conducted to determine the favourable alternative. This is an F-test that compares the two alternative ways to analyse panel data: pooled OLS (restricted specification) and fixed effects model (unrestricted specification). However, it is important to note that the comparison between both specifications is conducted only for period fixed effects, given that the GDP_1st variable contemplates the same value (level of per capita GDP in 1995) for each country throughout the years, and thus cross-section fixed effects cannot be considered, or the model would be affected by a multicollinearity problem. Table 5 demonstrates such results where, once again, given the probability of the *redundant test*, the null hypothesis is rejected, indicating that a period fixed effects approach must be chosen, since individual fixed effects are not redundant.

It could be argued that the GDP_1st variable only accounts for different levels of economic development, not considering other non-observable sectional fixed effects. As such, accounting for the possibility of conducting the same analysis without this variable, where period and cross-section fixed effects can be considered, an additional *redundant test for fixed effects* is performed for this scenario. The results, that can be found in Table 5, indicate once again that a fixed effects model would be the appropriate approach to be followed.

Table 5: Redundant test for period fixed effects

	Test	Statistic	Probability
Including GDP_1ST	Period fixed effects	9.2839	0.0000
Excluding GDP_1ST	Cross-section fixed effects	5.4533	0.0000
	Period fixed effects	7.8969	0.0000

In the following subsections, the influence of GDP_1st on economic growth will be considered as suggested by Kumar and Woo (2010), so that t-1 dummy variables denoting period fixed effects (λ_t) are added to the model.

4.4. Endogeneity as a sources of bias

Trying to infer a causal relationship between public debt and economic growth is not an easy task. There is always the possibility that we may just be picking up the effects of an unobserved confounder that has a joint effect on both variables for which we are trying to establish a causal relationship. If that is the case, we are in the presence of biased and irrelevant coefficients due to endogenous regressors, that is, explanatory variables that are correlated with the error term.

Often, endogeneity can be the result of omitted variables – factors that are not included in the regression but influence an endogenous variable. If we recall the theoretical and empirical studies described in subsection 2.4., there is strong evidence that public debt ($Debt_{it}$) may be affected by Baumol's Cost Disease – a non-observable factor in the regression. Following this line of thinking, one can hypothesize a possible correlation between this variable and the error term (ε_{it}): $Cov(Debt_{it}, \varepsilon_{it}) \neq 0$, implying that indeed an endogeneity bias may be an issue inherent to the model, which results in the inconsistency of the OLS estimates. To confirm such suspicion, an endogenous test, also known as the *Hausman test of endogeneity* is conducted, in which some steps must be followed: 1) estimate the reduced form by expressing $Debt_{it}$ solely as a function of the exogenous variables, the dependent variable and the respective error terms (equation II); 2) obtain the residuals; 3) plug the reduced form equation into the structural form (equation I) and rearrange it; at last 4) perform a t-test on the coefficient of the estimated residuals – if the coefficients are insignificant (null hypothesis), one can reject the possibility of endogeneity, otherwise it must not be rejected. The results for the *Hausman test of endogeneity* are shown in Table 6 where the endogeneity problem is confirmed, given a null *p-value*.

$$Debt_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 g_{i.t+k} + \alpha_3 Y_{i1} + \lambda_t + \nu_i + \mu_{1t}, \quad t=1,\dots,T; i=1,\dots,N \quad (II)$$

Table 6: Hausman test of endogeneity

Test	Value	Probability
Hausman teste of endogeneity	4.08E+13	0.0000

In section 2, it was explained how multiple authors tried to tackle this obstacle, either through the introduction of a lagged value for the endogenous variables (Cecchetti et al., 2011), by using a GMM dynamic panel regression (Kumar & Woo, 2010) or by instrumenting public debt as a percentage of GDP with the average public debt of the remaining countries (Checherita-Westphal & Rother, 2012). However, for this study, the approach by Panniza and Presbitero (2014) is followed, where the model is estimated through 2SLS with the addition of an instrumental variable that has a combined effect on the dependent and the endogenous variables.

Hence, first it is important to identify the possible observable instrument, Z_{it}, not included in the baseline equation that satisfies two jointly conditions: must be uncorrelated with the error term $Cov(Z_{it}, \varepsilon_{it})=0$, and be correlated with the endogenous variable $Cov(Z_{it}, Debt_{it}) \neq 0$ (Wooldridge, 2010).

According to what was introduced in subsection 2.4., Baumol's Costs suggest a possible instrumental variable to be considered since it was clearly demonstrated that they are theoretically correlated with public debt, due to the increase in government expenditure in the presence of such costs, and with economic growth, because of labour transference to the stagnant sector in detriment of the productive sector. Thus, appropriate next steps should be to understand if there is evidence for the existence of the Baumol's Cost Disease, and if this happens to be the case, create the Baumol variable, i.e, the possible instrumental variable

– Z_{it} – and examine if it meets the necessary criteria mentioned above. If all these steps are validated, it creates an adequate argument for the inclusion of this variable into the growth regression as an instrumental variable to solve the endogeneity problem.

