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關於外債和經濟增長的論文

Essays on External Debt and Economic Growth

Student: Oscar René Vargas Delgado

Advisor: Wen-Chieh Wu

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Abstract Chinese

本文探討了政府負債與經濟成長之間的長期關係。為了研究兩者之關係，我們考慮了經濟成長的多元要素之廣泛性，以及專業文獻呈現之錯綜複雜的觀點，比如其中的逆向因果關係和內因性，因此，我們將從數十年間之跨國與國內兩層面進行探討。

我們利用 10 個迴歸模型對 103 個國家的縱橫資料進行分析以及對美國進行時間序列分析。我們在跨國分析的部分，包含運用了追蹤資料分量迴歸分析、非動態縱橫資料門檻迴歸分析以及分流樣本門檻迴歸分析以呈現舉債對所有國家之經濟成長在統計上的負面影響。同時，在國內分析的部分，我們利用了分量迴歸分析、滯後變數模型分析和轉折點門檻迴歸模型進行分析。

整體而言，我們的實證結果揭示了舉債對長期經濟成長之有害關聯。在跨國研究的部分中隱含，舉債因該經濟體之經濟成長率，對經濟成長有著錯綜複雜的影響，而當該國舉債佔 GDP 比率超過 92.15%時將產生不良影響，超過該門檻之影響程度則取決於該國體制特徵。

首先，我們從實證去觀察舉債與經濟成長之長期關係，並著重於舉債在不同經濟成長區段之影響。事實上，這個概念架構是使人們能夠不需運用變數下，理解政府舉債額度如何影響該國的人均國內生產毛額之成長。

我們運用模型 1，固定效用分析之分量迴歸模型，其中包含兩種不同制度變數，即民主程度與制度品質。首先，經濟成長受到舉債影響的程度因不同經濟成長率而異。再者，其顯著性也因其百分

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位數有所不同。我們證實了舉債在 1%的顯著水準下在第 25 百分位數時，對經濟成長造成限制。

而後，我們運用模型 2，靜態追蹤資料中的門檻效應，來測試舉債水準對人均 GDP 增長的非線性影響，以識別在兩個變數在不同狀態中所呈現之不對稱關係。我們發現在有制度變數的模型 2（9.26、48.9、125.22）中，舉債和人均 GDP 之間存在三個門檻效果，而舉債在其他狀態中均限制了人均 GDP 之成長。

接著，我們使用模型 3，制度品質的樣本分流與門檻評估，以及模型 4，對民主程度樣本分流與門檻評估衡量舉債，以呈現制度之異質性與舉債成長之關聯。在對制度面之評估結果中得出，對於舉債規模佔國內生產毛額高於 92.15%以上的國家，制度對於舉債之影響非常關鍵。在兩模型中，制度品質與民主程度低落的國家承受了舉債負擔帶來的負面影響，但在制度完善的國家，其制度對舉債增長的影響尚無定論。

在國內研究的部分，我們的分量迴歸分析結果指出，舉債對經濟成長的影響，在所有不同成長百分比率並不一致；債務成長與人均國內生產毛額呈現共整合，且另外在短期和長期具有變換的趨勢。此外，我們觀察到舉債因其成長率對經濟成長有著不對等的影響，當門檻值為 2.5%時，低於門檻值對經濟成長有正向影響，當負債成長率高於 2.5%時，舉債將造成經濟成長的限制。

隨後，在模型 5，非線性自我迴歸分配遞延模型區間測試，舉債之變化對國內生產毛額變化之影響被重新檢視。相同地，非線性自我迴歸分配遞延模型區間測試法執行之共整合檢定證實了共整合

DOI:10.6814/NCCU202101114

的存在。此外，其短期和長期影響在兩個回歸模型中具有顯著性差異並趨於收斂。建模結果也顯示，經濟成長在短期內會受到舉債的刺激，但在長期會受其限制。總而言之，短期的影響是正面的；但在長期下將慢慢收斂，對人均 GDP 成長造成 37.3%的反效果。

接著，我們使用模型 6，時間序列分量迴歸分析法來估算舉債對整體成長率分佈之影響。結果顯示，負債成長對人均 GDP 在各項條件百分位數上有著各種影響。我們的模型顯示，低百分位數和高百分位數在所分析的變數之間產生了正向的交互關係。舉例來說，在第 90 個百分位數的正面影響在 10% 的顯著水準時具有顯著性差異。同時，在第 30 到 60 個百分位數之範圍，舉債對赤字率的成長具有負面的非統計性結果。

最後，本論文運用 Fong、Huang、Gilbert 和 Permar（2017 年）發表的轉折點門檻迴歸分析，探討政府舉債之成長對人均 GDP 成長之非線性影響。負債成長具有門檻區隔效應，在模型 7 轉折點門檻迴歸分析：門檻區隔效應， 有 2.5%之機率轉換狀態。在舉債低成長時期，舉債可以刺激經濟成長；然而，在高成長時期，舉債將造成負面影響降低經濟成長。模型 8、9 和 10 則證實，舉債不具有門檻轉折、連續或區隔效應。

關鍵詞：公共債務，經濟增長，分位數回歸，閾值回歸，自回歸分佈滯後模型，閾值變化點回歸

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Abstract English

This thesis explores the long-term relationship between the changes government indebtedness and changes in economic growth. To examine this relationship, we used a cross-country and within-country dimension over several decades that considers a comprehensive variety of economic growth factors and estimation complications exposed in the specialized literature, such as the reverse causality and endogeneity.

We use ten models to analyze panel data of 103 countries and time series analysis of the United States of America. Our cross-country analysis involves using panel quantile regression, threshold regression for non-dynamic panels, and threshold regression with sample splitting to demonstrate the negative statistical impact of debt on economic growth in all countries. Meanwhile, we use quantile regression, autoregressive distributed lag model, and the threshold change-point regression model for within-analysis.

Generally speaking, our empirical results expose a harmful association between changes in debt in long-term economic growth. The cross-country study suggests that debt has a heterogenous impact on economic growth depending on the economy's growth rate, debt has adverse effects above a 92.15% GDP ratio, and the impact above the threshold will depend on the institutional characteristics such as institutional quality or democratic qualities of the countries.

First, we empirically investigate the long-run association of debt on economic growth, considering its impact on different growth ranges. In effect, this framework enables one to comprehend how the governmental amount of debt influences a country’s gross domestic product per capita growth beyond the usage of the means of such variables.

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We applied Model 1 Quantile Regression with Fixed Effects analysis which includes two institutional variables, namely democratic quality and institutional quality. Firstly, the impact magnitude of debt on economic growth differently depending on the rate of its economic growth. Secondly, its significance varies, too, depending on the percentile. We confirm that debt constrains economic growth at the 25th percentile with a 1% significance level.

Later, we employ Model 2 Threshold effects in non-dynamic panels to test the non-linear effects of debt levels on GDP per capita growth to identify the different regimes exposing an asymmetrical relationship between both variables. We find a three threshold effect between debt and GDP per capita in Model 2 (9.26, 48.9, 125.22) with institutional variables. Debt constrains GDP per capita growth in all regimes except in the third regime.

Next, we evaluate the debt in a Model 3 Sample Splitting and Threshold Estimation for Institutional Quality and Model 4 Sample Splitting and Threshold Estimation for Democratic Quality to address the heterogeneity of institutions in the debt growth link. The institution's estimation results reveal that the impact is of great significance in determining the effect of debt in countries that have debt magnitudes measured to the gross domestic products above 92.15%. In both models, countries with the low institutional quality and democratic quality suffer from the negative impact of debt overhang, but in countries with strong institutions, the effect of debt on growth is inconclusive.

Regarding the within-country study, our quantile regression results indicate that the impact on growth is not uniform across the different growth percentiles; debt growth is cointegrated with GDP per capita and

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has other effects in the short term and long term with a tendency of conversion. Additionally, we observed debt having an unequal impact on growth depending on the debt growth rate, with a threshold point at 2.5%, where below the threshold point, the effects on growth are positive, and when the debt growth rate is higher than 2.5% debt constrains economic growth.

Later, the gross domestic product changes caused by changes in debt are revisited in the short and long term in Model 5 Autoregressive-Distributed Lag Bounds Testing Approach to Cointegration. Again, the autoregressive distributed lag model bound test of cointegration confirms the existence of cointegration. Moreover, the short-term and long-term effects are statistically significant, which tends to converge in both regression models. The modeling results show that the economy per capita is stimulated by debt in the short term but limited by debt in the long term. Consequently, short-term effects are positive; but slowly converge to long-term adverse effects on growth at 37.3%.

Next, we used the Model 6 Time Series Quantile Regression approach to estimate the effects of debt on the entire growth rate distribution. Results suggest that debt growth effects on GDP per capita are heterogenous across conditional percentiles of GDP per capita growth. Our models reveal that the low and upper percentiles create positive interactions among the variables analyzed. For example, the positive impact on the 90^{th} percentile was statistical significance at a 10% significance level. Meanwhile, around the 30 to 60^{th} percentile, Debt-to-GDP growth has a negative non-statistical outcome.

Finally, this dissertation examines the non-linear impact of Public Debt Growth on GDP per capita growth using the threshold change-point

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regression developed by Fong, Huang, Gilbert, and Permar (2017). Debt growth has a threshold segmented effect with a regime switch at 2.5 percent in Model 7 Change point threshold regression: Threshold Segmented Effects. In a low debt growth regime, debt can stimulate economic growth; however, in a high debt growth regime, debt has an adverse impact reducing economic growth. Models 8, 9, and 10 confirm that debt does not have the threshold hinge, step, or stegments effects.

Key words: Public Debt, Economic Growth, Quantile Regression, Threshold Regression, autoregressive distributed lag model, Threshold Change Point Regression

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Dedication

To my mother, Myriam Patricia Delgado Montalván and father, Oscar-René Vargas Escobar. She not only brought me to this world but also inspired me and supported me throughout my life. My dad showed me the academic world, and despite the dangers he is currently facing, he still fights with his ink and pen to make my country a better place.

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The completion of this research is the product of a long and sometimes difficult journey. This research has benefited from the help of several individuals who contributed and who, without them, the doctoral thesis would indeed not have taken place. Some have been in the foreground, and some others in the background.

Firstly, I acknowledge the people in the foreground, my supervisor Wen-Chieh Wu. Firstly as a friend who, through the years, helped me during my stay in Taiwan and his understanding with my full-time jobs and fatherhood. Secondly, as a teacher and mentor for his support and guidance through the years have trained me as a researcher. I am thankful for his help in the development of ideas to reach the product you read today.

I want to thank professor Hsin-Yi Lin that contributed significantly to the initial stages of the research. She is a passionate researcher, open to helping to solve all the statistical challenges I faced. I wish to acknowledge the suggestions, criticism, and comments I received from Frank Peng.

I am also thankful to my friend Daniel Wilkinson and my brother Rene Alberto Vargas for allowing me to receive all their invaluable input and comments proofreading the final draft of the thesis.

Several people helped in the background intentionally to this dissertation.

I would like to thank my wife, Lidiia Pulova, and children Oscar René Vargas Pulov and Natalia Patricia Vargas Pulova, for their love and sacrifices. Thank you, Lidia, for your help and for taking care of the kids during my absence.

DOI:10.6814/NCCU202101114

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DOI:10.6814/NCCU202101114

TABLE OF CONTENTS

DOI:10.6814/NCCU202101114

List of Figures

List of Tables

DOI:10.6814/NCCU202101114

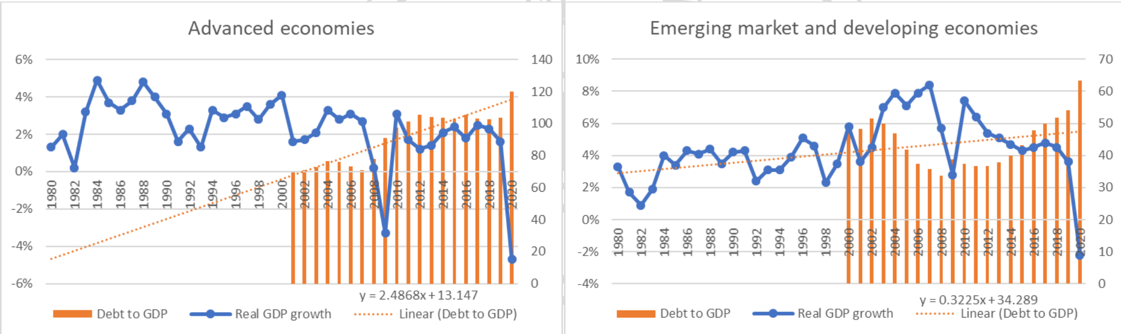
List of Models

DOI:10.6814/NCCU202101114

1. Introduction

Many countries enlarged debts to mitigate the negative external shock of the COVID-19 on economic activity. The usage of fiscal and monetary expansionary policies smoothened the economic downturn. It prevented the economy's collapse, but it also contributed to an upsurge in public debt magnitude measured to the gross domestic product in many countries. As a result, it exposed that many advanced and developing countries had accumulated significant unprecedented debt levels (Fund, 2020b). See Figure 1 below.

Figure 1 Debt accumulation and GDP per capita growth



Source: Author's Elaboration based on data by **IMF DataMapper 2020**

The International Monetary Fund calculated 2020 government deficits increased on average 11.7 percent of GDP for advanced economies and 9.5 percent for Emerging market and developing economies (EMDE). From 2011 to 2020, advanced economies' debt levels grew from 69.7 percent to 120.1 percent. Meanwhile, EMDEs debt rose from 47.3 to 63.3 percent to GDP (Fund, 2020a).

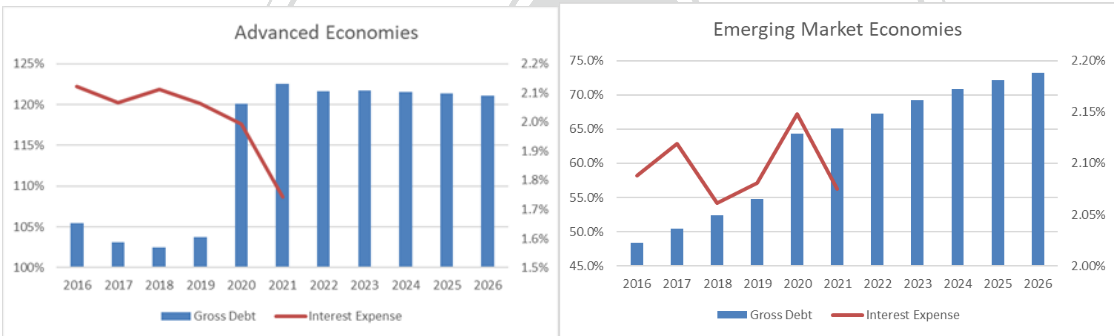
Today, this debt builds up is happening in an ambiguous environment. On one side, countries are going through slower growth rates compared to past decades (Kose, Nagle, Ohnsorge, & Sugawara, 2021). The ongoing policy support to overcome the adverse effects of COVID-19 will continue to push debt levels higher depending on the divergent recovery paths (Fund, 2021b).

DOI:10.6814/NCCU202101114

Additionally, the dept-to-GDP level continues to increase until 2025, reducing debt to 2026 in advanced economies (Fund, 2021a).

On the other side, low interest rates on debt have been widespread in advanced economies and emerging market and developing economies. Changes in financial markets and the upsurge of regional banks have contributed to the growth of debt levels and decreased the spread of debt bonds between advanced and emerging economies. We can appreciate that long-term interest rates on government bond yields are currently low, and at the moment, the interest expense of debt on economies is also low (Kose et al., 2021). See Figure 2.

Figure 2 Advanced Economies and Emerging market and developing economies, Interest Expense and Government Debt, 2016–26



Source: Author's Elaboration based on data by Fund (2021a). Percent of GDP; Debt-to-GDP, left scale; Interest expense, right scale. Projections 2021 to 2026

For all the reasons mentioned previously, economists are re-evaluating the recent history of debt accumulation and the likelihood of debt crisis (Carmen M. Reinhart & Rogoff, 2009), financial problems (Kalemli-Özcan, Reinhart, & Rogoff, 2016; Koh, Kose, Nagle, Ohnsorge, & Sugawara, 2020; Carmen M. Reinhart & Rogoff, 2015), and high debt constraints on economic growth over the long term (Carmen M. Reinhart & Rogoff, 2009, 2010).

The link between debt and growth evolved from evaluations from past experiences of debt crises. Since the 1980s, there have been three major debt

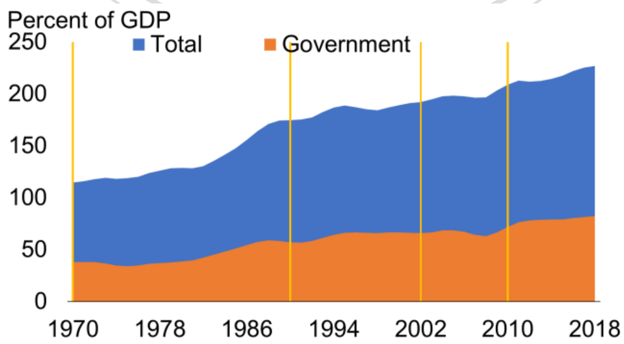
DOI:10.6814/NCCU202101114

crises; debt built-ups of the past unfolded into three crises: 1982s, 1991, and 2009. Kose et al. (2021) categorized these three debt accumulations into four periods. See Figure 3 Global General Government Gross Debt. The first crisis impacted mainly in Latin America, Low-income countries, and Sub-Saharan African countries and was primarily the result of external government borrowing during the 1970s.

Research focus on external debt as the only cause of the debt crisis changed in the second crisis. The second crisis during the 1990s and 2000s impacted East Asia and the Pacific region and governments in Europe and Central Asia. It was caused by the private sector and governments that issued short-term debt in foreign currency.