Firstly, we must recall that, the Baumol's Cost Disease was defined as the difference between the ever-increasing per unit costs of the public sector relative to those of the private sector, and that, according to Colombier (2017), this phenomenon is majorly prominent in the health and education sectors, both of which are mostly financed by the government and display relatively low productivity growth but are crucial for economic development. As such, statistical evidence for the existence of the Baumol's Cost Disease will be provided by gathering data from Eurostat for the 19 Euro Area countries ranging from 1995 to 2020, regarding the labour cost index (LCI)[4] and its growth rate for the business economy and that for the education and health average. This index is a short term indicator that assesses labour costs incurred by employers, and these costs include costs for wages, salaries, and non-wage costs, such as, social contributions, in accordance with the Eurostat definition. By using this data, a scatter plot is constructed (Figure 4) to assess the behaviour between the two, where the labour cost growth rate for the business economy is represented in the horizontal axis, the average labour cost growth rate for health and education is displayed on the vertical axis, and the correlation between the two can be observed through the OLS fitted line.

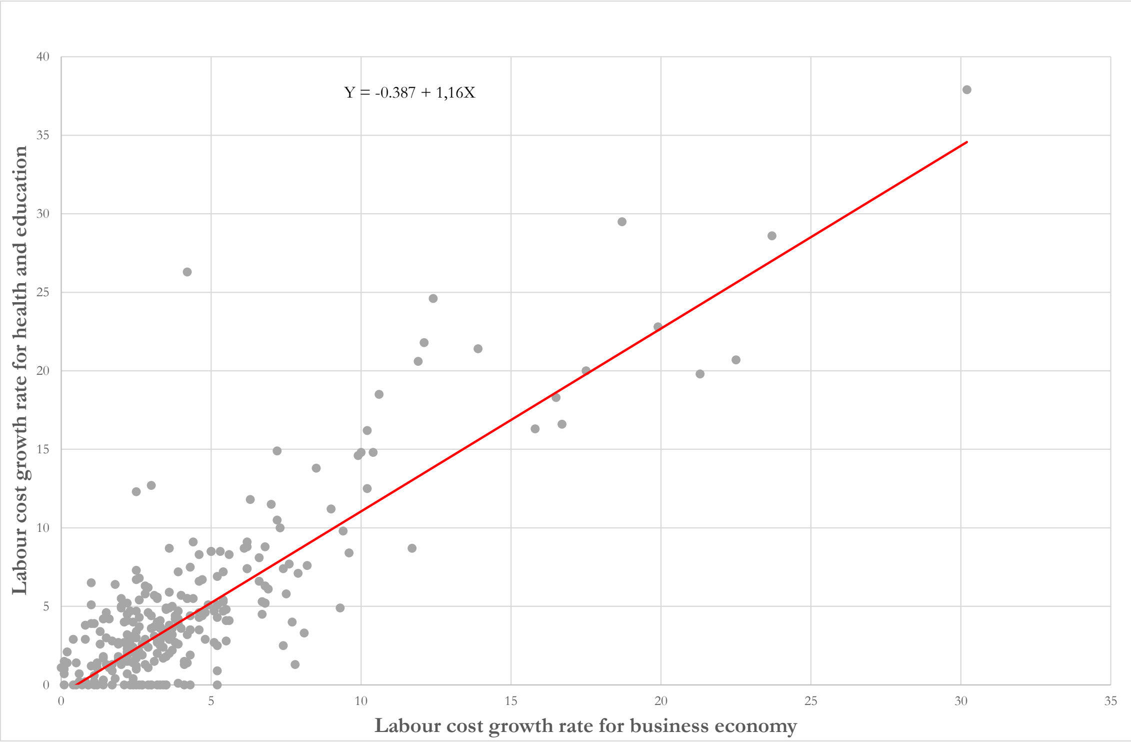
Because the slope of the OLS fitted line is above 1, it is suggested that the labour cost growth rate for health and education tends to increase more rapidly than the labour cost growth rate for the business economy, in other words, the cost of labour for the activities more prominent in the public sector is shown to grow faster than the cost of labour for the business economy thus, there is some indication that the prior may suffer from Baumol's Cost Disease. Thereby, this simple statistical analysis creates a good argument to continue with the evaluation of this possible instrument, jumping to the next step, in which the variable must be created.

For this, the inspiration is drawn from Hartwig (2008) and the difference between the growth rate of nominal wages and productivity per employee for the public sector is considered to create the variable that translates into data the thesis by Baumol (1967), which will be named: Baumol Variable; as in Hartwig's (2008) study. Once again, the data is

[4] Available at https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lc_lci_r2_a&lang=en

collected from Eurostat for the 19 Euro Area countries, including all the years considered in the previous sample – from 1995 to 2019.