Typically, debt was only associated with developing countries, but the third crisis changed this view. The last situation in 2009 mainly occurred in Europe. The nationalization of private debt caused it to save several banks and corporations in distress because of excessive borrowing. Currently, we are in the fourth wave of debt accumulation, and economists are closely examining the phenomena to avoid economic problems in the future.

Figure 3 Global General Government Gross Debt



Source: Author’s Elaboration based on data by Kose et al. (2021). Yellow vertical lines represent the start of debt accumulation in 1970, 1990, 2002, and 2010.

DOI:10.6814/NCCU202101114

For this reason, our study goal is to address three critical problems found in the economic literature. Firstly, mixed results of the changing values of gross domestic product per capita are associated with changes in debt levels.

Secondly, the lack of empirical studies analyzing whether there are variations from the mean debt values impacting economic growth. Consequently, in chapter 4, we use quantile regression to estimate an entire set of debt effects to economic growth at different percentiles of the conditional distribution of growth. We build on the idea of possible heterogeneity of debt and growth depending on the strength of GDP growth.

Lastly, the problem of threshold model identification, the none comparability among models, and the lack of characterization of the debt trajectory before and after the change-point, threshold point. Under those circumstances, we employ the technique proposed by Fong et al. (2017) to determine the optimal type of threshold model and the tipping point. We use the CHNGPT threshold modeling technique to find the debt-to-GDP thresholds from which debt constrains economic growth but identify and evaluate which of the five different threshold effects is best suited to the country analyzed in an endogenous manner.

The doctoral dissertation is organized as follows. The second section conducts a concise review of the recent relevant literature that study in detail the changes of economic growth per capita explained by the effects of governmental debt. The third section describes data and methodologies conducted to test how its governmental debt influences a country's gross domestic product per capita growth to its gross domestic product, variable selection of data, model specification, and estimation strategies applied. The fourth and fifth section presents the quantitative results and discussions. The last section gives the conclusion.

DOI:10.6814/NCCU202101114

DOI:10.6814/NCCU202101114

2. Literature Review

Initially, the study of debt and economic growth was not made explicit until several studies identified high debt ratios were correlated with several financial problems faced by developing countries in Latin America and Africa in the 1980s. Dornbusch and de Pablo (1990) linked that a high debt burden caused high inflation, macroeconomic instability lowering investment, and slower economic growth in Argentina.

Similar evidence was provided by Sachs (1989); Sachs and Williamson (1985), analyzing data from developing countries that debt undermined investment and that the high debt-service ratios impeded economic growth. Similarly, Cohen (1993) found that for every increase in debt-service to GDP paid to creditors, reduced domestic investment to GDP was reduced 0.3 percent.

Meanwhile, Alesina and Guido (1989) linked high debt levels caused political instability because of the outflow of funds to creditors, and governments made social spending cuts that generated public discontent and anti-governmental rallies opposing austerity measures that caused a dilemma for the incumbent government, on one side keep popular support and repay the creditor. Additionally, Pastor (1990) linked debt to capital flight that found economic agents transferred their assets abroad to avoid appropriation from governments' economic policy measures to raise funds to pay their growing financial obligations to creditors.

The discussion of the influence of the Debt-to-GDP ratio on GDP per capita growth evolves from a theoretical perspective. Mankiw and Elmendorf (1999) argue in favor of the short-term, the economy is Keynesian and debt would rise aggregate demand government expenditure financed by debt would increase income and household expenditure contributing to GDP per capita growth.

DOI:10.6814/NCCU202101114

Theoretically, endogenous economic growth models debt constraints GDP growth(Bräuninger, 2003, 2005; Romer, 1986; Saint-Paul, 1992). Alfred Greiner (2012b) showed theoretically using an endogenous economic growth model how a high debt ratio crowds out investment and reduces long-term economic growth because non-productive public spending would lower the price of private capital and labor supply in a way that diminishes household savings and investment.

Meanwhile, there are cases where debt may increase economic growth in the long term. Firstly, governmental transfers financed by debt would not impact economic growth. Meanwhile, Minea and PatrickVillieu (2009) expose theoretically two scenarios where debt would not harm growth using the endogenous growth model. Secondly, debt would promote growth in a country with "low" equilibrium (with low growth and high public debt). Lastly, when government offsets the extra debt burden without reductions in public investment.

Most studies focus on examining the long-term effect of debt on economic growth, but we found limited studies of debt and short-term effects on economic growth (Baum, Checherita-Westphal, & Rother, 2013; Gómez-Puig & Sosvilla-Rivero, 2017, 2018), and we believe this is due to the predominant view that short-term the economy is Keynesian (Elmendorf & Mankiw, 1999).

Looking at Cristina Checherita-Westphal and Philipp Rother (2012) short-term estimates, two facts stand out. First, debt in linear form did not show relevant results, but debt in the quadratic form of debt to check the non-linear effects displays statistically significant harmful effects results using Ordinary Least Square Fixed effects (FE) models and Instrumental variables (IVREG) models.

Secondly, the results are consistent in their cross-country and within-country estimates of the twelve-European Union countries using the Euro currency. In data Cross-Country Studies debt harmed growth at 97 percent debt

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magnitude measured to the gross domestic product using OLS and 93 percent using IVREG debt-to-GDP ratios; meanwhile, the debt thresholds for the within-country study found that debt had damaging effects between 86 to 114 debt to GDP depending on the country. Meanwhile, Gómez-Puig and Sosvilla-River (2015) found that mixed results: in some countries in the European Monetary Union, debt caused positive impact and, in other countries, adverse effects.

There is essential evidence that debt has adverse long-term effects on economic growth (Rugy & Salmon, 2020). These examinations have examined cross-country (Masuch, Moshammer, & Pierluigi, 2017; Swamy, 2020) and within-country relationships (Bentour, 2020; B. E. Hansen, 2017; Spilioti & Vamvoukas, 2015).

The predominant view, based on cross-country studies, is that debt at high levels has an adverse effect (Panizza & Presbitero, 2013), and at low levels, it has no effect on growth (Aguiar & Amador, 2014); see Whajah, Bokpin, and Kuttu (2019); Yang and Su (2018); Yolcu Karadam (2018) or non-conclusive statistical link between debt and growth (Eberhardt, 2019; Panizza & Presbitero, 2014; Pescatori, Sandri, & Simon, 2014)

In contrast to cross-country studies, more positive changing values of gross domestic product per capita associated with changes in debt levels can be seen in within-country studies. A substantial amount of the empirical literature using time series finds a robust negative relationship between debt levels and real growth (Panizza & Presbitero, 2013; Salmon & de Rugy, 2020), significantly above a certain threshold level no causality. Few studies show a positive effect in some countries (Bentour, 2020; Masuch et al., 2017)

Comprehension of the link between Debt-to-GDP ratio and GDP per capita growth progressed due to its continuing examinations. First, scholars focused on

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the theoretical and statistical appreciation of the association (Dornbusch & de Pablo, 1990). From a theoretical point of view, as Krugman (1988) argued, high public debt levels may constrain growth, harming investment caused expectations of higher taxes or other confiscatory policies that may affect their wealth. Meanwhile, Friedman (1978) exposed that debt discourages private investment.

Next, studies paid attention to establish a correlation between both variables using linear regression models. These studies mainly focused on establishing that debt and growth were correlated. To understand how debt affects the long-term effect of debt on economic growth, studies have used several modeling techniques: linear models (Bal & Rath, 2014; Gong, Greiner, & Semmler, 2001; Spilioti & Vamvoukas, 2015) and non-linear models (Yolcu Karadam, 2018).

Initially, economists used linear models. The usage of the OLS technique, which addressed the heterogeneity problems, was the application of OLS fixed effects panel regression that permits the model to control all time-variant country-specific factors (Greene & Villanueva, 1991). Equally important, they solved the heterogeneity problem by introducing a lagged explanatory variable of the initial level of debt to GDP per capita un a dynamic panel specification (Savvides, 1992)

Cunningham (1993) ran an OLS regression model for low-income countries model and found negative relevant results for his sample of 35 sub-Saharan countries in his examination period 1971 to 1979 but no robust results for the 1980s. Additionally, its OLS results show 1980 to 1990, and results were susceptible to the equation used, country sample selection, period, and explicative variables.

One possible cause of endogeneity is the reverse causality between economic and level of public debt ratios. Since the debt variable is measured as a

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relation with GDP, there is a possibility that low economic growth may lead to higher debt accumulation for reasons unconnected to debt (Mencinger, Aristovnik, & Verbic, 2014). `empirical challenge, and researchers began to apply instrumental variable regression to solve the endogeneity as a result of reverse causality. Most studies examined implement lagged-Debt-to-GDP ratios as instruments (Checherita & Rother, 2010).

Scholars worry that OLS estimators are biased and inconsistent because the lagged income level correlates with the error term (Presbitero, 2008). One possible solution is presented by the usage of the Generalized Method of Moments (GMM) technique. The System-GMM method developed by Blundell and Bond (1998) solves several statistical problems raised by the usage of lagged differences of the dependent variable as instruments for equations in levels and makes results robust despite homoscedasticity. Supporting the use of this method, Cordella, Ricci, and Ruiz-Arranz (2009) points out that System-GMM also reduces the dynamic bias associated with unobservable country-specific factor and controls for potential endogeneity of the explanatory variables. In their panel of 79 developing countries over the period 1970 to 2002, Cordella et al. (2009) found mixed results since debt had only a negative impact in the low debt countries (-0.406) and no effects in highly indebted countries.

The emphasis on the non-linear study of debt and growth can be attributed to Carmen M. Reinhart and Rogoff (2010), which found a non-linear relationship. Debt had a negative statistically significant impact on economic growth only when it breached 90% debt to GDP for advanced economies and 60% debt to GDP for emerging economies. Authors modeled GDP per capita growth explained by debt magnitude measured to the gross domestic products and inflation, instrumentalizing GDP to capture the long-run growth rate. To address the non-linearity, studies have used quadratic forms of debt in linear models,

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spline regressions, asymmetric regressions, and threshold regression models. Few studies conducted an asymmetric analysis to study the non-linear relationship.

Applied asymmetric methods have been used recently to test the different growth responses towards debt accumulation and relief. To our knowledge, only Gómez-Puig and Sosvilla-Rivero (2018) and Makun (2021) have applied and demonstrated that debt does not have a constant impact on economic growth. Their estimated results show that debt has a higher negative impact on economic growth when a given country acquires debt than a constructive effect on GDP per capita growth due to debt relief.

The dominant econometric method used is threshold regression models. Threshold models have been functional to measure the level of debt at which the marginal effect of debt on growth turns harmful; any value above the threshold would have an adverse marginal input.

In the beginning, threshold regressions models calculated the thresholds in an exogenous manner. In other words, scholars divided country samples into different debt-threshold categories and considered sample homogeneity except for income levels. For example, Carmen M. Reinhart and Rogoff (2010) analyzed advanced country's sample in four categories, depending on if the debt was below 30%, between 30 to 60%, between 60 to 90%, and above 90% of GDP. Similarly, they categorized emerging economies samples in the same manner.

Cecchetti, Mohanty, and Zampolli (2011a) also divided the sample by different debt levels found that debt is negatively correlated to economic growth when debt levels are above 85%. Meanwhile, other scholars created debt threshold categories using quantile debt threshold values, proving evidence that debt has a particularly significant inverse relationship, when debt increases, gross domestic product per capita decreases, and vice a versa in the Third, Fourth, and

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Fifth debt quantile using ordinary least square regression with fixed effects and instrumental regression (Pattillo, Poirson, & Ricci, 2011).

Later studies began to apply endogenous threshold models in which debt thresholds are endogenously calculated. B. E. Hansen (1999) extended the threshold regression model introduced by Tong (1978) to time series analysis to a non-dynamic cross-country to explore the link between variables in a non-linear setting since threshold models exhibit non-linear behavior that linear models cannot duplicate. It permits the estimate of single and multiple threshold limits and corresponding regime coefficients and standard errors. Baum et al. (2013) used this model to study the non-linear link between the Debt-to-GDP ratio and GDP per capita growth.

According to Baum et al. (2013) study of twelve European Union countries using the Euro as currency countries for the period, 1990 to 2010 found that in non-dynamic panel debt contributed to economic growth when debt levels were below 66.4 percent debt-to-GDP ratio, meanwhile above the threshold it was no longer statistically significant. Additionally, the debt harmed economic growth for debt levels above 95 percent debt-to-GDP ratio.

Due to recent concerns of country heterogeneity, scholars have begun to explore time series analysis. For example, kink Threshold Regression was developed by B. E. Hansen (2017) for time series data. Hansen analyzed the United States and found that debt had an inverse relationship; when debt increases, gross domestic product per capita decreases, and vice versa above the debt magnitude measured to the gross domestic product of 43 percent. Yang and Su (2018) and Bentour (2020) also applied the same threshold model, confirming that there is no uniform threshold turning point and varies significantly across countries. Bentour (2020) analyzed 20 advanced economies and obtained low threshold values for Portugal and Japan, 14 to 22 percent debt magnitude

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measured to the gross domestic product, respectively. Meanwhile, Yang and Su (2018) also analyzed the United States from but modified a bit the Hansen method to take into account time variations and state-dependent thresholds. These difference may provide some validity to Ouyang and Rajan (2014) findings that the threshold point is significant across countries due to by unique structural factors such as credit history, central bank reserves, currency regime, financial depth of bond market, and baking system characters which most studies do not take into account.

A new trend of studies is currently trying to examine debt and growth address sample heterogeneity of countries being evaluated using endogenous threshold models. As an illustration, Masuch et al. (2017) point out that their threshold estimation results greatly depending on the institutional strength of the group of countries analyzed. Debt had only a negative impact around the 60 to 70 percent debt-to-GDP ratio in the sample of countries with low institutional ratings; meanwhile, debt did not cause significant effects in countries with strong institutions. This evidences that debt thresholds are not the same across countries. Even though the author does not say it directly, the impact of debt could be endogenous to the quality of public institutions.

As a result, empirically, economists have been unable to prove irrefutably what type of relationship is between debt-growth without controversy in the long term. Problems arise due to the potential endogeneity of the dynamic interaction of both variables (Panizza & Presbitero, 2013), threshold effects (Égert, 2015a, 2015b), the sensitivity of the results to the time and country of control group analyzed (Herndon, Ash, & Pollin, 2013), weak correlation (De Vita, Trachanas, & Luo, 2018), limited data availability, heterogeneous economic and institutional country characteristics, interdependence upon countries (Gómez-Puig & Sosvilla-Rivero, 2017), and unlikely universal debt threshold tipping point from

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which debt harms economic growth (Chudik, Mohaddes, Pesaran, & Raissi, 2017), no causal relationship has been able to be established (De Vita et al., 2018).

This section examines the effects of public debt on economic growth. The review is organized as follows. It starts with theoretical issues that describe the link between the debt-to-GDP ratio and GDP per capita growth. Next, we explain techniques used to examine this linkage, and we end by presenting few practical problems faced doing this task.

2.1.Theoretical Issues

Comprehension of the connection between external debt and economic growth has changed over time. First, scholars focused on theoretical issues giving preliminary insights into the effects of debt. Later, empirical work expanded the theoretical frameworks. The academic assessment can be traced back to classical economists, such as Adam Smith and David Ricardo. Smith argued in favor of balanced budgets and opposed large public debts (Skousen, 2007) since he thought it represented a detrimental factor to the prosperity of England (Kennedy, 2010) and considered it would ruin all countries in the long run (Berry, Paganelli, & Smith, 2013).

David Ricardo further developed a theoretical framework where increasing debt service taxation distorted the efficient allocation of resources and ongoing growth (Churchman, 2001). The extraordinary rise of debt by England influenced Ricardo's study of debt towards viewing it as the result of the unproductive nature of government spending and adverse effects of debt service on taxation (King, 2013).

Formal economic models were created; later, debt was thoroughly examined within different growth models. Generally speaking, the impact on economic growth is ambiguous; it may have a positive or negative effect,

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depending on the time horizon analyzed or the economic conditions of the borrowing country. Economists theoretically endorse that debt in the short term has a positive impact and in the long term has a negative effect (Elmendorf & Mankiw, 1999). The adverse effects of debt have been verified theoretically in basic economic identities (Modigliani, 1961), overlapping generation models (Azariadis & Reichlin, 1996), neoclassical economic growth models (Diamond, 1965; Alfred Greiner & Fincke, 2009, 2015), and endogenous economic growth models (Bräuninger, 2003, 2005; Romer, 1986; Saint-Paul, 1992). Meanwhile, it seems that the exception to the long term adverse effects has to do more with specific financial situations; for example, in depressed economies borrowing at meager interest rates may not negatively impact long term growth (Delong & Summers, 2012), debt used for public transfers or debt used by countries in low growth situations (Minea & PatrickVillieu, 2009; Minea & Villieu, 2012).

There are two main theoretical arguments of this adverse effect; i) debt overhang and ii) crowding out effect. Paul Krugman coined the term debt overhang to explain the harmful effects of high debt burdens, debt overhang is defined as an "inherited debt (is) large sufficiently large that creditors do not expect with confidence to be fully repaid" (Krugman, 1988) and economists have continued to amplify its application. He argues that significant debt levels create Pareto inefficiencies due to the limited resources a government can commit. In other words, not all the income that the government receives can be used to pay the debt due to economic and political considerations (Alesina & Guido, 1989; Alesina, Ozler, Roubini, & Swagel, 1996). Meanwhile, the crowding-out effect in a country occurs when rising public sector spending drives down or even eliminates private sector spending on investment (Spencer & Yohe, 1970).

Statistical studies have expanded the two theoretical arguments above by finding correlations between debt and intermediate variables in periods of high

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debt levels, giving ideas in favor of the predominant view that the impact of debt on economic growth is indirect, and there is a set of intervening socio-economic variables that link debt and economic growth.

The early literature studying a potential negative link between the two variables focused on describing the effects of debt on taxes (Churchman, 2001) theoretically. Afterward, scholars focused on the influence over the number of government revenues, private stock of capital (Modigliani, 1961), taxes, interest ratio (Diamond, 1965), the efficiency of public investment (Friedman, 1978), investment, and capital flight (Pastor, 1990).

Recent investigations have proved empirically previous theoretical claims through which high debt can affect long term economic growth by impacting public investment, savings, interest rates (Cristina Checherita-Westphal & Philipp Rother, 2012), total factor productivity (Afonso & Jalles, 2013), labor productivity (Kumar & Woo, 2015). As debt rises, so does the debt service ratio to GDP; this will decrease the proportion of government allocation to public expenditure (Augustin Kwasi Fosu, 2008a, 2010). Likewise, the drop in public investment will hamper the positive externalities of public investment on private investment (Blavy, 2006). Additionally, the rising investment associated risks will reduce the quantity and quality of investment (Afonso & Jalles, 2013; Nguyen, Bhattacharya, & Clements, 2003), and lower investment incentives (Pao, 2003, p. 120). Private sector investors have an incentive to postpone investments until the economic situation is more predictable. (Servén, 1997).

High debt ratios harm public investment (Deshpande, 1997) and private investment (Greene & Villanueva, 1991). Correspondingly the enlargement of investment-related risk asymmetry (Eaton, 1987; and Khan & Ul Haque, 1985) diminish business activity and discourage household and enterprise consumption (Elmendorf & Mankiw, 1998, p. 18) that ultimately increases poverty (Loko,

DOI:10.6814/NCCU202101114

Mlachila, Nallari, & Kalonji, 2003; Maier, 2005, pp. 7-11). In like manner, reductions on people's wealth by reductions of public transfers and shifts in priorities of public expenditure and investment that in the end undermine the net disposable income.

Economic activity drops with concerns over solvency, profitability, and the probability of defaulting on securities. Investors demand higher interest rates to maintain providing money to the state. Interest rates rise due to high debt levels (Engen & Hubbard, 2004, 2005), not only in the long-term interest rates (Ardagna, Caselli, & Lane, 2007) but also in the long-horizon forward rates (Laubach, 2009). Economic agents move their capital abroad (Ndikumana & K. Boyce, 2008; Ndkikumana & Boyce, 2003). This is prompted by the fear of likely debt crises (Eaton, 1987), macroeconomic instability (Dornbusch, Branson, & Cline, 1985; Ndkikumana & Boyce, 2003), and any other detrimental elements adversely affecting the national rate of return.

Analyzing this phenomenon more deeply, reductions in public expenditure such as in education (Augustine Kwasi Fosu, 2007), health services (Augustin Kwasi Fosu, 2008b), promotion of innovation (Presbitero, 2012, p. 16) impacted the total factor productivity. Uncertainty on the future monetary and fiscal policies will increase investment risks and, as a response, hinder labor productivity (Kumar & Woo, 2015; Wamboye & Tochkov, 2015). Blavy (2006) suggests that reductions in investments lower productivity gains (total factor productivity growth rate).

A rise in debt service obligation to the governmental budget will pressure a decline in public investment and fewer public services rendered to citizens, reducing public safety nets and public services. Consequently, this scenario will create popular discontent(Alesina & Ardagna, 1998; Alesina & Guido, 1989; Alesina & Perotti, 1994) and government will lose popular support (Alesina et

DOI:10.6814/NCCU202101114

al., 1996; Alesina & Perotti, 1996). With this in mind, high debt levels also increase political instability (Battaglini, 2011).

Studies reveal that high debt levels contribute to altering the macroeconomic stability of the economy (Sutherland, Hoeller, Merola, & Zieman, 2012), the likelihood of financial crises (Carmen M. Reinhart, Reinhart, & Rogoff, 2012; Carmen M. Reinhart & Rogoff, 2009, 2015) and recessions (Sutherland et al., 2012). Macroeconomic instability, which can be defined as the "phenomena that make the domestic macroeconomic environment less predictable" (WB, 2005, p. 93), and the government's need to pay its present financial obligation will negatively impact private wealth (Alesina & Tabellini, 1992; Grilli, Masciandaro, Tabellini, Macilinvaud, & Pagano, 1991; Roubini, Sachs, Honkapohja, & Cohen, 1989; Roubini & Sachs, 1989).

Economists are lately identifying that another set of moderating socio-economic variables moderates the impact of external debt on economic growth. More recent literature seems to point out that the level of indebtedness is relevant. Still, its degree of influence may depend on its degree of impact will depend on fiscal multiplier effects of the budgetary policy (Brincaa, Holterd, Kruselle, & Malafry, 2016; Ethan Ilzetzki a, 2013; Farhi & Werning, 2016), debt composition (Hausmann & Panizza, 2011) and the rigidities of the economy (A. Greiner, 2011; Alfred Greiner, 2013), the nature of the deficit expenditure (Alfred Greiner, 2015), the quality institutional factors (Masuch, Moshammer, & Pierluigi, 2016) and governance (Jalles, 2011).

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2.2.Empirical Issues

Initial empirical studies focused on analyzing how a country's gross domestic product per capita growth is influenced by its governmental amount of debt to its gross domestic product using statistical data to show the effects of debt in several countries which experienced debt problems in the 1980s (Degefe, 1992; Mbire & Atingi, 1997). The main interest at that time was to expose high debt burdens and caused several economic distortions that undermined economic growth (Sachs & Williamson, 1985) and, in some cases, too big that needed debt relief to be able to enable economic growth (Esquivel, Larraín B., & Sachs, 1998).

Later studies applied econometric tools to link debt and growth. Initially, linear models were used, and later, due to the inconsistencies of results and theoretical reasons previously exposed in the theoretical review section, scholars began to use non-linear models. The next part of the literature review will look briefly at research on the linearity effects between both variables and then turn to the non-linear relationship between both variables under examination due to its predominant view in the field.

2.2.1. Linear Models

The first type of linear model used was the Ordinary Least Square model to test the correlation between debt and growth. Up to now, many studies have included this type of method. Kumar and Woo (2015) estimate an OLS model of real GDP and public debt in a panel of 38 advanced and emerging economies from 1970 to 2008. They found a negative correlation using random effects (-0.022) and fixed effects (-0.015) in their sample. Pattillo et al. (2011) estimated an OLS model for 18 OECD countries from 1980 to 2010 and found that debt is detrimental for growth: a 10 percent increase of debt-to-to GDP causes a reduction of GDP growth by 17 to18 basis points in 5-year subsequent average annual growth.

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Despite the statistically significant results exposed previously, the robustness of these OLS results is mixed since other studies did not obtain good results using OLS. For example, Checherita and Rother (2010) investigated and did not find statistically significant results in their lineal specification for twelve European Union countries using the Euro as currency countries from 1970 to 2011.

Other scholars concerned with endogeneity problems inherent in the debt growth relationship applied instrumental variable regressions. Scholars use this type of model to tackle the reverse causation problem: if low or negative growth rates of per capita GDP create high debt burdens (Checherita & Rother, 2010) and simultaneity bias. In other words, scholars use instrumental variable regressions models to solve concerns of correlation between the composite error terms with the actual regressor in the OLS model, which leads to bias and inconsistency in OLS, simultaneity bias (Gujarati & Porter, 2013).

Pattillo, Poirson, and Ricci (2002) estimated the correlation between debt and growth using IV regression and found no statistically significant negative relationship (-0.41) in a linear form. Still, between both variables in 93 developing countries from 1969 to 1998, the Instrumental Regression debt coefficient was -2.291. In contrast, to other studies, Cristina Checherita-Westphal and Philipp Rother (2012) found that public debt had a positive impact on growth.

To address concerns of heteroskedasticity of unknown forms (L. P. Hansen, 1982) that make IV regression estimates of the standard error inconsistent, scholars began to apply the generalized method of moments (GMM). Some additional positive features of this statistical method are that GMM regression is an optimal tool to control endogeneity and avoid correlated individual effects (Griliches & Hausman, 1986).

DOI:10.6814/NCCU202101114

Pattillo et al. (2011) had already concluded that SGMM models were good statistical tools to measure the effects on debt levels in countries; they found negative statistically significant results (-0.87) for 93 developing countries. Kumar and Woo (2015) also obtained consistent regression results theoretically and empirically, applying the System GMM dynamic Cross Country Regression for several countries and explicative variables.

2.2.2. Non-Linear Models

Initial estimations of debt and growth in a non-linear setting in the 1990s and early 2000s were prompted by studies regarding the unsustainability of low-income countries' debt. Scholars argue the high debt burden impeded the economic growth of low-income countries, and debt write off had to be implemented to regain economic growth. The implications of the non-linear relationship have had essential repercussions in world affairs. As an illustration, in 1998-1999 and 2005, the international financial institutions led by the International Monetary Fund initiated a debt relief to heavily indebted developing countries based on the premises of debt overhang and the notion that beyond a particular threshold, debt has a detrimental effect on economic growth. The debt relief under the Heavily in debt developing country initiative and the multilateral debt relief initiative (Fund & Bank., 2006) has helped 36 counties with more than 99 billion dollars in debt write-offs.

After the debt relief initiatives, economists have begun to search to find early warning signs to prevent debt overhang. In this line of research, the quest to identify when debt begins to hamper economic growth was initiated. Additionally, the Debt sustainability framework was developed to monitor the new indebtedness of countries who received debt relief and gradually has been expanded by all IMF members. Even though the framework does not say this directly, the input to establish the recommended indebtedness levels which

DOI:10.6814/NCCU202101114

countries may have are the results of studies that identify when debt has an inverse relationship with GDP per capita; when debt increases, GDP per capita decreases—depending to it income level and other factors.

Since 2007 an extensive proliferation of studies began to understand better how its governmental amount of debt influences a country's gross domestic product per capita growth to its gross domestic product. Reinhart and Rogoff (2009) studied 800 years of economic history to comprehend the phenomena of financial crises. Two key common findings were that some empirical regularities in the crises branded: they were proceeded by high levels of indebtedness (private, domestic, or foreign), and economic contractions occurred subsequent years.

In 2010, the unthinkable happened – a debt default of an advanced economy, Greece. This event exposed that countries not only incur debt defaults before their financial capabilities are exhausted but also high ratio debt to GDP, historical events of previous defaults, and institutional factors play an essential role (C. M. Reinhart, Rogoff, & Savastano, 2003). This event reinforced the importance of monitoring debt sustainability and which aspect should be taken into account, when debt impacts economic growth, and what additional factors should be examined (Kraay & Nehru, 2006).

The popularization from linear models to non-linear models to analyze debt and economic growth may be attributed to Carmen M. Reinhart and Rogoff (2010). Their statistical study of an extensive panel data set of 44 countries over 400 years and their discovery that gross external debt inhibited GDP per capita growth at high debt levels prompted other scholars to examine the non-linear link (Carmen M. Reinhart & Rogoff, 2009). As an illustration of the wide acceptance, the International Monetary Fund justified their policy recommendation based on

DOI:10.6814/NCCU202101114

the concerns for economic growth (IMF, 2010) by high debt levels extracted from (Koeda, 2008; Carmen M. Reinhart & Rogoff, 2010) research.

The non-linear relationship analysis has taken many forms, from the quadratic term of the debt variable to capture the non-linear effect of debt in a linear regression model, spline regressions, asymmetric regressions, and threshold regressions. Threshold regressions are the dominant methodology used today, and their usage has evolved through time. Initially, scholars split country income group samples by different debt levels and conducted linear regression within the same debt-threshold range. Later, economists applied more complex regressions, endogenous threshold regressions, where the threshold point and the threshold effect parameters are obtained without the need for scholarly instrumentation of samples by different debt levels.

The principal focus of using a quadratics instrumentalization of debt in the growth regression is to understand the intensity of indebtedness to growth Elbadawi, Ndulu, and Ndung'u (1997) and identify which debt level marginally harms economic growth becomes negative. Some studies, such as Pattillo et al. (2002), Clements, Bhattacharya, and Nguyen (2003), Elbadawi et al. (1997), and Cristina Checherita-Westphal and Philipp Rother (2012), have focused on using a quadratic relationship to measure the impact of debt on economic growth.

Empirical evidence shows Clements et al. (2003) debt quadratic term to be negative statistical significant, and Pattillo et al. (2002) found that a debt reduction from one 60 percent to 30 percent would increase growth per capita by 0.4 percent. Elbadawi et al. (1997) evaluated the experiences of 99 developing countries from 1980 to 1995. They confirmed that overborrowing and debt constrains economic performance using the debt in the quadratic form, but its coefficient values were sensitive to changes in the specification model.

DOI:10.6814/NCCU202101114

Cristina Checherita-Westphal and Philipp Rother (2012) provided evidence from twelve countries in the European Union that used the Euro as currency for 40 years suggest that the contemporary negative impact on growth is associated with threshold debt levels at about 90 to 100 percent of GDP on average for the sample (Cristina Checherita-Westphal & Philipp Rother, 2012) using a quadratic functional form of debt to measure the non-linearity. Similarly, Liu and Lyu (2021) found that quadratic coefficients of public debt at a 1% level in the sample covering 102 countries from 1980 to 2016. As far as the weakness of this method, performance has been challenged because of the sensitivity to outliers and omission of the formal test very a U-shape relationship such as Sasabuchi-Lind-Mehlum Test (Panizza & Presbitero, 2013).

Other studies provide similar evidence using spline regressions, which constitutes a non-parametric regression method in which the data set is separated into points called knots. Empirically, polynomial regression is conducted between the knots, and the series of polynomial segments strung together, jointing the knots is the spline regression (Marsh & Cormier, 2002). Pattillo et al. (2011) present a thorough spline regression analysis of debt that negatively impacted economic growth at 50 percent GDP and 95percent of debt to exports. Meanwhile, Kumar and Woo (2010) found that debt had only a statistically negative impact when the debt was higher 90 debt-to-GDP ratio.

A novel study of debt and growth has studied the asymmetry effect of debt accumulation and debt reduction. The findings indicate that high debt-to-GDP ratio increments have more noticeable results in constraining economic growth rather than benefiting impacts on GDP per capita growth during debt deleveraging (Gómez-Puig & Sosvilla-Rivero, 2018; Makun, 2021). Gómez-Puig and Sosvilla-Rivero (2018) used their asymmetric results for 10 Euro countries from 1980 to 2015 and found that debt has a different magnitude impact on

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economic growth; on the one hand, debt increases compared to a debt reduction. Additionally, there are incremental changes in debt effects differing across countries.

Makun (2021) found support for not only symmetric effects but also asymmetric changing values of gross domestic product per capita associated with changes in debt levels in a time series analysis of Fiji conducting an auto-regressive distributed lagged model (Pesaran, Shin, & Smith, 2001; Shin, Yu, & Greenwood-Nimmo, 2014) and non-linear autoregressive distributed lagged model) model for the period of 1980 to 2018. The modeling technique permitted for asymmetric analysis of positive and negative decomposition of external debt differential impact on economic growth resulted showed increasing adverse effects when a country experiences an increasing external debt shock compared to a decreasing external debt shock—rising external debt. Additionally, the threshold model provides evidence of a negative relationship when debt magnitude measured to the gross domestic product breaches 62 percent.

A substantial body of literature applies a threshold regression model to test the non-linear link between debt on economic growth. The threshold literature often assumes that the regression function has either a discontinuous (jump) or a continuous (kink) at a threshold point. As an illustration, Fong et al. (2017) present three continuous threshold regression types, such as Segmented and Hinge, and a three-phase segmented model, while two discontinuous threshold types, such as step and hinge. Some of the most widely used discontinuous threshold models applied can mention B. E. Hansen (2000), B. E. Hansen (1999), and Chan and Tsay (1998). Meanwhile, in the literature, we found continuous threshold models B. E. Hansen (2017) and Chang and Chiang (2012), and Zhang, Zhou, and Jiang (2017).

DOI:10.6814/NCCU202101114

The initial approaches to conducting a threshold regression analysis were performed by identifying the levels of debt at which the average and the marginal impact of debt became negative exogenous. Scholars determined sorted debt values into different ranges to organize countries' data in a low to high indebtedness. For example, Carmen M. Reinhart and Rogoff (2010) used a panel data method for twenty highly developed countries and studied the periods 1946-2009 and 1900 to 2009. They constructed ad-hoc threshold Debt-to-GDP ratio levels below 30%, between 30% and 60%, between 60% and 90%, and above 90%. Their result shows that debt constraints GDP per capita growth in countries with above 90 percent debt magnitude measured to the gross domestic product.

An alternative manner of selecting the debt threshold was conducted by Pattillo et al. (2011) study of a large panel of emerging economies, 93 developing countries during 1969-1998. Authors used quantile values of debt to find the non-linear impact of debt and economic growth; their results show a negative statistically significant effect of external debt on per capita above 35-40 percent of GDP. In the same way, Cecchetti, Mohanty, and Zampolli (2011b) found that debt levels beyond 85 percent of debt-to-GDP ratio debt are bad for growth. They constructed the threshold assessment by splitting the sample based on the distribution of the debt magnitude measured to the gross domestic product using quartile values from 18 OECD countries from 1980 to 2006.

Kumar and Woo (2015) report that their empirical study confirms Carmen M. Reinhart and Rogoff (2010) found that debt constrained economic growth when the debt ratio was greater than 90 percent debt-to-GDP ratio in developed and developing countries analyzed using a dummy debt variable composed of different levels of public debt. In their paper, they analyze 38 advanced and 41 emerging economies for the period 1970-2008. Their results show evidence of non-linearity.