Figure 4: Labour cost index of the business economy and education and health sector for the Euro Area, 1995-2000



Source: Eurostat Database.

At last, to make sure this path is feasible, we must determine if the possible instrumental variable meets the necessary conditions: $Cov(Z_{it}, \varepsilon_{it})=0 \wedge Cov(Z_{it}, Debt_{it})\neq 0$. Through a simple analysis of the correlation matrix[5], it is possible to observe a correlation between the endogenous variable, $Debt_{it}$, and the instrument, Z_{it} equal to 0.77 alongside a correlation of zero between the instrument and the residuals, which fulfils both requirements.

By comprehending all of this, it seems likely that the Baumol variable can be used as our instrument, and consequently, we can proceed to solve the endogeneity problem by estimating a 2SLS model with period fixed effects alongside a robust estimator (*white diagonal*

[5] The correlation matrix can be found as an annex.

estimator) that corrects for heteroscedasticity. As the name indicates, such procedure relies on two steps like those presented above*:* 1) estimation of the reduced form, and 2) substitution of the debt variable in the structural form (I) by the reduce form (II) and rearrangement.

4.5. Econometric results for the causal relationship

The econometric analysis conducted until this point has been majorly influenced by two different strands of the literature. On one hand, the baseline model in which the real growth of per capita GDP is regressed on public debt as a percentage of GDP, initial level of real per capita GDP, the index for human capital, government consumption, the degree of openness, inflation, and the dummy variable for banking crisis, is closely in line with Kumar and Woo's (2010) baseline estimates. On the other hand, it differs from this study when it comes to the resolution of the endogeneity problem, in which the inspiration is drawn from Panizza and Presbitero's (2014) work, strongly based in finding a proper instrumental variable that is introduced into the model by a 2SLS estimation method (IV specification), like it has been done here.

The estimations for the 2SLS model with period fixed effects alongside a robust estimator (white estimator) are depicted in Table 7. For comparison, another 2SLS model is additionally estimated but with the use of a lagged value for the endogenous variable as an instrument, and although some disadvantages of this procedure were pointed out by Panizza and Presbitero (2014), this is the most agreed upon manner to solve endogeneity when other instrumental variables cannot be identified. Nevertheless, this estimate is only conducted as a means of comparison between the innovative approach considered throughout this study and the method that one would possibly rely upon given the impossibility of identifying a proper instrument.

Table 7: Estimation results using the 2SLS fixed effects method

Variables	IV Specification	
	(1)	(2)
DEBT	-0.0153 (-2.9103) ***	-0.0175 (-3.1460) ***
GDP_1ST	-0.0824 (-7.0862) ***	-0.0827 (-6.9109) ***
H_CAP	0.5978 (1.4737)	0.5777 (1.3975)
INFLATION	-0.0160 (-0.3406)	0.0276 (0.0384)
OPENNESS	0.0082 (4.3179) ***	0.0078 (4.1318) ***
P_CONSUMPTION	0.1103 (1.8671) *	0.1384 (2.3141) **
BANK_CRISIS	1.4149 (2.6528) ***	1.4705 (2.4996) **
F-statistic	15.4980	15.4870
P-value (F-statistic)	0.0000	0.0000
R^2	0.5330	0.5333
Observations	380	361

Note: Model (1) is the estimation of 2SLS using the Baumol variable as an instrumental variable while model (2) relies upon the first differences of every explanatory variable. The t-student statistics can be found in brackets. Moreover, *, ** and *** indicate, respectively, statistical significance at levels of 10%, 5% and 1%. The complete estimation output is presented as an annex.

The estimates of the 2SLS regression using the Baumol variable as an instrument presented in column 1 of Table 7 are surprisingly close to the results obtained in column 2, where a lagged variable of debt to GDP ratio is considered as an instrumental variable. In fact, there are only small divergences between the two models. For instance, although the significance level for most variables is the same, there is a few exceptions – the P_CONSUMPTION variable – which demonstrates a significance level of 10% in model 1, whereas in model 2 this variable is significant at the 5% level. However, for both estimates, the observed relationship between this variable and economic growth is different from the expected in theoretical terms. There is a suspicion that this variable could be endogenous as well, which would explain these results, but when the model was estimated without the inclusion of this variable, the results were very similar to the ones present here, thus it does not seem likely that this variable could be influencing the results in any meaningful disruptive way.