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Later, economists applied threshold regression models that solved the shortcomings of the arbitrary debt brackets by methods that found the point breaks endogenously. Minea and Parent (2012) endogenously estimate debt threshold using a panel smooth threshold regression method developed by Gonzales et al. 2005. They reveal that their results are sensitive to inclusion outliers in the sample and sources of data selection. Firstly, they found a negative effect of debt on growth economic growth but progressively declines even found that the link is positively associated with debt ratios above 115 percent. They did not find a statistically significant relationship in countries with debt levels between 60 and 90% when using alternative data sources, Maddison 2007, and IMF public debt Database Abbas 2011.

Égert (2015b) applied an endogenous threshold model by Hansen 1999 to Reinhart and Rogoff's data set and found that the statistically significant link between variables occurs at lower levels (between 20% to 60% of GDP) compared to Reinhart and Rogoff's 2010 discoveries and results are sensitive to modeling choices, country selection considered and time selection required in each non-linear regime. A 10% increase in public debt ratios lowers growth by 0.1 to 0.2 percentage points. Similar results were obtained by Égert (2015a) using a different dataset, OECD's Economic Outlook database examining 29 OECD from 1960 to 2010 considering traditional long-term growth factors and considering uncertainty.

Baum et al. (2013) belong to the group of authors who used dynamic and non-dynamic threshold Cross Country Regression to analyze the non-linear impact of public debt on economic growth. Baum et al. (2013) found that for the twelve European area countries over the period 1990 to 2007, public debt had a positive effect on GDP at low levels of indebtedness. That debt turned to harm economic growth only beyond the 95 percent of debt-to-GDP ratio. In an

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application of Caner and Hansen (2004) threshold model for dynamic models extended to data panel framework by Kremer, Bick, and Nautz (2012)

Another study using the threshold least squares regression model (Caner, Grennes, & Koehler-Geib, 2010) found that debt harmed growth at the 77percent debt-to-GDP ratio. A study that analyzed Reinhart–Rogoff dataset using Threshold effects in non-dynamic panels (B. E. Hansen, 1999) limited evidence in favor of a negative non-linear connection between debt-to-GDP ratio and GDP per capita, and the tipping point when debt turns bad is between 20 to 60 percent debt-to-GDP ratio.

Égert (2015a) conducted a bivariate regression for Central government debt applying threshold effects in non-dynamic panels developed by B. E. Hansen (1999), level and growth rate. General (and central) government debt during the more recent period 1960–2009 suggests that economic slowdown occurs when public debt moves above 60% or 90% of GDP.

Égert (2015b). the study shows that above the 20% threshold, an additional increase in debt magnitude measured to the gross domestic product causes and 0.008 percentage point decline in economic growth. In a three-regime model is selected, the upper debt threshold varies from 41% to 54% of GDP.

The empirical literature shows support for the presence of heterogeneous thresholds based on the ground of sample heterogeneity. Carmen M. Reinhart, Kenneth S. Rogoff, and Miguel A. Savastano (2003) first proposed the heterogeneous effects of debt on growth. They argue that the defaults on external debt are influenced dramatically by debt level, inflation, and macroeconomic stability. Empirical evidence of credit history for 100 countries since the 1820s suggests that countries with bad credit history and high inflation record, low economic, financial, and institutional development experience default on their

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debt not only at low lower debt levels than other countries with similar characteristics. They coined the term debt intolerance to countries that are highly sensitive to default in low debt thresholds.

A recent empirical study by Matsuoka (2020) showed evidence that the debt level per se was necessary for the debt intolerance framework. Countries with specific characteristics of bondholders may exacerbate the effects. He argues that long-term yields are sensitive to the type of bondholders and type of financial instrument.

Gómez-Puig and Sosvilla-Rivero (2017), who analyzed the empirics of the debt growth nexus using time series and data panel data with two different models, provided evidence of the importance of country heterogeneity in fiscal rules implementation. Some empirical evidence suggests that gross domestic product per capita changes caused by the changes in the government debt levels vary due to institutional characteristics, budgetary policy, and economic systems (Ahlborn & Schweickert, 2017). Meanwhile, Chudik et al. (2017) and Simon, Sandri, and Pescatori (2014) find evidence that the debt may have heterogonous effects due to institutional factors.

Dreger and Reimers (2013) found that for debt for twelve European Union countries using the Euro as a currency had only a negative impact on countries whose debt levels were considered unsustainable, meanwhile for the other group of countries that had sustainable debt levels, the results showed a positive effect on economic growth for 18 European Union countries using the Euro as a currency from 1980 to 2011. This is similar to Liu and Lyu (2021) findings that debt thresholds are influenced by changes in the current account balance, gross savings, and trade openness in panel data of 102 countries during the period 1980 to 2016. One implication of these studies is the importance of macroeconomic conditions calculating the debt to GDP threshold.

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One manifestation of debt intolerance is the sensibility to rises in interest rates. As economic growth literature points out, higher interest rates tend to constrain economic growth and high debt levels (Baum et al., 2013; Laubach, 2009). Although authors do not say so directly, debt intolerance is highly related to the debt overhang hypothesis that high debt levels cause detrimental effects on economic growth, such as debt default due to its repercussions on the economy before and after bankruptcy. One implication of debt intolerance countries is that debt per se is not the only element to be considered in debt sustainability. This study sparked new literature aimed at assessing the heterogeneous growth effects of public debt. We found several reasons that seem to favor this argument that the impact of debt on growth may differ across countries because of country-specific characteristics.

Additionally, Giordano and Tommasino (2011) provide empirical evidence that political and economic institutions (central bank independence) influence a country's debt intolerance. As a result, a homogenous impact and a standard threshold for a group of countries only divided by their income levels may not provide the most accurate results when analyzing these countries with debt default history within the same income level.

In a recent discussion on changes in the gross domestic product caused by changes in debt, authors have considered insights from the debt intolerance framework and added more explicative variables into their models. Presbitero (2012) included institutional quality in his work and concluded that institutional quality mediated the effects of debt and growth. Panizza and Presbitero (2013) argued in favor that the link between variables is heterogeneous across countries and periods since the effects depend on unique cyclical and structural factors.

In like manner, other scholars have also found the importance of institutional quality in mediating the impact of the debt to growth relationship

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(Butkus & Seputiene, 2018; Cordella et al., 2009; Masuch et al., 2017). Mensah, Bokpin, and Boachie-Yiadom (2018) provide evidence that institutional solid quality may mediate the adverse effects on economic growth in 36 SSA countries during 1996 and 2013 using system GMM regression models. Masuch et al. (2017) analyzed EU countries from 1995 to 2017 using pool mean estimate and countries below the average institutional quality of EU countries experience an amplified negative effect of debt on economic growth, and countries with solid institutional quality did not have any adverse impact on long term economic growth (15 years subsequent growth) found that the negative impact of debt on growth. These studies seem to suggest that debt does not have a constant negative impact on growth but instead it may vary in the presence of strong institutions.

Kourtellos, Stengos, and Tan (2013) found that external debt impact on growth is influenced by political institutions based on a country's democratic institutions. It argues that the studies should modify the criteria of sample splitting; the country group selection should not be divided by the level of income but instead by the country's quality of its democratic institutions. They conclude that the adverse effects of debt on growth (-0.0109) are neutralized in the group of countries with high democracy in 10 years panel dataset covering 82 countries from 1980 to 2009 using a structural threshold regression (Kourtellos, Stengos, & Tan, 2015). Meanwhile, when applied other methods such as Linear OLS and GMM and the threshold regression model of B. E. Hansen (2000), the debt had a lower impact in-country samples with high democracy. We infer that a standard threshold for a whole group of countries without considering political, institutional quality may skew the threshold results.

Clements et al. (2003) argue that debt may have a different impact in low-income context since countries that receive large sums of donations might offset the negative effect of debt since they found that foreign aid had a positive

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statistical impact (coefficient between 0.06 to 0.09) on public investment in their study of 55 low-income countries during the period 1970 to 1999. This seems to suggest that any country that receives considerable donations or financial rescue packages to its GDP may experience an influx of funds that can offset the negative impact of external debt. Another critical factor that may cause a different debt to growth impact is the amount of debt denominated in foreign currency Bordo, Meissner, and Stuckler (2010). In like manner, Panizza and Presbitero (2014) included foreign currency and exchange rate in their study of the effects of government debt and economic growth. After debt magnitude measured to the gross domestic product was instrumented by its foreign currency debt weight by the exchange rate, his results lost statistical significance in his model of 17 OECD countries during the period 1980 to 2010 for the second stage of the IV regression.

2.2.3. Estimation Difficulties

The debt-growth relationship is complex, and economists have not solved all technical challenges to establish a causal relationship between both variables. Empirical must overcome several statistical challenges in which there is no consensus on how to solve it in an unrefutably manner, such as reverse causality and endogeneity (Aguiar & Amador, 2014; Aguiar, Amador, & Gopinath, 2009; Panizza & Presbitero, 2013). We will conduct a brief review of how these challenges are addressed.

The first empirical problem is an endogeneity problem in modeling how its governmental debt influences a country's gross domestic product per capita growth to its gross domestic product (Dell'Erba, Hausmann, & Panizza, 2013). Endogeneity is present in a regression when the independent variable is correlated with the error term of the regression model. The common reason endogeneity occurs is the omission of essential variables in the regression model, also called "omitted variable bias," and when the independent variable is correlated with the

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regression error term. Scholars use lagged to mitigate the endogeneity problem (Panizza & Presbitero, 2013) or lagged values of the explanatory variables as GMM estimators developed by Blundell and Bond (1998). In addition, some apply instrumental variable techniques (Cristina Checherita-Westphal & Philipp Rother, 2012; Panizza & Presbitero, 2013). Alternatively, the usage of GMM regression models has been used to address endogeneity (Cecchetti et al., 2011a; Kumar & Woo, 2015).

The second empirical problem is the reverse causality problem. Reverse causality is present when the dependent variable is causing the change in the explicative variable. Scholars have a long-term perspective to solve the reverse causality problem; some used the lagged values of debt (Kumar & Woo, 2015), while others used initial debt values to explain subsequent GDP growth. Alternatively, some studies use a two-stage least squares instrumental variable method (Gómez-Puig & Sosvilla-Rivero, 2017) and GMM (Cristina Checherita-Westphal & Philipp Rother, 2012) to estimate the final model to avoid reverse causation.

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3. Methodology and Data

The methods applied in this dissertation consist of assessing how the levels of debt impact long-term GDP per capita growth. This chapter is ordered in the following manner: it describes the effects of external debt on economic growth analytically. Next, we explain the several econometric methodologies used in our panel data and time series examinations to understand how both variables interact in different settings. Finally, it exposes the essential features of the data used in the study and its stylized facts of quality of data to conduct statistical analysis such as normal distribution and stationarity tests results.

Following previous studies analyzing debt and growth, we use the typical growth model augmented with debt variables to provide the reader a basic analytical notion of the debt dynamic in an endogenous growth model; we selected for simplicity AK model in an open economy with imperfect capital mobility to expose what occurs theoretically when there is an increase in the budget deficit ratio and the government purchase ratio.

3.1. Theoretical Background

Analytically, the impact of external debt on economic growth can be understood by examining the capital dynamics within the Solow model for a small open economy with imperfect capital mobility. This analysis can take two forms. Firstly, considering countries with high productivity that makes their marginal product of domestic capital exceed the world interest rate. Secondly, considering countries with low productivity countries characterizable by their product of domestic capital fall short of the world interest rate. In other words, the first case considers countries as international debtor countries, and the second case considers countries as international creditors (Bräuninger, 2003; Alfred Greiner, 2012a, 2012b; Alfred Greiner & Fincke, 2015).

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3.1.1. High Productivity Country

The capital dynamic for an international debtor country can be summarized as follows: A countries output growth, external debt growth, and its capital accumulation growth are determined endogenously by the government budget deficit ratio, government expenditure ratio, gross national savings ratio, scale parameter, and international credit limit.

$$\hat{Y} = \hat{F} = \widehat{K} = \frac{s(1 - g + b - \alpha m) - b}{1 - m} A \tag{1}$$

With: $Y = national\ income$ $F = foreing\ debt$;; $K = domestic\ capital$; $s = saving\ ratio\ constant$; $g = constant\ purchase\ of\ good\ and\ services$ $b = deficit\ ratio\ constant$; $A = marginal\ product\ of\ domestic\ capital$; $m = ratio\ below\ 1$

The essential insights from this model are: Firstly, when the fiscal deficit increases in the short run to a higher budget deficit and raises public debt, which crowds out investment. As a result, capital growth and output decline. Meanwhile, in the medium term, lower output growth will cause a reduction in tax revenue growth, an increase in public debt growth, and higher interest payment growth. Therefore, to balance the budget, the government must increase the tax rate to reduce consumption.

Secondly, Government expenditure increases. The analysis starts from the steady-state of the economy, where the public debt and capital and foreign assets grow at the same rate. Then, due to a higher government purchase ratio, the government balances the budget by raising taxes, and consequently, savings and investment drop. In effect, there is a decline in output growth and fiscal deficit in

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the short-term. Meanwhile, output growth and public debt growth come together in the long run.

3.1.2. The Low-Productivity Country

The capital dynamic for an international creditor can be summarized as follows:

A country's output growth, external debt growth, and capital accumulation growth are determined endogenously by the quantitative relation between debt and capital. v

$$\hat{Y} = \hat{F} = \hat{K} = \frac{s((1-g+b)A}{1+m} - bA + msr^{*} + msr^{*}\frac{D}{K} \tag{2}$$

With: $Y = national\ income$ $F = foreing\ debt$;; $K = domestic\ capital$; $s = saving\ ratio\ constant$; $b = deficit\ ratio\ constant$; $A = marginal\ product\ of\ domestic\ capital$; $m = ratio\ below\ 1$; $D = public\ borrowing$; $r = domestic\ interest\ rate$

The essential insights from this model are: firstly, when the Fiscal deficit increase. In the short term, the budget deficit ratio decreases capital growth while increasing debt and foreign assets growth rate. Consequently, output declines and reduces the budget deficit. On a longer time, prospect, foreign assets growth falls.

Secondly, when Government expenditure increases. In the short term, capital growth drops while maintaining constant debt growth. Under those circumstances, output and foreign assets decline. Deficit growth will adjust to debt growth. For a longer time, the government budget deficit slows, and output growth drops.

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Next, we expose the econometric specifications of the models used in our cross-country analyses and time-series analyses. Each econometric model used involves some trade-offs that may be useful to examine a particular econometric problem. Still, at the same time, it is subject to a specific different type of bias. The dissertation did not address the econometric models' limitations used in our study since we considered it was not the goal and space limitations.

3.2.Econometric Specifications

We selected six types of regression analysis to study the link between debt and economic growth. For the cross-country analysis, we decided on Panel Quantile regression (Koenker, 2004), Threshold effects in non-dynamic panels (B. E. Hansen, 1999), and Sample Splitting and Threshold Estimation (B. E. Hansen, 2000). First, quantile regression was selected to provide insights into how a country's gross domestic product per capita growth is influenced by its governmental debt to its gross domestic product using estimates of the conditional median target variable. We did not find studies using this method. Second, threshold effects in non-dynamic panels were selected to test the presence of more than one threshold and provide insights into the mixed results of threshold values exposed in the literature. Third, Sample Splitting and Threshold Estimation was selected to test the heterogenous effects of debt caused by institutions.

For the within-country analysis, we selected quantile regression (Koenker & Bassett, 1978), autoregressive distributed lag models bound test (Pesaran et al., 2001), and Estimation and Hypothesis Testing for Threshold Regression (Fong et al., 2017). The fourth model, quantile regression for within-country analysis to test the debt growth relationship outside of the mean of the data. Fifthly, autoregressive distributed lag models bound test to differentiate short- and long-term effects that permits exploring the time heterogeneity in debt to economic growth relationship. Finally, the sixth and last model, Estimation and Hypothesis

DOI:10.6814/NCCU202101114

Testing for Threshold Regression, allow the characterization of the behavior of the debt threshold variables to suggest a solution to the lack of comparability among threshold models and description of the debt trajectory before and after the change-point.

We will explain each of the economic models more in-depth, but since we applied several econometric modeling techniques, we summarized to expose the key points considering space limitations briefly.

3.2.1. Cross Country Analysis: Case Study 103 countries

First, we apply quantile regression analysis to calculate the conditional mean of growth given the concerns among economists that the usage of linear regression in analyzing debt and growth may suffer from non-linearity, homoscedasticity (Panizza & Presbitero, 2013). Additionally, our method would provide better results against outliers and give a more comprehensive analysis since we analyze different central tendency and statistical dispersion measures.

Model 1 Quantile Regression with Fixed Effects

The empirical model for the was developed by Koenker (2004) as is defined as follows model given:

$$\mathrm{Y}_{it} = \alpha_i + \beta(\tau)\mathrm{d}_{it} + \gamma(\tau)X_{it} + \varepsilon_{it} \tag{3}$$

Where i denotes different individual, t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years for country i at time t. α_i has pure location shifts effects on the conditional quantiles of response exposing the country fixed effects; d_{it} represents initial Gross government debt-to-GDP of country i in year t which is the primary variable of interest and X_{it} represent the impact control variables

DOI:10.6814/NCCU202101114

used in the estimations such as Gross government debt-to-GDP, Democracy, GDP per capita growth (annual %), Savings, Investment, Inflation, Institutions, Population country i in year t and ε_{it} is the error term. The parameters $\beta(\tau)$ and $\gamma(\tau)$ are parameters to be estimated and depend the quantile, τ tau of interest but the α_i do not.

To address the ongoing debate of gross domestic product per capita changes caused by the changes in the government debt levels, we conduct two cross-country threshold regressions to test the non-linear relationship and examine if debt ratios affect the GDP per capita growth in the long term.

Model 2 Threshold effects in non-dynamic panels

Second, we apply panel data threshold regression developed by B. E. Hansen (1999), which permits us to examine at which point debt influences economic growth per capita and test the presence of a threshold effect or not. The regression model we estimate can be specified as follows:

$$\begin{aligned} \mathrm{Y}_{it} = \alpha_i + X_{it}(d_{it} < \gamma_1)\beta_1 + X_{it}(\gamma_1 \leq d_{it} < \gamma_2)\beta_2 + X_{it}(\gamma_2 \leq d_{it} < \gamma_3)\beta_3 \\ + X_{it}(d_{it} > \gamma_3)\beta_4 + u_i + \varepsilon_{it} \end{aligned} \tag{4}$$

Where i denotes different individual, t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years for country i at time t. d_{it} is the threshold variable representing initial Gross government debt-to-GDP of country i in year t which is the primary variable of interest and X_{it} represent the impact control variables used in the estimations such as Democracy, GDP per capita growth (annual %), Savings, Investment, Inflation, Institutions, Population country i in year t. The parameters γ_1, γ_2 and $\gamma_3$is the threshold parameters that divide the equation into regimes

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with coefficients β_1, β_2 , β_3 and β_4 are to be estimated. the parameter u_i is the individual effect and ε_{it} is the error term.

Model 3 Sample Splitting and Threshold Estimation for Institutional Quality

Third, we apply threshold regression with sample splitting effects for our models 3 and 4 following the baseline estimation of B. E. Hansen (2000) for multiple thresholds. In this model, debt threshold thresholds are calculated to determine if debt constrains growth or promotes growth. The threshold value will permit us to obtain two regimes: regime 1 (low indebtedness) and regime 2 (high indebtedness). Regime 1 (low indebtedness) consists of countries below the 1st threshold variable (debt), and regime 2 (high indebtedness) consists of countries above the 1st threshold variable (debt). We follow B. E. Hansen (2000) equation for multiple thresholds (j thresholds) regressions for our models 3 and 4 are as follows:

$$\mathrm{Y}_{it} = \alpha_i + X_{it} I(d_{it} \leq \gamma_1)\beta_1 + X_{it} I(\gamma_1 < d_{it} \leq \gamma_2)\beta_2 + X_{it} I(d_{it} > \gamma_2)\beta_3 + \varepsilon_{it} \tag{5}$$

Where i denotes different individual, t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years for country i at time t. d_{it} is the threshold represents initial Gross government debt-to-GDP of country i in year t which is the primary variable of interest and X_{it} represent the impact control variables used in the estimations such as Democracy, GDP per capita growth (annual %), Savings, Investment, Inflation, Institutions, Population country i in year t. γ_1, and γ_2 is the threshold parameters that divide the equation into regimes with coefficients β_1 and β_2. Where. I(.) is an indicator function of the threshold variable. Later we use the first threshold is to split the sample into two regimes, regime 3 (low debt with low institutional quality) and regime 4 (low debt and high institutional quality).

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Next, it uses the first threshold into another two regimes, regime 5 (high debt and low institutional quality) and regime 6 (high debt and high institutional quality).

Model 4 Sample Splitting and Threshold Estimation for Democratic Quality

We follow B. E. Hansen (2000) equation for multiple thresholds (j thresholds) regressions for our models 3 and 4 are as follows:

$$\mathrm{Y}_{it} = \alpha_i + X_{it}I(d_{it} \leq \gamma_1)\beta_1 + X_{it}I(\gamma_1 < d_{it} \leq \gamma_2)\beta_2 + X_{it}I(d_{it} > \gamma_2)\beta_3 + \varepsilon_{it} \tag{6}$$

Where i denotes different individual, t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years for country i at time t. d_{it} is the threshold represents initial Gross government debt-to-GDP of country i in year t which is the primary variable of interest and X_{it} represent the impact control variables used in the estimations such as Savings, Investment, Inflation, Institutions, Population country i in year t. γ_1, and $\gamma_2$is the threshold parameters that divide the equation into regimes with coefficients β_1 and β_2. Where. I(.) is an indicator function of the threshold variable. Later we use the first threshold is to split the sample into two regimes, regime 3 (low debt with low democratic quality) and regime 4 (low debt and high democratic quality). Next, it uses the first threshold into another two regimes, regime 5 (high debt and low democratic quality) and regime 6 (high debt and high democratic quality).

In the following subsection, we selected time series models to avoid considerable cross-country heterogeneity. We acknowledge that the impact of debt may vary over time within countries, primarily due to financial market development and the complexity of financial products. With the selection of time series of individual countries, we avoid several panel data challenges such as unobserved heterogeneity and cross-section dependence (Presbitero, 2012).

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3.2.2. Within Country Analysis: Case Study USA

Model 5 Autoregressive-Distributed Lag Bounds Testing Approach to Cointegration

Fifth, we conduct some cointegration techniques to test if there is cointegration between debt and economic growth. Our model selection was the autoregressive distributed lag (ARLD) modeling framework developed by Pesaran et al. (2001) to examine the long-run relationship between the variables. This method permits the confirmation of the presence of a long-run relationship irrespective of the lag order.

The ALRD model permits estimating the short- and long-term parameters solving endogeneity problems, and tests cointegration among variables. It consists of p_i past periods of the i th independent series and q lags of the dependent series. The ARDL (p,q) model developed by Pesaran et al. (2001) implies the estimation of the following equation:

$$y_t = \mu_0 + \sum_{i=1}^{k}\left(\sum_{j=0}^{p_i}\beta_{ji}\,L^j\right)X_{ti} + \left(\sum_{i=1}^{q}\gamma_i\,L^i\right)y_t + \varepsilon_t \tag{7}$$

Where L is the lag operator, μ_0 is the constant, y_t is the dependent series and X_{ti} is the independent series, i −th independent series, p_i is the lag order of i −th independent series, and q is the autoregressive order of the model and ε_t is the error term. The model can directly be fitted to observed short- and long-term characteristics of the series.

Model 6 Time Series Quantile Regression

Fourth. We use a Time Series Quantile Regression test the link between debt-to-GDP ratio and GDP per capita growth and can be denoted as follows:

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$$Q\tau(\mathrm{Y}_t) = \beta_0(\tau) + \mathrm{d}_{it}\beta_1(\tau) + X_t\beta_2 + \varepsilon_{it} = \tau, 0 < \tau < 1$$

(8)

t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years at time t. d_{it} is Gross government debt-to-GDP in year t which is the primary variable of interest and X_{it} represent the impact control variables used in the estimations such as Government expenditure, percent of GDP, Interest paid on public debt, percent of GDP, Gross public debt, percent of GDP, the real long-term interest rate on gov't debt, and Institutional quality. The number 1 in the equation is an indicator function, τ is the quantile value, and ε_{it} is the error term.

Model 7-10 Change point threshold regression models

The sixth method and last analysis use a Change Point Threshold Regression model developed by Fong et al. (2017). Conventional literature has it that heterogeneous effects on growth occur due to different country structural factors that influence the levels which debt impacts economic growth. We contribute to the debate on heterogeneous effects on growth, saying this also occurs by exogenous threshold model selection. Thereby, we conduct five different models developed by Fong et al. (2017) to show how results vary depending on each model. Additionally, their technique permits the comparison of the different threshold model results, thereby allowing the possibility of choosing which model is adequate to the country analyzed in an endogenous manner and permitting the simple inference of the trend after the debt to GDP breaches the trend threshold changing point.

To examine the non-linear changes of economic growth per capita explained by the influence of governmental debt growth outlined in the previous section, we use equations (9), (10), (11), and (12) to capture the nonlinear changes

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in economic growth per capita explained by government debt growth. We use a new econometric technique developed by Fong et al. (2017), which allows not only determine the kind of continuous nonlinear relationship between the outcome and the predictor but also permits us to evaluate if the link between variables is among the five most common threshold effects: step, hinge, segmented and segmented. The base model equation for our models 7 to 10 in the threshold regression models are the following (Fong, 2020; Fong et al., 2020; Fong et al., 2017):

Continuous threshold effects:

Model 7 Change point threshold regression: Threshold Segmented Effects

$$\mathrm{Y}_t = \alpha_1 + \alpha_2^T z + \beta_1 I(x > e) + \gamma^x \tag{9}$$

Model 8 Change point threshold regression: Threshold Hinge Effects

$$\mathrm{Y}_t = \alpha_1 + \alpha_2^T z + \beta_1 I(x - e) \tag{10}$$

Discontinuous threshold effects:

Model 9 Change point threshold regression: Threshold Step Effects

$$\mathrm{Y}_t = \alpha_1 + \alpha_2^T z + \beta_1 I(x > e) \tag{11}$$

Model 10 Change point threshold regression: Threshold Stegmented Effects

$$\mathrm{Y}_t = \alpha_1 + \alpha_2^T X_{it} + \beta_1 I(\mathrm{d}_{it} > e) + \gamma^x + \beta_2 I(\mathrm{d}_{it} > e) \tag{12}$$

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In equations (9), (10), (11) and (12), Where i denotes different individual, t denotes the time of sample observation, Y_{it} is the per capita gross domestic product growth rate of 5 subsequent years for country i at time t. d_{it} is the threshold and represents initial Gross government debt-to-GDP of country i in year t which is the main variable of interest and X_{it} represent the impact control variables used in the estimations such as Democracy, GDP per capita growth (annual %), Savings, Investment, Inflation, Institutions, Population country i in year t. $I(d_{it} > e) = 1$ when $d_{it} > e$ and 0 otherwise.

3.3.Data and descriptive statistics

Empirical study examinations were limited by data availability. Therefore, the explanatory variable selection was influenced by the previous variable selection of prior studies on this matter and the findings of Sala-i-Martin, Doppelhofer, and Miller (2004). To investigate the role of democracy as a possible mediating factor between debt and growth following Giordano and Tommasino (2011) findings of democratic quality, we use the Polity V dataset Institutionalized Democracy. At the same time, we follow Presbitero (2008), Daron Acemoglu, Johnson, Robinson, and Yared (2008), and D. Acemoglu, Gallego, and Robinson (2014) findings of evaluating the institutional quality as a mediating factor by using the Polity V dataset Revised Combined Polity Score.

Implementation of empirical studies between debt and economic growth poses several problems mentioned in the previous section, such as reverse causality and endogeneity. We follow standard practice in instrumentalizing the dependent variable, per capita GDP, as the average subsequent growth rate of per capita GDP over five years. All the independent variables are in initial values form in the sample of countries analyzed to mitigate the reverse causality problem. In other words, we will test the correlation of initial government debt, initial values of control variables, and subsequent growth of real per capita GDP.

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The initial debt of 1900 explains the GDP per capita of 1901, 1902, 1903, 1904, and 1905. The criteria balanced the data that the missing values were replaced by the average of the values of the sample under scrutiny.

3.3.1. Cross Country Analysis: Case Study 103 countries

The cross-country analyses of this dissertation use a balanced sample of 103 countries from 1986 to 2010. Data for the panel data study were collected from various sources, the World Bank (World Development Indicators) and the International Monetary Fund's (Historical Public Debt Database) and from the Center of System Peace (Polity V Project database). Per capita income, Investment, Initial domestic savings (% of GDP), Initial inflation rate, and Initial population size were collected from World Bank World Development Indicators. Gross government debt-to-GDP data were obtained from Historical Public Debt Database. See Table 1.

Table 1 Cross-Country Analysis - Variables Description and Sources

Variable	Description and sources
Democracy	Democracy Index (Marshall, 2020)
GDP per capita	GDP per capita growth (annual %) (Bank, 2021).
Savings	Gross domestic savings (% of GDP) (Bank, 2021).
Investment	Gross fixed capital formation (% of GDP)(Bank, 2021).
Debt	Gross government debt to GDP ratio (Ali Abbas, Belhocine, El-Ganainy, & Horton, 2011).
Inflation	Inflation, consumer prices (annual %) (Bank, 2021).
Institutions	POLITY2 score (Peace, 2020).
Population	Total Population (Bank, 2021).

Due to different concepts of public debt by countries across time and elements measured cross country analysis of the impact of debt on economic growth has to be applied with caution (Abbas, Belhocine, ElGanainy, & Horton, 2010; Ali Abbas et al., 2011). As a result, we use the International Monetary

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Funds' Historical Public Debt Database that homogenizes the different sources of individual country reporting and databases from researchers and international organizations. This dataset was constructed by instrumentalizing all the various sources to make a continuous time series and adapt the dataset to the ongoing changes made by the different primary sources.

The descriptive statistics for the cross-country study are the following. The decomposition of the data was conducted by the application of the R Statistics "plm" package (Croissant et al., 2020), and the R Statistics "pastecs" package (Grosjean, 2018) was used to obtain panel data descriptive statistics. The summary of the descriptive statistics is shown in Table 2, sample, mean, median, max value, min value, standard deviation, skewness, kurtosis, and the Shapiro-Wilk test.

Our panel data is balanced with size and is 2575 observations for all variables used in the cross-country study. The mean of dependent variable per capita growth rate instrumentalized as five years subsequent growth is 1.91 (SD=2.51), and the median Per capita growth rate is 1.85. This shows that data distribution is skewed with a -0.13 value; this means data has a long tail of the left side of distribution to the right since the mean is less than the median.

The independent variables such as debt magnitude measured to the gross domestic product mean are 73.32, and the median debt magnitude measured concerning the gross domestic product is 58.7. This shows that data distribution has a positive skew value of 17.96, which refers to a longer tail on the right. They understand the spread of the distribution; we find that the standard deviation is 122.76. The initial real GDP per capita variable averaged 1.86 with a midpoint of 1.85. Looking at the dispersion of data, we see that it is negative skew -1.07 with a standard deviation of 4.28.

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Table 2 Cross-Country Analysis - Descriptive Statistics, 1986 to 2014

Variable	Mean	Median	Standard Error Mean	Standard Deviation	Skewness	Kurtosis
Dependent Variable						
Real GDPpc	1.91	1.85	0.05	2.51	-0.13	2.02
Independent Variables						
Initial GDP per capita	1.85	2.11	0.08	4.28	-1.07	12.76
Initial investment	21.67	21.33	0.14	6.92	1.06	6.65
Initial savings	19.83	20.33	0.25	12.72	-0.14	2.70
Initial inflation rate	23.57	5.77	3.57	180.95	22.43	634.48
Initial population size	51.84	11.71	3.13	158.97	6.32	41.62
Initial debt	73.32	58.70	2.42	122.76	17.96	390.41
Democracy	4.03	7.00	0.24	12.32	-6.32	42.92
Institutional Quality	3.56	6.00	0.13	6.60	-0.63	-1.18

In terms of population, the total had a mean value of 51.84 million people. The majority of the data is skewed to the right, with a 6.32 value, and the median is 11.71, which is lower than the mean, followed by a high spread data from the mean with the 158.97 standard deviation score. The Savings data set has a mean of 19.83. Now the median is 20.33 and is negative skewed -0.14.

The univariate analysis of Investment has its central tendency with a mean of 21.67 and median of 21.337, and its dispersion is 6.92 measure by the standard deviation. The mean of inflation is 23.57 is greater than the median 5.77, is showing a right-skewed distribution with a positive skew value of 22.43 and a standard deviation of 180.95.

The univariate analysis of Democracy has its central tendency with a mean of 4.03 and median of 7, and its dispersion is 12.32 measure by the standard deviation. The mass distribution is concentrated on the right, with a negative skew -6.32. The mean of Institutional Quality is 3.56 is lower than the median of 6.00;

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this shows a negative skew of -0.63, with a distribution skewed to the left with a standard deviation of 6.6.

3.3.2. Within Country Analysis: Case Study USA

For the within-country analysis of this dissertation, we used three data sources, Mauro, Romeu, Binder, and Zaman (2015) and Maddison (2021), for our economic variables and Marshall (2020) for our institutional variable. It conducts an examination balance data set of the United States from 1900 to 2004.

The economic variables gathered at Public Finances in the Modern History database constructed by Mauro et al. (2015) are consistent with the IMF's World Economic Outlook classification definitions. The variables used are Real GDP growth rate as our dependent variables, Government revenue, percent of GDP, Government expenditure, percent of GDP, Interest paid on public debt, percent of GDP, Gross public debt, percent of GDP, the real long-term interest rate on gov't debt, and Institutional quality as our independent variables. Variable descriptions and sources are displayed in the following table.

Table 3 Time Series Data Variables Description and Sources

Variable	Description and sources
GDP per capita growth	Real GDP per capita growth rate (Maddison, 2021).
revenue,	Government revenue, percent of GDP, (Mauro et al., 2015).
expenditure,	Government expenditure, percent of GDP (Mauro et al., 2015).
Interest paid	Government Interest paid on public debt, percent of GDP (Mauro et al., 2015).
debt,	Gross government debt to GDP ratio (Ali Abbas et al., 2011).,
long-term interest rate	Government real long-term interest rate on debt (Mauro et al., 2015).
Institutional quality	POLITY2 score (Peace, 2020).

The descriptive statistics for the within-country study are the following. The sample size is 125 observations for the analysis of the United States. The

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summary of the descriptive statistics is shown in the Descriptive Statistics Within Country Studies.

The summary of the descriptive statistics are shown in Table 2, the sample, mean, median, max value, min value, standard deviation, skewness, and kurtosis. The mean of dependent variable per capita GDP growth rate instrumentalized as five years subsequent growth is 1.5, and the median Per capita growth rate is 1.66. This shows that data distribution is skewed to the right since the mean is less than the median. The mean of the dependent variable GDP instrumentalized as five years subsequent growth rate is 3.4 with a median value of 3.24, suggesting that the data is skewed to the right. The skewness is -0.95, proving that more values are concentrated on the right side of the distribution growth.