Another estimate that, at first glance, goes against the expected theoretical negative coefficient is the one for the banking crisis dummy variable, significant at 1% and 5% level for model 1 and model 2, respectively. According to the coefficients, 5 years after a banking crisis, economic growth increases around 1%. This can be justified by the fact that we are considering what the real GDP per capita growth would be 5 years after the crisis, and if we take a closer look at the data, it can be easily observed that, in fact, the maximum number of years in a row that the dummy variable equals 1 is 5 years. Typically, the economic growth experienced 5 years after a crisis is greatly superior to the one exhibited during such phenomenon.

By contrast, the estimate for the coefficient of GDP_1ST, significant at the 1% level in explaining long run economic growth, demonstrates a negative sign as it would be expected. This is in accordance with the theory of the catch-up effect, which hypothesises that poorer economies typically grow more when compared to wealthier ones.

OPENNESS is another significant variable, with a *p-value* smaller than 1%, in line with the idea that a country with a greater level of external commerce improves the efficiency in the allocation of resources and improves total factor productivity due to the diffusion of knowledge (Barro & Sala-i-Martin, 2004).

Furthermore, focusing on the most important variable to examine the link between public debt and economic growth – DEBT – we can see that the corresponding estimate is equally significant in explaining subsequent economic growth, given a *p-value* smaller than 0.001. Hence, the results agree with the existence of a correlation between the two variables that, according to the coefficient's negative sign, is a negative effect, and thus, there is some evidence that higher levels of public debt can be detrimental for subsequent economic growth. Specifically, the estimate suggests that a 1 percentage point increase in public debt as a percentage of GDP is associated with a 0.02 percentage points decrease on real GDP growth, *ceteris paribus*.

As last points of comparison, the R^2 – the statistical indicator that measures the percentage variation in economic growth that is explained by the regressors – is around 0.53

for both models, whereas the *p-value* of the F-statistic for both models reject the hypothesis that all coefficients are equal to zero. These results provide some evidence of the appropriateness of considering the Baumol Variable as a possible instrument, and additionally emphasize the similarities between the models.

However, there is one main difference between the models suggesting that model 1 should be preferred, which is the number of observations. For the model where the Baumol variable is used as an instrumental variable (model 1), the number of observations is 380, greater than the 361 observations in model 2, given the use of the lagged regressor as an instrumental variable that disregards one entire year of data for each of the 19 countries. Hence, because one should aim at analysing the greatest number of observations[6], an argument could be made for model 1 to be the favourable methodology.

Taking all of this into account, the main step of this investigation is concluded, with the results for the 2SLS estimation hitting that increases in the level of public debt ratio can be a significant deterrent for economic growth.

Now, the question to be asked is how rigorous these results are. Although, it has already been confirmed that the instrumental variable, i.e., the Baumol Variable, satisfies both necessary conditions, it is still possible that this variable constitutes a weak instrument. If that happens to be the case, these estimates are only marginally valid and can cause an array of problems, namely, biased results for the coefficients' estimates of the explanatory variables. Thereby, a robustness check is conducted to, hopefully, increase the confidence in these results.

4.6. Robustness of the results

Thus far, the Baumol Variable has been considered an adequate instrumental variable to solve the omitted variable bias. Not only has the instrumental variable fulfilled the two necessary conditions considered by Wooldridge (2010), due to it being uncorrelated with the error term and correlated with the endogenous variable, but also the 2SLS estimation provided the expected results as in accordance with the majorly influential theoretical and empirical literature.

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[6] Note that, by considering k=5 the number of observations is inevitably being shrunk, the reason behind such decision will be explained in subsection 4.7.

Still, a particular problem that might arise whenever one chooses an instrument is the possibility of a weak correlation between the instrument and the endogenous variable and, in that case, the Baumol Variable would be considered a weak instrument. As mentioned above, in the presence of a weak instrument, the 2SLS estimation may be unreliable and the conclusions would be misleading when it comes to answering the question regarding the causal relationship between public debt and economic growth.

Although, there is not a unique agreed upon method to test for weak instruments, the Kleibergan-Paap (K-P) F-test is chosen as to follow the same route as Panizza and Presbitero (2014). This test allows to determine how strong the relationship between the endogenous variable and the instrument is. The result can be seen in Table 8, where it is presented a value of 7.85 for the F-statistic. To understand this result, once again, the rationale by Panizza and Presbitero (2014) is followed, in which the authors based their interpretation on the rule of thumb for 2SLS suggested by Staiger and Stock (1997). This rule states that if the first stage F-statistic for the instrumental variable is smaller than 10, then the instrument can be considered weak. Indeed, the F-statistic is below 10, indicating that the Baumol Variable may be a weak instrument. Curiously enough, the results for the instrument used by Panizza and Presbitero (2014) were also below 10, for which the authors argued that this bias tends to be smaller in exactly identified models – when the number of instruments is equal to the number of endogenous variables – and tends to disappear when the correlation between the instrument and the endogenous variable is greater than one. Although the latter is not the case, the model is, in fact, exactly identified and thus, it could be argued that despite the results of the F-statistic, the weak instrument problem may not be as severe as previously described and the Baumol Variable could still be a potentially adequate instrument to solve the endogenous problem and establish a negative relationship between public debt and economic growth.