When the independent variables such as Debt magnitude are measured to the gross domestic product, the mean is 39.9, and the median debt magnitude measured concerning the gross domestic product is 42.52. This shows that the distribution of data is skewed to the right. To understand the spread of the distribution, we find that the standard deviation is 27.6. The initial real GDP per capita variable averaged 3.5with a midpoint of 3.36. Looking at the dispersion of data, we see that it is negative skew -0.08 with a standard deviation of 5.6.

Government revenue, percent of GDP, mean is 16, the median is 13.94. the mean and the media represent the skewing of data, and it is skewed to the right. Government expenditure, percent of GDP, data set has a mean of 18. The median is 15.93, showing outliers in the high-end distribution, suggesting that the data is skewed to the right.

The univariate analysis of Interest paid on public debt, percent of GDP, has its central tendency with a mean of 1.3 and median of 1.32. Its dispersion is one measure by the standard deviation. The univariate analysis of the Real long-term

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interest rate on government debt percent has its central tendency with a mean of 2.5 and median of 3.15. Its dispersion is 4.6 measure by the standard deviation. The mass distribution is concentrated on the right, with a negative skew of -0.87.

Table 4 Time Series USA Data Descriptive Statistics, 1882 to 2006

	Central Tendency		Dispersion or Variation		
Variable	Mean	Mean	Standard Deviation	Skewness	Kurtosis
Dependent Variable					
Real GDPpc	1.5	1.66	2.3	-0.95	6.89
Independent Variables					
Initial GDP per capita	1.5	2.15	4.8	-0.97	5.20
Initial GDP	3.5	3.36	5.6	-0.08	4.16
Initial Revenue	16	13.94	13.1	0.23	1.28
Initial Expenditure	18	15.93	14.7	0.20	1.33
Initial Interest Rate Paid	1.3	1.32	1	0.58	2.37
Initial Debt	39.9	42.52	27.6	0.37	2.65
Initial Long-Term Bond Interest rate	2.5	3.15	4.6	-0.87	6.24
Initial Institutional Quality	9.2	9	0.5	0.18	2.93
Initial Population	156760.8	138937	71297.9	0.36	1.93
Growth Revenue	1	0.64	12.2	1.36	8.86
Growth Expenditure	-0.8	-0.12	27.5	-4.57	41.39
Growth Interest Rate Paid	-0.7	-2.09	15.7	1.32	12.17
Growth Debt	-0.2	-2.5	13.3	2.11	10.56
Growth Long Term Bond Interest Rate	-62.1	0.17	513.8	-5.88	41.73
Growth Institutional Quality	0.1	0	2.1	5.07	74.04
Growth Population	1.4	1.33	0.5	0.19	1.98
Debt to GDP*Debt growth rate	0.4	-0.34	5.3	2.00	11.78

DOI:10.6814/NCCU202101114

The mean of Institutional Quality is 9.2 is lower than the median of 9.00; this shows a positive skew of 0.18, with a distribution skewed to the right with a standard deviation of 0.5. Regarding population, the total had a mean value of 156760.8 thousand people. The majority of the data is skewed to the right because the media is 138937 thousand people, which is lower than the mean, followed by a high spread data from the mean with the 71297.9 standard deviation score.

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4. Results and Discussion: Cross Country Analyses

Before estimating to produce statistically robust results from panel data analysis, we conducted five-panel unit root models test if the variables are stationary and one normality test. Later, we operate three types of regressions for the cross-country analysis. GDP per capita growth with five years subsequent growth is the dependent variable and initial values of real GDP per capita, domestic investment (% of GDP), domestic savings (% of GDP), inflation rate, population size, institutional democracy and institutional quality as explicative variables.

4.1.Data Diagnostic Tests

The five-unit root tests were: Maddala-Wu Unit-Root Test (Maddala & Wu, 1999), Im-Pesaran-Shin Unit-Root Test (Im, Pesaran, & Shin, 2003), Choi's modified P Unit-Root Test (Im et al., 2003), Choi's Inverse Normal Unit-Root Test (Im et al., 2003) and the Levin-Lin-Chu Unit-Root Test (Levin, Lin, & James Chu, 2002) to test stationarity. Results in Table 5 show that the data is stationary.

Table 5 Unit Root Tests – Cross Country data, 1986 to 2014

Variable	Maddala-Wu Unit-Root Test	Choi's modified P Unit-Root Test	Im-Pesaran-Shin Unit-Root Test	Choi's Inverse Normal Unit-Root Test	Levin-Lin-Chu Unit-Root Test
Dependent Variable					
Real GDPpc	-0.185*** (-17.170)	-0.185*** (-17.170)	-0.185*** (-17.170)	-0.185*** (-17.170)	-0.185*** (-17.170)
Independent Variables					
Initial real GDP per capita	-0.616*** (-22.402)	-0.616*** (-22.402)	-0.616*** (-22.401562)	-0.616*** (-22.402)	-0.616*** (-22.402)
Initial Investment	-0.150*** (-13.532)	-0.150*** (-13.532)	-0.150*** (-13.531)	-0.150*** (-13.532)	-0.150*** (-13.532)
Initial Saving	-0.090*** (-10.166)	-0.090*** (-10.166)	-0.0904*** (-10.166)	-0.090*** (-10.166)	-0.090*** (-10.16)

DOI:10.6814/NCCU202101114

Initial inflation rate	-0.492*** (-22.135)	-0.492*** (-22.135)	-0.492*** (-22.135)	-0.492*** (-22.135)	-0.492*** (-22.135)
Initial population size	-0.039*** (-7.135)	-0.039*** (-7.135)	-0.039*** (-7.135)	-0.039*** (-7.135373)	-0.038786*** (-7.135)
Initial Debt	-0.175*** (-12.906)	-0.175*** (-12.906)	-0.175*** (-12.906)	-0.175*** (-12.906233)	-0.175*** (-12.906)
Democracy	-0.394*** (-21.293)	-0.394*** (-21.293)	-0.394*** (-21.293)	-0.394*** (-21.293)	-0.39399639*** (-21.292)
Institutional Quality	-0.0839*** (-10.659)	-0.084*** (-10.659)	-0.084*** (-10.659)	-0.084*** (-10.659)	-0.0839*** (-10.659)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t-values

We applied a Shapiro-Wilk test for normality (Shapiro & Wilk, 1965) and found that the variables are normally distributed. See Table 6

Table 6 Normality Test – Cross Country data, 1986 to 2014

Test	*Real GDPpc*	*Initial GDP per capita*	*Initial investment*	*Initial savings*	*Initial inflation rate*	*Initial population size*	*Initial debt*	*Democracy*	*Institutional Quality*
Shapiro-Wilk Test	0.98*** (0.01)	0.91*** (0.01)	0.95*** (0.01)	0.98*** (0.01)	0.08*** (0.01)	0.29*** (0.01)	0.24*** (0.01)	0.35*** (0.01)	0.84*** (0.01)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the p-values

Our literature review noticed that the cross-country studies mainly examined how governmental debt influences a country's gross domestic product per capita growth to its gross domestic product. We acknowledge that the impact of debt may vary over time within countries, mainly due to financial market development and the complexity of financial products.

We consider two types of analysis to examine how its governmental debt influences a country's gross domestic product per capita growth to its gross domestic product. Firstly, it analyzes the changes of economic growth per capita explained by the effect of governmental debt using two models, one with no institutional variable and another with an institutional variable. The cross-country

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analysis uses GDP per capita growth five years subsequent growth as the dependent variable, and initial values of real GDP per capita, domestic investment (% of GDP), domestic savings (% of GDP), inflation rate, population size and, institutional democracy and institutional quality as explicative variables. The Threshold Regression with Sample Splitting requires two threshold variables. Hence, its first model used debt and Institutional quality, and the second regression uses debt and democracy.

The literature analyzing debt and growth exposes that there are inconsistent results. Consequently, we want to explore if estimating the conditional median of the outcome variables and not the conditional mean can provide some light in this area. We examine the relationship of both variables using a panel quantile regression. The contribution of the usage of this technique is that it can also provide a better understanding of the concerns of heterogeneous effects of debt depending on the different growth rates, and to our knowledge is the first study using this technique.

4.2. Quantile Regression with Fixed Effects: Model 1

The quantile regressions used a quantile regression methodology in a fixed-effect panel data framework. Model 1 examines the whole sample of 103 countries in Table 7 regression results. Firstly, debt has a constant negative impact in all percentiles ranging from -0.0013 to -0.0001. Secondly, debt has a low impact on growth at the 10th and 25th percentile (-0.0013) and later increases, having a peak impact at the 50th percentile (-0.0016) to diminish to low marginal levels at 75th and 90th -0.006 and -0.001, respectively. Thirdly, the only statistically significant effect is at the 25th percentile with a 10 percent significance level.

Initial GDP per capita and population are associated with modest increases in GDP per capita growth. However, both variables have a more significant

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positive impact at a low level and gradually decreasing effect; initial GDP per capita values between 0.1 and 0.05, population values between 0.07 to 0.05) over the whole range the percentile distribution. Institutional quality was statistically significant at the low percentiles 10th to 50th. Additionally, both variables are statistically significant at 10% and 1 % significance levels. Savings, investment, inflation, and democracy were not statistically significant.

Table 7 Model 1 Quantile Regression with Fixed Effects: Regression estimates

	Percentile				
Variable	*10th*	*25th*	*50th*	*75th*	*90th*
Initial Debt	-0.0013 (-1.07)	-0.0013* (-1.71)	-0.0016 (-1.57)	-0.0007 (-0.39)	-0.0001 (-0.03)
Initial real GDP per capita	0.0903*** (3.01)	0.1002** *(4.79)	0.0809*** (4.01)	0.0841*** (4.99)	0.0498*** (1.85)
Initial Investment	-0.0092 (-0.33)	-0.0025(- 0.13)	0.0044 (0.25)	0.0114 (0.52)	0.0193 (0.67)
Initial Saving	-0.0053 (-0.47)	-0.0084(- 0.91)	-0.0133 (-1.36)	-0.0142 (-1.29)	-0.0135 (-0.86)
Initial inflation rate	-0.0028 (-1.37)	-0.0003(- 0.27)	0.0001 (0.02)	0.0001 (0.11)	0.0004 (0.71)
Initial population size	0.0067*** (5.32)	0.0058*** (5.03)	0.0054*** (5.08)	0.0051*** (3.97)	0.0055*** (3.91)
Initial Democracy	0.0032 (0.38)	3 (-0.05)	0.0021 (0.33)	-0.0065 (-0.8)	-0.0133 (-1.19)
Initial Institutional Quality	0.0941*** (3.12)	0.0615*** (3.12)	0.0316*** (1.65)	0.0227 (1.34)	0.0292 (1.17)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

As a result, our Model 1 addresses some concerns of previous scholars of influence of outliers, linearity, homoscedasticity, independence, and normality. Overall, it supports the findings of some authors in the literature review section that debt has a heterogeneous effect on economic growth. The significance of debt is not constant in all percentiles, so this may be the reason previous studies show sensibility of regression results depending on the country sample and period

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selection because debt exhibits heterogeneous behavior under different economic growth rates. Our findings show a new type of heterogeneity that debt-to-GDP levels only cause constraints to economic growth at the 25th percentile.

The idea that debt usage may help promote economic growth in low-growth scenarios is refuted in our results. Debt harms economic growth in low growth scenarios, and it had a statistically harmful impact on the changes on GDP per capita growth at the 25th percentile. Our results seem to suggest that the classical view is predominant, debt has a harmful effect on long-term economic growth independently of the growth rate, but the significance is heterogenous depending on the conditional growth regime.

Our policy recommendation is that debt should be carefully used to promote long-term economic growth. Our Quantile results show that debt does not promote growth in the long term in the case of the vas variety of countries independently of the economic situation. Due to heterogenous effects of debt on growth, an indepth analysis must be conducted if our generalized analysis of 103 countries fits the country under scrutiny.

The fixed-effects quantile regression results are consistent with the argument exposed in the literature review section; debt has a heterogenous impact on economic growth performance. The change of degree of impact may be attributed to the fact that our results are sensitive to time-varying growth rates as countries increase their level of development and are subject to external shocks such as various economic crises experienced. Since we use quantile regression fixed effects, we partially solve the heterogeneity issues, but the country heterogeneity in economic development within the same country remains. As an illustration, different country income groups may experience different growth rates; Korea transitioned from a developing country to a high-income country, while Germany has always been categorized as a high-income country.

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Additionally, it is empirical that high-income countries have diminished their growth rates, and economists attribute this to the development stages these countries belong to and other factors. As a result of all these, these changes in growth rates within the same countries may skew the results due to the transitioning of development stages during the period analyzed. No studies conducting quantile regression were found analyzing debt and growth.

Next, we expose the results of the threshold regression effects in non-dynamic panels (B. E. Hansen, 1999). We want to explore the possibility of more than one threshold effect. The contribution of the usage of this technique is that it can also provide a better understanding of the concerns of the presence of 1 or more threshold effects. B. E. Hansen's (1999a) framework solves the ad hoc method group countries according to the different debt ratios. As a result, this method permits us to observe the influence of the debt-to-GDP ratio on GDP per capita growth in an endogenous threshold model.

4.3. Threshold Regression: Model 2

Model 2 used initial debt as the threshold variable and trimmed off 5% at both sides for the threshold estimator in all models. The bootstrap number of 300 respectively to calculate the LR Test (F-statistic) and its p-value of the models used. The LR test for threshold effects is also called the likelihood ratio statistic $F(\gamma)$, is based on a bootstrap method to simulate the asymptotic distribution. This bootstrap estimates the asymptotic p-value. Additionally, the stationary tests show that all the variables have stationarity characteristics. These findings permit the usage of the threshold regression model made by B. E. Hansen (1999).

The observations are divided into regimes depending on whether the threshold variable debt is lower or more prominent than the threshold value; in our case, it has four regimes for a given triple threshold. This method assumes that the threshold variable debt is not time-invariant and identifies the threshold

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level of debt above which debt influences growth differently than at a low debt-to-GDP ratio.

First, we test the significance of the single threshold model, in which the null hypothesis is there is no threshold and if it is rejected means that the model is non-linear:

$$\beta_1 = \beta_2 \tag{13}$$

The null hypothesis of no threshold is rejected if the p-value is smaller than the critical value. We find that in the results for our Model 2, a single threshold is significant at the 1% level, with a bootstrap p-value of 0.01. The F_1 statistics of 42.1147 is more prominent than its critical value at a 1% significance level of 41.7. As a result, F-statistic, $F_1 = 42.1147$, is highly significant with a p-value of 0.01, and the estimator of the single threshold is 39.26% with a 99% confidence interval.

Next, we test the significance of the double threshold model, in which the null hypothesis is that the existence of one threshold is rejected in favor of two thresholds if F_2 is large (B. E. Hansen, 1999). We find that the test results for a double threshold are insignificant, with a low F-statistic, $F_2 = 15.5478$ and a p-value of 0.48. Consequently, we conclude that there is no double threshold effect of debt ratio on GDP per capita.

Table 8 Model 2 Threshold effects in non-dynamic panels - Tests for threshold effects

Variable	*Single Threshold*	*Double Threshold*	*Triple Threshold*
Threshold value	39.26	39.26, 125.22	39.26, 48.9, 125.22
Threshold Confidence Region 95%	(38.11 - 40.65)	(48.9 - 137.27)	(14.65 - 105.11)

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F-Statistic	42.1147	15.5478	30.3947
p-value	0.01**	0.48	0***
Critical Values of F-Statistics (10%, 5%, 1%)	28.6, 30.9 and 41.7	28.8, 35.2 and 37.7	15.6, 18.4 and 23.1

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01.

Next, we test the significance of the triple threshold model, in which the null hypothesis is that the existence of two thresholds is rejected in favor of three thresholds if F_3 is large. The F_3 statistics of 30.3947 is more prominent than its critical value at a 1% significance level of 23.1. As a result, F-statistic, $F_3 = 30.3947$, is highly significant with a p-value of 0.01, and the estimator of the triple threshold is 39.26%, 48.9%, 125.22% with a 95% confidence interval between 14.65% to 105.11%.

The regression slope estimates are shown in Table 9. The regression slope estimates, conventional OLS standard errors, and White corrected standard errors are shown. The coefficients of primary interest are those of the triple threshold. Investment, Initial population size, Democracy Institutional Quality are positively related to economic growth. Meanwhile, Saving and Initial inflation rates are negatively associated with economic growth. Based on Hansen's methodology, the threshold estimates are consistent, and according to the distribution, Theorem 1 is correct up to a scale effect according to the asymptotic confidence intervals.

Table 9 Model 2 Threshold effects in non-dynamic panels - Regression estimates

Variable	*Single Threshold*	*Double Threshold*	*Triple Threshold*
regime-dep covariates			
Initial Debt	-0.0253*** (-5.66)	-0.0135*** (-2.57)	-0.0187*** (-3.17)
Initial Debt	-0.001*** (-2.24)	0.0061*** (3.18)	-0.0026 (-0.63)

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Initial Debt		-0.0008* (-1.71)	0.0051*** (2.58)
Initial Debt			-0.0008* (-1.93)
regime-indep covariates:			
Initial Investment	0.0008 (0.06)	0.0039 (0.31)	0.004 (0.31)
Initial Saving	-0.0618*** (-6.34)	-0.0615*** (-6.37)	-0.0613*** (-6.37)
Initial inflation rate	-0.0003 (-1.11)	-0.0003 (-1.17)	-0.0004 (-1.3)
Initial population size	0.0101*** (7.33)	0.0095*** (7)	0.0093*** (6.76)
Initial Democracy	0.0009 (0.22)	0.0003 (0.06)	0.0005 (0.12)
Initial Institutional Quality	0.1385*** (9.5)	0.1429*** (9.72)	0.1441*** (9.76)
mean squared error	8992.801	8938.828	8918.822

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

The results in Table 9 imply that in the cases of our single threshold and triple threshold model, the effect of debt in four regimes is relevant: When Debt to GDP is below 39.26%, the negative coefficient of -0.019 implies negative changes in economic growth explained by the influence of governmental debt per capita growth. When Debt to GDP is between 39.26% to 48.9%, the negative coefficient of -0.003 implies negative changes of economic growth explained by the influence of governmental debt per capita growth. When Debt to GDP is between 48.9% to 125.22%, the positive coefficient of 0.005 implies positive changes in economic growth explained by the influence of governmental debt per capita growth. When Debt to GDP is above 125.22%, the negative coefficient of -0.001 implies negative changes in economic growth explained by the influence of governmental debt per capita growth.

The findings indicate a non-linear relationship. In effect, the results show that debt can influence growth in different ways depending on the level of the

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Debt-to-GDP ratio. We find evidence of the existence of three threshold levels of debt in the regression relationship. These thresholds divide the observations into four regimes, in which the impact of debt on growth will be inverse. Additionally, our results suggest that the optimal level of Debt magnitude measured to the gross domestic product is between 48.9% to 125.22% to obtain a positive outcome from debt with current characteristics of countries.

The excessive use of debt may harm economic growth because of crowding out effects and debt overhang. Therefore, the governments should investigate whether their debt levels are excessive and which regime they are situated in. If the debt level is too big or small, the efficiency of debt may not be optimal.

Debt managers ought to examine their country's indebtedness levels concerning GDP to find their specific tipping point before debt harms economic growth. A correct fiscal policy must consider the country's economic development status and its institutional qualities to determine correctly from beyond which public debt level harms economic growth to maximize economic growth.

Our special assessment of conduction regression analysis of countries omitting differences by geographics and income provided a special assessment. Other studies divided the sample by income groups (Cordella et al., 2009; Égert, 2015a) or geographical characteristics (Calderón & Fuentes, 2013; Cristina Checherita-Westphal & Philipp Rother, 2012). In the study that applied the same threshold technique, Égert (2015a) found a triple threshold effect in his study of advanced and emerging economies between 20 to 60 percent using data from 1946 to 2009.

Next, we will test the effects of two different institutional variables, which might better understand which institutional characteristics should be observed.

DOI:10.6814/NCCU202101114

The literature exposes heterogenous threshold effects of debt using incorporating institutional assessments in their models in ad-hoc manners. We learned that debt impacts economic growth depending on the levels of indebtedness that this relationship is influenced institutional quality in a given country.

This led us to apply the next threshold regression model with sample splitting developed by B. E. Hansen (2000) with slight modification by Tsung-Wu (2018), enabling heteroskedastic errors. This model uses Hansen's hetero-corrected bootstrap technique, which is appropriate when the error terms are heteroscedastic since it provides a perfect bootstrap reference when there is heteroscedasticity. The contribution of the usage of this technique is that it can offer a better understanding of how debt impacts growth above in a low and high institutional setting depending on the debt level of the country in an endogenous manner, avoiding the Adhoc sample splitting of countries according to their institutional characterization.

4.4. Threshold Regression - Sample Split Effects: Model 3 and Model 4

Panel data Threshold Regression developed by B. E. Hansen (2000) enables us to explore the heterogeneity in how a country's gross domestic product per capita growth is influenced by its governmental amount of debt to its gross domestic product considering institutional characteristics. This model permits threshold estimation of sample splitting in a regression tree analysis proposed by Durlauf and Johnson (1995) endogenously. We can identify the effects of debt below and above the threshold combined with the institutional threshold variable in each subgroup endogenously. Model 3 uses institutional quality as the second threshold variable, and Model 3.2 uses democracy as the second threshold variable. Model 3 analyzes how debt impacts growth when countries already have high indebtedness to their GDP levels distinguished by their institutional quality. See Table 10.

DOI:10.6814/NCCU202101114

Firstly, we examine the first sample Split to identify if there is the existence of a threshold effect. Then, two regressions are conducted to analyze the significance test of the single threshold model for Debt and another case of the Institutional Quality variable. The null hypothesis is that there is no threshold, and if it is rejected, it means that the model is non-linear:

$$\beta_1 = \beta_2 \tag{14}$$

The null hypothesis is rejected with F Statistic higher than the critical value, and the p-value is smaller than 0.01. Our first regression shows that debt has a single threshold with significance at the 1% level, with F_1 statistics of 45.7. Next, second regression examining of the existence of threshold effect of Institutional Quality is also statistically significant 1% level, with F_2 statistics of 135. Both variables have one threshold effect in our data sample.

Secondly, we examine the second sample Split to identify if there is the existence of a second threshold within the subsample of debt. In other words, we split the sample again in two based on the initial GDP. Results show that there are no second significant threshold effects within the debt thresholds obtained in the first sample split using debt with a p-value of 0.103 and F_3 statistics of 15.4. No further sample split could be conducted.

Next, the fourth regression calculates the threshold effects of institutional quality in the Sub-Sample debt above 95.34% debt-to-GDP ratio. Results show a possible threshold effect with a F_4 statistics of 28.4 with a p-value of 0.00. The model intends to conduct further splits in the Third Sample Split, but none met the required bootstrap significance tests, and a higher observation quantity is needed to analyze further.

DOI:10.6814/NCCU202101114

Table 10 Model 3 Sample Splitting and Threshold Estimation for Institutional Quality - Tests for threshold effects

Variable		Test Sample Split		
	Variable	*F-Stat*	*P-value*	
First Sample Split	Debt	45.7449	0	Pass
First Sample Split	Institutions	135.12819	0	Pass
Second Sample Split	Debt	15.84607	0.1033333	Fail
Second Sample Split	Institutions	28.38536	0	Pass
Third Sample Split	Debt	13.74368	0.21	Fail
Third Sample Split	Institutions	22.03464	0	Fail
Third Sample Split	Debt	17.84157	0.06	Fail
Third Sample Split	Institutions	25.58689	0	Fail

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01.

Table 12 shows the regression slope estimates of the regression models 5. Let us first analyze our primary explicative variable, debt. When the debt level is below 92.15% of debt magnitude measured to the gross domestic product, the coefficient is negative with -0.0014, but the confidence interval includes zero, making the results insignificant. Later, when the debt level is above 95.34%, Debt magnitude measured to the gross domestic product debt has a statistical negative significant impact on economic growth, the negative coefficient of -0.0011 suggests that debt is negatively correlated to GDP per capita and the confidence interval ranges between (-0.01 to -0.01).

Table 11 Model 3 Sample Splitting and Threshold Estimation for Institutional Quality – Regression Estimates

	Testing for a First Sample Split, Using Debt			
	Below Threshold debt <=92.15		Above Threshold debt>92.15	
	Coef.	*CI 95%*	Coef.	*CI 95%*
Investment	0.0164 (1.04)	(-0.0153 to 0.0473)	-0.0218 (-1.03)	(-0.2455 to 0.0279)
Saving	-0.07*** (-2.88)	(-0.1176 to 0.023)	0.0401 (3.24)	(0.0158 to 0.1866)

DOI:10.6814/NCCU202101114

Inflation	0.008 (0.87)	(-0.0102 to 0.026)	-0.003 (-2.29)	(-0.0059 to -0.0002)
Population	0.0466*** (4.44)	(-0.0016 to 0.0672)	-0.0095 (-2.73)	(-0.0163 to 0.0002)
Debt	-0.0014*** (-2.86)	(-0.0024 to -0.0003)	-0.0004 (-0.7)	(-0.012 to 0.0068)
Degrees of Freedom:	2017		546	
Sum of Squared Errors:	11167.84		3104.343	
Residual Variance:	5.536855		5.685609	
R-squared:	0.1265783		0.03032825	

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

The impact of debt on economic growth when debt magnitude measured to the gross domestic product is above 92.15 will vary depending on the country's institutional quality. However, we notice two effects: Firstly, when governments have a polity2 score below -6 polity two scores, Debt has a statistically negative impact on growth with a coefficient of -0.0014, with a confidence interval of between (-0.0023 to -0.0004). Secondly, when countries have a polity2 score above -6, Debt harms growth with a coefficient of -0.0003, but with a confidence interval between (-0.0119 to 0.006). Consequently, the results are not statistically significant.

Investment positively affects economic growth with a coefficient of 0.09 if the debt level is below 95.3% of debt to GDP but negatively impacts the threshold with -0.01. The coefficient shows a positive effect on growth in Models 5, and when debt levels are above 92.15 and countries have a polity2 score below -6, and the results are negative, but in countries with debt level above 92.15 and a polity two score above -6 is -0.03.

Table 12 Model 3 Sample Splitting and Threshold Estimation for Institutional Quality - Estimated Coefficients

Testing for Sub-Sample debt > 92.15, Using Institutional Quality

DOI:10.6814/NCCU202101114

	Below Threshold polity2<=-6		*Above Threshold polity2>-6*	
	Coef.	*CI 95%*	Coef.	*CI 95%*
Debt	-0.0014*** (-2.86)	(-0.0024 to -0.0003)	-0.0004 (-0.7)	(-0.012 to 0.0068)
Invest	0.0164 (1.04)	(-0.0153 to 0.0473)	-0.0218 (-1.03)	(-0.2455 to 0.0279)
Saving	-0.07*** (-2.88)	(-0.1176 to 0.023)	0.0401 (3.24)	(0.0158 to 0.1866)
Inflation	0.008 (0.87)	(-0.0102 to 0.026)	-0.003 (-2.29)	(-0.0059 to -0.0002)
Population	0.0466*** (4.44)	(-0.0016 to 0.0672)	-0.0095 (-2.73)	(-0.0163 to 0.0002)
Degrees of Freedom:	156		384	
Sum of Squared Errors:	983.4903		1878.794	
Residual Variance:	6.304425		4.892693	
R-squared:	0.1730853		0.06450354	

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

Next, we examine Model 3.2 that modified the second threshold variable to Democratic Quality instead of Institutional quality in Model 3. Finally, we report the results of the threshold regression sample split using debt as our first threshold variable and democratic quality as our second threshold variable in Table 13.

The model rejects the null hypothesis in the first sample split with no threshold effect at the 1% significance level, and the threshold is apparent. Therefore, debt and democratic quality have non-linear effects on GDP per capita growth. Then the sample is then divided into countries with high or low debt to GDP levels, according to the threshold variables debt. Next, we observe the second sample split, where Debt fails with no statistical significance with a p-value of 0.12. Later we test a second sample split, using democracy as the threshold, and observe significance with an F-Statistic of 26.7 with a p-value of 0.00. Finally, we evaluate a possible third sample split, but the Bootstrap P-Value,

DOI:10.6814/NCCU202101114

the LM tests of both sub-regimes, do not have statistical significance. We do not continue further due to a lack of statistically significant results.

Table 13 Model 4 Sample Splitting and Threshold Estimation for Democratic Quality - Threshold Regression Effects

Variable		*Test Sample Split*		*Threshold*	
	Variable	*F-Stat*	*P-value*	*Estimate*	*Verdict*
First Sample Split	Debt	45.7449	0		Pass
First Sample Split	Democracy	140.41407	0		Pass
Second Sample Split	Debt	15.84607	0.123333333		Fail
Second Sample Split	Democracy	26.72858	0		Pass
Third Sample Split	Debt	16.37813	0.063333333		Fail
Third Sample Split	Democracy	39.10929	0		Fail
Third Sample Split	Debt	20.04066	0		Fail
Third Sample Split	Democracy	17.18607	0.003333333		Fail

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01.

Table 14 presents the estimated coefficients. We see debt has a negative coefficient, but it insignificantly impacts GDP per capita growth below debt level 92.5%. If the debt ratio is higher than 92.15 percent, the estimated coefficient is - is -0.01, which implies that GDP per capita decreases 0.01 percent with an increase of 1 percent. The results suggest a debt overhang effect beyond 92.15 percent, harming the GDP per capita growth.

Table 14 Model 4 Sample Splitting and Threshold Estimation for Democratic Quality - Estimated Coefficients

	Testing for a First Sample Split, Using Debt			
	Below Threshold debt <=92.15		*Above Threshold debt>92.15*	
	Coef.	*CI 95%*	Coef.	*CI 95%*
debt	-0.0015 (-0.57)	(-0.0078 to 0.0041)	-0.0012*** (-2.6)	(-0.0021 to -0.0001)
invest	0.0826*** (6.22)	(0.0523 to 0.109)	-0.0013 (-0.1)	(-0.0396 to 0.0324)
saving	-0.0161*** (-2.61)	(-0.0283 to -0.0002)	0.0118 (0.9)	(-0.0346 to 0.0506)
infla_wdi	0.0002	(-0.0004 to 0.0006)	-0.0028***	(-0.0062 to 0.0009)

DOI:10.6814/NCCU202101114

	(0.93)		(-2.1)	
pop	0.004*** (13.85)	(0.0034 to 0.0045)	-0.0018 (-0.59)	(-0.0124 to 0.0095)
Degrees of Freedom:	2017		546	
Sum of Squared Errors:	11167.84		3104.343	
Residual Variance:	5.536855		5.685609	
R-squared:	0.1265783		0.03032825	

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

Our findings for a second sample split imply that the more outstanding the democratic quality of the country, the adverse debt effects are statistically insignificant due to the confidence interval including zero. On the other hand, the estimated coefficient of debt when the country has a low democratic quality has a statistically significant negative effect. This implies that GDP per capita decreases by -0.01 percent with an increase of 1 percent in debt ratio for countries with a debt threshold of more than 92.15% and have lower democratic quality than 7.Model 4

Table 15 Model 4 Sample Splitting and Threshold Estimation for Democratic Quality - Estimated Coefficients

	Testing for Sub-Sample debt > 92.15, Using Democratic Quality			
	Below Threshold polity2<=7		*Above Threshold Democ>7*	
	Coef.	*CI 95%*	Coef.	*CI 95%*
debt	-0.0012*** (-2.63)	(-0.0023 to -0.0003)	-0.0027 (-0.57)	(-0.0119 to 0.0066)
invest	0.0157 (1.14)	(-0.0221 to 0.0427)	-0.1688*** (-4.55)	(-0.2416 to 0.0429)
saving	-0.0064 (-0.43)	(-0.0785 to 0.0227)	0.135*** (5.24)	(0.0278 to 0.1855)
infla_wdi	-0.0058*** (-5)	(-0.0099 to 0.0233)	-0.001*** (-2.43)	(-0.006 to -0.0002)
pop	0.012 (1.79)	(-0.0013 to 0.0474)	-0.0077* (-1.96)	(-0.0178 to 0.0001)

DOI:10.6814/NCCU202101114

Degrees of Freedom:	403		137	2017
Sum of Squared Errors:	2379.582		503.88	11167.84
Residual Variance:	5.904669		3.677956	5.536855
R-squared:	0.05940646		0.2466942	0.1265783

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

The quality of institutions, the measure by the institutional quality, and democracy have statistically significant effects in modifying the impact of debt above a certain threshold. First, the regression results show that in countries with a debt threshold above 92.15%, the effect of debt will depend on the quality of their institutions and democratic quality. Second, when governments are below their respective institutional threshold, debt has a significant negative impact.

Second, despite both institutional variables being relevant, we can observe that the confidence interval of institutions is vast since the Institutional threshold is -6 when the polity2 score ranges from -10 to 10. Meanwhile, the democratic assessment seems more precise, with a threshold value of 7 and the range of the variable contents from -10 to 10.

Third, the most considerable adverse effect of debt is experienced by countries with poor institutional scores, either institutional or democratic evaluations. Taken on the whole, the results imply that while there is some evidence of debt overhang, this type of behavior is only confined to the portion of countries with low-quality institutions. Our results indicate that the impact on growth is not uniform for all countries in the within-country study.

The insignificant impact of debt on economic growth in models 5 and 6 when countries have strong institutions may be attributed to the fact that countries with better institutions tend to use resources more efficiently (Law, Ng, Kutan, & Law, 2021). Equally important, Daron Acemoglu, Johnson, and Robinson (2005)

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exposed the importance of institutions as factors of economic growth, and low-quality institutions lead to poor economic policies and investment decisions (Robinson & Acemoglu, 2012).

Our policy recommendation is that policymakers invest considerable resources in improving government effectiveness to build strong institutions. Debt management has to consider the evolving debt levels and institutional characteristics to improve the effectiveness of fiscal policy to promote economic growth. Institutions are an essential determinant of economic growth and limit adverse effects caused by high debt levels.

The regression results exposed in models 5 and 6 provide similar insights studies that included institutional characteristics in their regression to address country-specific heterogeneities showing that solid institutions can offset the harmful influence of high debt levels relative to GDP has on economic growth (Giordano & Tommasino, 2011; Kourtellos et al., 2013; Law et al., 2021; Masuch et al., 2017; Presbitero, 2008). The classification of country samples by their institutional strength usage of different assessments of institutional quality can modify the effects of high public debt on economic growth and the importance of institutions as factors of economic growth.

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5. Results and Discussion: Within-Country Analysis

The selection of within-country analysis was performed to avoid several heterogenous country characteristics that may influence cross-country analysis in the previous sections. Additionally, it permits us to use unique econometric techniques available only to time-series research. Finally, the country selection was mainly based on data availability, and it is predominantly in the literature to use the United States of America as a case study.

5.1.Data Diagnostic Tests

Before the estimation to produce statistically robust results from panel data analysis, we conducted a normality test and three tests of panel unit root models to test if the variables are stationary. Five unit root tests were conducted: Maddala-Wu Unit-Root Test (Maddala & Wu, 1999), Im-Pesaran-Shin Unit-Root Test (Im et al., 2003), Choi's modified P Unit-Root Test (Im et al., 2003), Choi's Inverse Normal Unit-Root Test (Im et al., 2003) and the Levin-Lin-Chu Unit-Root Test (Levin et al., 2002) to test stationarity.