Table 8: Weak instrument test

Test Statistic	Value
F-Statistic	7.8520

4.7. Nonlinear relationship

As a final step of this research, the nonlinear relationship between public debt and economic growth is explored. Whereas many studies used a public debt as a percentage of GDP squared variable to address this question, the use of such regressor would implicate the presence of two endogenous variables in the model, given that if the debt variable is endogenous so it would be its square, for which two instrumental variables would have to be identified to satisfy the rank condition for the consistency of the 2SLS estimation. The rank condition is a necessary and sufficient rule for the identification of all estimated coefficients of the reduced form which states that there must be at least as many instruments as the number of endogenous variables (Wooldridge, 2010). And although it could be assumed that if we consider the Baumol Variable to be a valid instrument, so it would be its squared value, there is not enough literature to support such claim, hence an alternative approach is conducted to check for nonlinearities in the model.

To test for nonlinearities, dummy variables are created for different intervals of public debt as a percentage of GDP in accordance with Kumar and Woo (2010) as well as Panizza and Presbitero's (2014) studies. These variables will take a value of one when public debt as a percentage of GDP is within the considered interval and the value of zero otherwise, as properly identified in Table 9. The intervals adopted represent the ones defined by Reinhart and Rogoff (2010) in their study that inspired most of the contemporary literature surrounding the topic.

Table 9: Public debt-to-GDP ratio dummy variables

Variable	Public debt (% of GDP) interval
DUMMY30	1 if Public debt (% of GDP) is below 30%, 0 otherwise
DUMMY30_60	1 if Public debt (% of GDP) is between 30% (inc.) and 60%, 0 otherwise
DUMMY60_90	1 if Public debt (% of GDP) is between 60% (inc.) and 90%, 0 otherwise
DUMMY90	1 if Public debt (% of GDP) is above 90% (inc.) of GDP, 0 otherwise

Both models are estimated with the addition of only three out of the four dummy variables created to avoid the dummy variable trap – multicollinearity between the dummy variables. The eliminated chosen dummy variable contains the levels of public debt as a percentage of GDP below 30%, and, as such, the coefficients of each included dummy are analysed in comparison with the missing one; in other words, given a negative coefficient for one of the intervals, that would mean that economic growth is relatively lower for that interval when compared to a public debt ratio below 30% of GDP. The results can be found in Table 10.

According to the results, most dummy variables are non-significant for model 1 as well as for model 2, and thus no conclusions can be drawn from its coefficients, which makes the definition of a threshold a harder task than intended. Yet, there is one exception: DUMMY30_60 – the dummy variable corresponding to a public debt ratio between 30% and 60% of GDP – with a significance level of 10%. Although this is not ideal, it can be a hint that when public debt levels range between 30% to 60% of GDP, economic growth will be 1 percentage point lower than when compared to lower levels of public debt.

Given the empirical and theoretical analysis conducted in section 2, one could assume that for low levels of public debt (below 30%) the relationship between public debt and economic growth could be positive; however, given the coefficient estimate for DUMMY30_60, it is possible that this relationship turns negative when debt levels are within this interval. However, with these results, it is not possible to precisely conclude anything, and all that can be said is that there is some indication that the threshold effect may be below 60% of GDP.

Table 10: 2SLS fixed effects estimation with the dummy variables.

Variables	IV Specification (1)	IV Specification (2)
DEBT	-0.0229 (-2.0811) **	-0.0335 (-2.9527) ***
GDP_1ST	-0.0858 (-7.2068) ***	-0.0862 (-6.9895) ***
H_CAP	0.7019 (1.7988) *	0.7030 (1.7814) *
INFLATION	-0.0486 (-0.9374)	-0.0066 (-0.0867)
OPENNESS	0.0067 (3.4244) ***	0.0063 (3.1714) ***
P_CON	0.09827 (1.7019) *	0.1205 (2.0399) **
BANK_CRISIS	1.5464 (2.9702) ***	1.6052 (2.7339) ***
DUMMY30_60	-1.0149 (-1.7466) *	-0.7660 (-1.3507)
DUMMY60_90	0.2353 (0.3467)	0.7453 (0.9428)
DUMMY90	0.2299 (0.1969)	1.1310 (0.9733)
F-statistic	14.68150	14.692
P-value (F-statistic)	0.0000	0.0000
R^2	0.5488	0.5492
Observations	380	361

Note: Model (1) is the estimation of 2SLS using the Baumol variable as an instrumental variable while model (2) relies upon the first differences of every explanatory variable. The t-student statistics can be found in brackets. Moreover, *, ** and *** indicate, respectively, statistical significance at levels of 10%, 5% and 1%. The complete estimation output is presented as an appendix.

4.8. Limitations

In any proper research there is a constant need for adaptation considering the multiple limitations that might arise, and this study was no different. Although the causal relationship between public debt and economic growth was established, with this negative link possibly becoming relatively clearer for debt levels between 30% to 60% of GDP, a few limitations must be considered.

First and foremost, we must address the Baumol Variable as an instrument. The results for the econometric analysis, given the use of this variable, were quite satisfactory and quite similar with what would be obtained if the common path of using the lagged endogenous variable as an instrumental variables was followed. However, once a robustness check was conducted, this instrument was proclaimed as weak, even though this problem was minimized given the exact identification of the model. One should not jump to conclusions and disregard this variable completely; in fact, I believe that the possible justification has to do with how the Baumol Variable was constructed – difference between the growth rate of nominal wages and productivity per employee, for the public sector, inspired by Hartwig (2008) – although appropriate and in accordance with what was explained in sub-section 2.4., other authors have diverged from this and indexed Baumol's Costs in different ways. Hence, given the lack of consensus regarding the creation of a Baumol Variable, the method that seemed most appropriate was followed, although there could be other possibilities.

Secondly, the choice to consider the real per capita GDP growth 5 years forward was not completely random, although I find it reasonable to consider the impact of the regressors on the dependent variable a few years forwards since, for example, an increase in public debt occurring in the present moment will only affect subsequent economic growth. There were two main reasons for this choice: 1) most of the literature reviewed inputted K=5, and 2) when lower levels for K were tried, public debt was non-significant, which then could be assumed that there was no causal relationship between the variables yet, the opposite is observed when K equals higher levels, and thus, to avoid any misconceptions, a period of 5 years was considered to study the long run impact of public debt on subsequent economic growth.

At last, the way that the nonlinear relationship was studied was not the ideal one. To concretely define a nonlinear relationship between the two variables, a variable for the square of the public debt-to-GDP ratio could have been added; however, as it was pointed out priorly, that would imply finding an additional instrumental variable as to satisfy the rank condition. Because there was not enough literature to validify if a squared Baumol Variable could have been a valid instrument, it was decided to not include this variable into the model and test for nonlinearities in an alternative way. Hence, the alternative chosen was to include dummy variables representing different debt intervals that, for the most part, were non-significant and unhelpful in identifying the threshold. It is acknowledged that different dummy variables could have been considered, but every attempted at that gave equally inconclusive results, thus it was preferred to stay close the literature from which this dissertation draws its inspiration and estimate the model in accordance with the traditional intervals.

Despite all the limitations, this study was helpful in conducting a popular topic of research in an innovative way, not only did it create an argument for the adequacy of the Baumol Variable as an instrument to solve the endogeneity bias, but it also suggested what the possible relationship between public debt and economic growth may be.

5. Conclusion

Following the economic and financial crisis of 2007-2009, public debt levels increased sharply for most European countries, and as a result, a particular concern came to light: what would be the impact of such levels on economic growth. Although multiple studies have been conducted on the topic, there is not a unanimous conclusion. While part of the literature shows evidence of a nonlinear relationship between public debt and economic growth, the remaining part demonstrates opposite results. For the majority of those who agree with a negative link between the two variables, a nonlinear relationship is observed, with the existence of a threshold effect – a level after which the relationship between public debt and economic growth changes from positive to negative.

Moreover, multiple transmission mechanisms through which public debt can affect economic growth are represented in the literature, specifically Kumar and Woo (2010) pinpoint the following: high long-term interest rates, high distortionary taxation, and inflation. Additionally, Checherita-Westphal and Rother (2010) also recognize investment and productivity as two other important transmission channels.

To add to the literature, this study has provided empirical evidence on the effect of current public debt to GDP ratio on annual 5-year forward real per capita GDP growth, for a panel of 19 Euro Area countries over 25 years (1995-2019). As an additional step, the research accounted for possible sources of bias, namely heterogeneity and endogeneity biases. The heterogeneity bias was resolved in a similar way to most studies done on the topic – by estimating a 2SLS model with fixed period effects alongside a robust estimator (*white estimator*). However, the main contribution of this dissertation was in solving the endogeneity bias through an innovative new path where the influence of the Baumol's Cost Disease on both variables was considered, given its correlation with public debt, due to the increase in government expenditure in the presence of such costs, and with economic growth, because of labour transference to the stagnant sector in detriment of productive ones.

After statistically confirming the effects of the Baumol's Cost Disease, due to the labour cost growth rate for health and education tending to increase more rapidly than the labour cost growth rate for the business economy, the Baumol variable was created in accordance with Hartwig's (2008) research, proceeding to be used as an instrumental variable to solve the endogeneity problem. This variable was thus indexed as the difference between the growth rate of nominal wages and productivity per employee, for the public sector.

As a next step, it was necessary to verify the adequacy of this instrument, where it was demonstrated how the two necessary conditions were satisfied, i.e., the instrument was correlated with the endogenous variable while uncorrelated with the residuals.

Moreover, the above estimation was conducted alongside a 2SLS model with the lagged endogenous variable as an instrument – the most agreed upon manner to solve endogeneity – as a mean of comparison that demonstrated similar results. That is, a negative relationship between public debt and economic growth.

However, it is important to recognize that choosing an instrument is never an easy task, and when a robustness check was considered, the Baumol Variable was identified as a weak instrument, meaning that the 2SLS estimation might be unreliable, although, it can be argued that this problem is minimized in exactly identified models, which is the case, and thus the Baumol Variable, although not ideal, can still be considered adequate.

Finally, there is some small evidence of a possible nonlinear relationship, with debt levels ranging from 30% to 60% of GDP having a significant negative effect on economic growth when compared with lower levels.

All being said, a clear implication of these results is that countries with higher levels of public debt should aim at keeping their debt levels under control as to not suffer the consequences of lower economic growth, as empirically demonstrated. Moreover, the definition of an interval for the threshold does not imply that authorities should stabilize debt levels close to the limit, instead, public debt should be maintained well below this value, since we never know when an exogenous shock will hit.

Lastly, it should be emphasized how throughout this dissertation some evidence has been shown for the adequacy of the Baumol Variable as an instrument to solve the problem of endogeneity as an alternative approach to the common path. Hence, I believe there is an array of future research possibilities that could dive deeper into this hypothesis.

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Annexes

EViews 10 Estimation outputs

Correlation matrix

	DEBT	GDP_1ST	H_CAP	INFLATION	OPENNESS	BANK_CRISIS	P_CONSUM	RESID
DEBT	1.000000	0.060852	-0.305262	-0.300201	-0.471602	0.122693	0.200281	-0.030565
GDP_1ST	0.060852	1.000000	-0.051912	-0.294879	0.568573	0.008006	-0.208693	-0.028102
H_CAP	-0.305262	-0.051912	1.000000	-0.032374	0.176823	0.018930	0.229428	-0.004176
INFLATION	-0.300201	-0.294879	-0.032374	1.000000	-0.002932	0.185725	0.143583	0.046119
OPENNESS	-0.471602	0.568573	0.176823	-0.002932	1.000000	0.059320	-0.369361	0.017837
BANK_CRISIS	0.122693	0.008006	0.018930	0.185725	0.059320	1.000000	0.203916	-0.007287
P_CONSUM	0.200281	-0.208693	0.229428	0.143583	-0.369361	0.203916	1.000000	0.025383
RESID	-0.030565	-0.028102	-0.004176	0.046119	0.017837	-0.007287	0.025383	1.000000
BAUMOL	0.772549	-0.213787	-0.067262	0.677899	0.028080	0.087614	0.011464	0.001717

IV Specification (1) estimated with 2SLS – period fixed effects.

Dependent Variable: GROWTH_PC(5)
Method: Panel Two-Stage Least Squares
Date: 07/13/21 Time: 12:53
Sample (adjusted): 1995 2014
Periods included: 20
Cross-sections included: 19
Total panel (balanced) observations: 380
White diagonal standard errors & covariance (no d.f. correction)
Instrument specification: C H_CAP INFLATION OPENNESS BANK_CRISIS GDP_1ST BAUMOL P_CONSUMPTION
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.629689	1.369834	-0.459683	0.6460
DEBT	-0.015326	0.005266	-2.910303	0.0038
GDP_1ST	-0.082434	0.011633	-7.086211	0.0000
H_CAP	0.597815	0.405644	1.473742	0.1414
INFLATION	-0.015978	0.046906	-0.340637	0.7336
OPENNESS	0.008153	0.001888	4.317893	0.0000
BANK_CRISIS	1.414942	0.533372	2.652822	0.0083
P_CONSUMPTION	0.110324	0.059088	1.867095	0.0627

Effects Specification

Period fixed (dummy variables)

R-squared	0.533037	Mean dependent var	2.030402
Adjusted R-squared	0.498643	S.D. dependent var	3.805068
S.E. of regression	2.694239	Sum squared resid	2562.399
F-statistic	15.49800	Durbin-Watson stat	1.171485
Prob(F-statistic)	0.000000	Second-Stage SSR	2562.399
Instrument rank	27	Prob(J-statistic)	0.091114

IV Specification (2) estimated with 2SLS – period fixed effects.

Dependent Variable: GROWTH_PC(5)
Method: Panel Two-Stage Least Squares
Date: 07/13/21 Time: 18:36
Sample (adjusted): 1996 2014
Periods included: 19
Cross-sections included: 19
Total panel (balanced) observations: 361
White diagonal standard errors & covariance (no d.f. correction)
Instrument specification: C DEBT(-1) GDP_1ST H_CAP INFLATION
P_CONSUMPTION OPENNESS BANK_CRISIS
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.214859	1.461242	-0.831388	0.4063
DEBT	-0.017506	0.005564	-3.146019	0.0018
GDP_1ST	-0.082680	0.011964	-6.910926	0.0000
H_CAP	0.577735	0.413407	1.397496	0.1632
INFLATION	0.027629	0.071871	0.384421	0.7009
P_CONSUMPTION	0.138425	0.059819	2.314054	0.0213
OPENNESS	0.007808	0.001890	4.131844	0.0000
BANK_CRISIS	1.470545	0.588316	2.499585	0.0129

Effects Specification

Period fixed (dummy variables)

R-squared	0.533382	Mean dependent var	1.893673
Adjusted R-squared	0.498560	S.D. dependent var	3.832046
S.E. of regression	2.713564	Sum squared resid	2466.749
F-statistic	15.48700	Durbin-Watson stat	1.185263
Prob(F-statistic)	0.000000	Second-Stage SSR	2452.258
Instrument rank	26		

IV Specification (1) estimated with 2SLS with the inclusion of dummy variables – period fixed effects.

Dependent Variable: GROWTH_PC(5)
Method: Panel Two-Stage Least Squares
Date: 07/13/21 Time: 13:59
Sample (adjusted): 1995 2014
Periods included: 20
Cross-sections included: 19
Total panel (balanced) observations: 380
White diagonal standard errors & covariance (no d.f. correction)
Instrument specification: C H_CAP INFLATION OPENNESS BANK_CRISIS
GDP_1ST BAUMOL P_CONSUMPTION DUMMY30_60 DUMMY60_90
DUMMY90
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.266794	1.385497	0.192562	0.8474
DEBT	-0.022884	0.010996	-2.081116	0.0381
GDP_1ST	-0.085800	0.011906	-7.206723	0.0000
H_CAP	0.701871	0.390195	1.798771	0.0729
INFLATION	-0.047594	0.050775	-0.937360	0.3492
OPENNESS	0.006727	0.001964	3.424429	0.0007
BANK_CRISIS	1.546441	0.520650	2.970212	0.0032
P_CONSUMPTION	0.098333	0.057777	1.701946	0.0897
DUMMY30_60	-1.014918	0.581067	-1.746644	0.0816
DUMMY60_90	0.235271	0.678619	0.346691	0.7290
DUMMY90	0.229925	1.167683	0.196907	0.8440

Effects Specification

Period fixed (dummy variables)

R-squared	0.548832	Mean dependent var	2.030402
Adjusted R-squared	0.511449	S.D. dependent var	3.805068
S.E. of regression	2.659606	Sum squared resid	2475.727
F-statistic	14.68150	Durbin-Watson stat	1.207129
Prob(F-statistic)	0.000000	Second-Stage SSR	2475.727
Instrument rank	30	Prob(J-statistic)	0.103378

IV Specification (2) estimated with 2SLS with the inclusion of dummy variables – period fixed effects.

Dependent Variable: GROWTH_PC(5)
Method: Panel Two-Stage Least Squares
Date: 07/13/21 Time: 19:22
Sample (adjusted): 1996 2014
Periods included: 19
Cross-sections included: 19
Total panel (balanced) observations: 361
White diagonal standard errors & covariance (no d.f. correction)
Instrument specification: C DEBT(-1) GDP_1ST H_CAP INFLATION
P_CONSUMPTION OPENNESS BANK_CRISIS DUMMY30_60
DUMMY60_90 DUMMY90
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.144541	1.490089	-0.097001	0.9228
DEBT	-0.033505	0.011347	-2.952727	0.0034
GDP_1ST	-0.086222	0.012336	-6.989527	0.0000
H_CAP	0.703021	0.394647	1.781394	0.0758
INFLATION	-0.006557	0.075649	-0.086674	0.9310
P_CONSUMPTION	0.120519	0.059080	2.039938	0.0421
OPENNESS	0.006272	0.001978	3.171357	0.0017
BANK_CRISIS	1.605174	0.587128	2.733943	0.0066
DUMMY30_60	-0.766081	0.567187	-1.350669	0.1777
DUMMY60_90	0.745348	0.790585	0.942781	0.3465
DUMMY90	1.131088	1.162157	0.973266	0.3311

Effects Specification

Period fixed (dummy variables)

R-squared	0.549198	Mean dependent var	1.893673
Adjusted R-squared	0.511178	S.D. dependent var	3.832046
S.E. of regression	2.679205	Sum squared resid	2383.142
F-statistic	14.69183	Durbin-Watson stat	1.223911
Prob(F-statistic)	0.000000	Second-Stage SSR	2361.002
Instrument rank	29		