The stationary results fail when analyzing the variables in level. We proceeded to change the measurement of variables and used growth rate to circumvent the statistical problems of the variables. However, using the variables in growth rates complies with the standards to examine the long-run relationship between the economic growth and debt and the other control variables. After modifying the data to growth rate, we can observe improvement in the normality tests and unit root tests. Although this is true, the population growth rate continued not to meet our standards of quality control of variables and was ultimately taken out of our estimation models.

Next, we applied a Shapiro-Wilk test for normality (Shapiro & Wilk, 1965) and found that the variables are normally distributed.

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Table 16 Normality and Stationarity Tests - Within Country data 1882 to 2006

	Normality Test		Stationarity Test		
Variable	Shapiro-Wilk normality test	Jarque Bera Test	Augmented Dickey-Fuller Test	Phillips-Perron Unit Root Test	KPSS Test for Level Stationarity
Dependent Variable					
Real GDPpc	0.89*** (0.00)	97.56*** (0.00)	-5.58** *(0.01)	-35.10*** (0.01)	0.15*** (0.1)
Real GDP	0.91*** (0.00)	119.17*** (0.00)	-5.51*** (0.01)	-35.18*** (0.01)	0.08*** (0.1)
Independent Variables					
Growth Revenue	0.88*** (0.00)	217.42*** (0.00)	-6.97*** (0.01)	-87.96*** (0.01)	0.083888** *(0.1)
Growth Expenditure	0.59*** (0.00)	8112*** (0.00)	-5.9464*** (0.01)	-97.48*** (0.01)	0.06*** (0.1)
Growth Interest Rate Paid	0.84** (0.00)	474.25*** (0.00)	-4.83*** (0.01)	-73.5*** (0.01)	0.27*** (0.1)
Growth Debt	0.83*** (0.00)	390.39*** (0.00)	-5.21*** (0.01)	-66.5*** (0.01)	0.13*** (0.1)
Growth Long Term Bond Interest Rate	0.35*** (0.00)	8532.9*** (0.00)	-3.91*** (0.02)	-155.9*** (0.01)	0.22*** (0.1)
Growth Institutional Quality	0.12*** (0.00)	26821*** (0.00)	-4.78*** (0.01)	-123.9*** (0.01)	0.04*** (0.1)
Growth Population	0.96*** (0.00)	6.15*** (0.05)	-2.9 (0.20)	-18.96 (0.08)	1.3197 (0.01)
Debt to GDP*Debt growth rate	0.75*** (0.00)	485.11*** (0.00)	-4.9817*** (0.01)	-49.51*** (0.01)	0.06*** (0.1)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

5.2.ARLD bound test for Cointegration

Next, we apply an ARLD bound test created by Pesaran et al. (2001) to test the long-run relationship between the variables. The Autoregressive Distributed lag bound test approach in Model 5 permits examining the potential time heterogeneity (Gómez-Puig & Sosvilla-Rivero, 2016) by differentiating short and long-term effects. It is essential to realize that it also enables exposure to long-term relationships between variables regardless of the order to integrate variables.

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The first challenge is to determine the number of the lag lengths in the model. We employ Akaike information criteria (AIC) to estimate the optimal length for the Error Correction Model. The AIC score suggests that the best model was q=4 and p-orders: 3, 1, 1, 1, 4, 1. We obtained that the optimum lag lengths are an autoregressive order: 3 and explicative variables lags p-orders: Growth Revenue (3), Growth Expenditure (1), Growth Interest Rate Paid (1), Growth Debt (1), Growth Long Term Bond Interest Rate (4) and Growth Institutional Quality (1).

Meanwhile, the Shapiro-Wilk normality test of the residuals shows a value of 0.9834 and a p-value of (0.1417), permitting us to conclude that the data is normal. The Pesaran, Shin, and Smith Cointegration tests obtained an F-statistic equal to 6.37 higher than the upper bound critical values of 1%, permitting us to conclude the presence of cointegration at a 1% level. See Table 17.

Ramsey's Regression Equation Specification Error Test (RESET Test) displays a p-value of (0.2124), confirming that the model does not have a model misspecification problem. The Ramsey RESET test is higher than 0.05; thus, RESET exposes no miss specification of the relationship between debt and explicative values in our models. Consequently, it proves that our variable has significant explanatory power and rejects the possibility that non-linear functions of the independent variables should be added to our estimated equation. The parameter estimates, standard error, and significance results can be observed in Table 18. Additionally, the whole model is significant, with a p-value of 0.001.

Table 17 Model 5 Autoregressive-Distributed Lag Bounds Testing Approach to Cointegration - Significance Tests

	Normality Test	Confidence Interval

DOI:10.6814/NCCU202101114

Variable	AIC Lags	F-Statistics	LB at 1%	UB at 5%, 1%,	Decision
Dependent Variable					
Model 5 Real GDP pc	(3, 1, 1, 1, 4, 1)	6.37	3.15	3.61; 4.43	Cointegration

1- GDP per capita average 5-year subsequent growth
2- GDP growth (annual %) average 5-year subsequent growth
3- LB= Lower Bound; UB= Upper Bound
4- Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01.

In the short-term analysis, $Debt_{t-2}$ has a positive coefficient, namely 0.0727, and is highly significant at p-value (0.01), confirming the existence of cointegration between debt and growth. The Speed of Adjustment Parameter coefficient is negative -0.3724, indicating convergence. Consequently, almost 37.24% of any disequilibrium de between GDP per capita and Debt will return towards long-term equilibrium within one year. Meanwhile, revenue, expenditure constrained growth. Meanwhile, the interest rate paid and long-term bond interest promoted short-term growth with above 10% significance. Institutional Quality did not yield statistically significant results.

Next, results in Table 18 suggest the existence of a single long-term relationship in which the production level would be the dependent variables (GDP per capita and GDP) and the growth rate of Growth Revenue, Growth Expenditure, Growth Interest Rate Paid, Growth Debt, Growth Long Term Bond Interest Rate and Growth Institutional Quality.

For the long-term analysis, an increase of one debt growth percentage point in the United States of America would decrease GDP per capita growth by 0.001.

$$GDP_t = -0.017Revenue_t + 0.0557Expenditure_t + 0.0568InterestRate_t - 0.0192Debt_t - 0.0005Bonds_t - 0.0408Institutions_t - 0.373Error\ Correction\ Term_t$$

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(15)

The analysis of the long-run relationship is robust; debt harms economic growth (-0.0192). The calculated F exceeds the upper critical bound for the case of unrestricted intercepts and not trends, permitting us to conclude the existence of a long-run relationship, regardless of order integration. See Table 17. Additionally, in the long run, the error correction term is now the speed of adjustment parameter or feedback effect due to the error term from the cointegration model being negative, indicating convergence.

Table 18 Model 5 Autoregressive-Distributed Lag Bounds Testing Approach to Cointegration- Coefficient Estimates

			GDP
Variable	Long Term	Order of Cointegration	Short Ternm
Growth Debt	-0.0192	1	0.0727*** (5.361))
Growth Revenue	-0.0170	3	-0.0147** (-1.9)
Growth Expenditure	0.0557	1	-0.0096* (-2.44)
Growth Interest Rate Paid	0.0568	1	0.0274*** (3.81)
Growth Long Term Bond Interest Rate	-0.0005	4	0.0005** (2.18)
Growth Institutional Quality	-0.0408	1	0.0064 (0.21)
Speed of Adjustment Parameter	-0.3730		-0.3724*** (-6.723)
Tests			
Adjusted R-squared			0.5326
F-statistic			10.77
p-value			0.00

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Shapiro-Wilk test	0.9834 (0.1417)
Ramsey's RESET Test	1.5728 (0.2124)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

Model 5 shows the presence of cointegration and lagged short-term impact of debt is found statistically significant. There is a slight difference in the short-term effect and long-term effects. The short-term impact is positive, and in the long term is harmful. Additionally, in both models, the negative value of the correction speed indicates convergence to equilibrium. These results give credit to the Keynesian economic theory that debt might have a positive impact on economic growth in the short term but validates the classical economic theory that in the long-term, debt rise harms growth.

The different effects between short and long term may be attributed to the that the short term public debt funds are used for non-productive purposes and might not be not large enough to cause long-term economic growth (Gómez-Puig & Sosvilla-River, 2015). Other scholars link the effects of debt towards misallocation of resources because the negative impact on economic growth is highly influenced by the composition of the usage of public expenditure (Devarajan, Swaroop, & Zou, 1996; Swamy, 2020).

The policy recommendation that can be extracted from our results is that the United States of America should conduct more portions of the debt towards productive investments with the debt loans to promote long-term growth. Further study is needed of the government expenditure to avoid inefficient use of funds.

We found studies that support our findings of our ARLD short and long-term effects. Despite using different country samples, some studies have found

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positive short-term effects and adverse long-term effects in European developed countries such as Austria, Finland, Germany, Spain, and Portugal (Gómez-Puig & Sosvilla-River, 2015).

Observing the significant cross relations from different lags of debt and economic growth and the existence of a long-run relationship, we proceeded to conduct a Granger causality test computed over the variables in question. This test is unidirectional; we test whether debt growth causes economic growth in Table 19 below. We can observe Debt Granger -cause GDP per capita growth (p-value=0.01), GDP per capita do not Granger-cause Debt (p-value=0.7). The Granger Causality test exposes a unidirectional Granger causality.

Table 19 P-values of Granger Causality Tests

	Y-Series			
X--Series	Real GDP pc F	Debt F	P-value	Decision
Dependent Variable				
Real GDP pc	N/A	0.1315	0.7175	Fail
Debt	6.0738**	N/A	0.01512***	Pass

1- GDP per capita average 5-year subsequent growth
2- GDP growth (annual %) average 5-year subsequent growth
3- LB= Lower Bound; UB= Upper Bound
4- Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01.

To tackle the lack of robustness of the linear regression model, we selected to apply a linear regression that estimates the conditional quantile function as a linear combination of the predictors robust to outliers. Additionally, its selection may provide insight into the presence of a heterogonous effect of debt depending on the different growth rates.

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5.3.Quantile Regression: Model 6

The quantile regression results for the United States of America in Model 6 are shown in Table 20**Error! Reference source not found.**. Firstly, the results suggest a U inverted pattern relationship across growth percentiles. At the extreme low percentiles, 10th to 20th, and the high 70th to 90th percentiles, debt positively affects economic growth. Meanwhile, between 30th and 60th percentiles, debt has an inverse relationship; when debt increases, gross domestic product per capita decreases, and vice versa. Secondly, the impact of deb changes along with the percentiles.

Firstly, debt has a low impact on growth at the 10th (0.003) and increase at the 20th percentile (0.0244) and later changes to a negative impact at the 30th percentile (-0.0024), having a peak impact at the 50th percentile (-0.0176) to diminish at the 60th percentile (-0.0048). Above the 70th percentile (0.0065), the effects change again to positive and having a peak impact at the 90th percentile (0.1215). Lastly, the only significant results are at the 90th percentile promoting growth with a 10% significance level.

Table 20 Model 6 Time Series Quantile Regression - Coefficients:

Percentile	*Growth Debt*	*Growth Revenue*	*Growth Expenditure*	*Growth Interest Rate Paid*	*Growth Long Term Bond Interest Rate*	*Instituional Quality*
10th	0.003 (0.04)	-0.0827 (-1.33)	0.0023 (0.08)	0.0481 (0.83)	-0.0002 (-0.06)	0.1709 (1.37)
20th	0.0244 (0.6)	-0.0312 (-0.63)	-0.009 (-0.41)	0.009 (0.36)	0.0003 (0.24)	0.1244 (1.25)
30th	-0.0024 (-0.09)	-0.0093 (-0.23)	-0.0018 (-0.1)	0.0166 (0.81)	0.0005 (0.54)	0.0815 (1.05)
40th	-0.0111 (-0.49)	-0.0203 (-0.52)	0.0009 (0.05)	0.0181 (1.31)	0.0007 (0.68)	0.0533 (1.03)
50th	-0.0176 (-0.57)	-0.0288 (-0.7)	0.0038 (0.19)	0.0261 (1.32)	0.0005 (0.66)	0.0328 (1.04)
60th	-0.0048 (-0.13)	-0.0226 (-0.56)	0.0061 (0.32)	0.0361 (1.62)	0.0006 (0.86)	0.0157 (0.01)

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70th	0.0065	-0.0181	0.0063	0.0361	0.0007	0.0069
	(0.14)	(-0.49)	(0.32)	(1.17)	(0.77)	(0.42)
80th	0.0614	0.017	-0.01	0.0061	0.0009	-0.0149
	(1.07)	(0.45)	(-0.44)	(0.16)	(0.85)	(-0.41)
90th	0.1215*	-0.0436	-0.0149	-0.032	0.0003	0.0451
	(1.77)	(1.28)	(-0.56)	(-0.66)	(0.27)	(-0.56)

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t value

Our regression suggests that debt will positively affect economic growth when the United States has an economic growth below 0.89 percent (10th and 20th percentile). Meanwhile, debt will harm economic growth when the economic growth is between 0.89 and 2.39 percent (30th to 60th percentile). Later, when the economy is growing beyond 2.39% (above 70th percentile), debt has a positive effect that increases economic growth. The estimates show that Debt to GDP increases by unity GDP growth increases by 0.1215 when the economy is at the 90th percentile with a 10% significance level. Debt was only significant when the GDP per capita was growing above 3.9 percent.

Growth Revenue, Growth Expenditure, Growth Interest Rate Paid, Growth Long Term Bond, and revenue growth did not show any statistical significance in all the percentiles analyzed.

The interpretation of our results is: Firstly, in low and high percentiles, the coefficients of debt have positive effects on growth with no significance except at the 90th percentile with a10 percent significance level. Secondly, percentiles around the 50th percentiles show an inverse relationship; when debt increases, gross domestic product per capita decreases, and vice versa but does not significantly affect the GDP per capita growth. Secondly, in periods of high GDP per capita of the United States of America, debt has positive effects on growth, which is significant at the 90th percentile.

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The idea that debt usage may help promote economic growth in low-growth scenarios is refuted in our results. Debt promotes economic growth in low growth scenarios, but it is statistically insignificant. Debt hinders economic growth around the 50^{th} percentile. Our results seem to suggest that the debt can only promote long-term economic growth when the economy is experiencing very fast GDP per capita growth, above 3.9 percent. Our results have to be taken with care since we analyzed a long period. The development stages of the United States of America have evolved throughout time; debt significance is heterogeneous depending on the conditional growth regime.

Our policy recommendation is that debt should be used carefully to promote economic growth due to the heterogenous impact of GDP per capita growth. United States of America's usage of public investment should be analyzed further to improve the fiscal multipliers effects of public investment. No studies conducting quantile regression were found analyzing debt and growth.

Later, we present the Change-point threshold regression to test four common variants of threshold regression models. This technique permits an interpretable way of modeling four different threshold effects between outcome and predictor—consequently, the ability to understand the predictor variable before and after the threshold points.

5.4. Threshold Change Point Regression: Model 7 to 10

Fong et al. (2017) developed our threshold regression model, and it permits the estimation of four categories of threshold types such as Segmented, Hinge, Step, and Stegmented the characterization of the behavior of debt before and after the threshold point.

Models 7 to 10 examine the impact of debt using threshold regression to identify if the debt has a regime switch that may change the relationship between

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debt and GDP per capita growth. This study adopts Fong's testing method to test the thresholds. Table 21 shows the bootstrap likelihood ratio test results to measure if our data sample fits four types of threshold effects: step, hinge, and stegmented. We confirm that our selection can be characterized by three threshold effects, Segmented, Step, and Stegmented. The null hypothesis is rejected in continuous segmented threshold effects Model 7 with a p-value of 0.064. This model expresses that debt has a slope of before and after the threshold hold. Our Hinge effects model 8 results reflect that it is not statistically significant with a p-value of 0.102. However, both discontinuous step Model 9 and stegmented Model 10 are significant with a 1% significance level.

Table 21 Models 7 to 10 Change point threshold regression models – Significance Tests

	Dep. Var = GDP per Capita			
Variable	Segmented	Hinge	Step	Stegmented
Threshold	2.5 (7.04)	10.34 (8.13)	-4.9 (7.29)	-4.9 (7.29)
Maximal Statistics	5.38	3.9	12.5	13.9
LR	5.3849*	3.9	12.5***	13.9**
P-value	0.064	0.102	0.007	0.013

Note= Threshold Equation 1= segmented; 2= hinge, 3=step and 4= stegmented

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the Standard errors

The coefficient estimates shown in Table 22 expose that the Debt coefficient is only statistically significant in Segmented threshold effects. We conclude that debt has a segmented interpretation. Having established a threshold effect with stegmented effects, we can confirm that the threshold estimate is 2.5. This model expresses that debt has a positive impact on the economy with a 0.1086 coefficient, but it also has a negative slope that gradually penalizes the positive effects before the Change point. After the debt breaches, the threshold

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debt has a negative effect -0.1491; the negative slope progressively augments the impact of debt on GDP per capita.

Table 22 Models 7 to 10 Change point threshold regression models – Estimated Coefficients

	Segmented Effects		Step Effects		Stegmented Effects	
Variable	Coef.	Confidence Interval	Coef.	Confidence Interval	Coef.	Confidence Interval
Debt Before Chngpt	0.1086*** (2.99)	(0.055 to 0.1976)			0.019 (0.12)	(-0.5028 to 0.1548)
Growth Debt After Chngpt	-0.1491*** (-3.14)	(-0.274 to -0.0874)			-0.0467 (-0.26)	(-0.2322 to 0.499)
Constant Debt After Chngpt			1.7308 (0.97)	(-3.5126 to 3.5355)	1.678 (0.62)	(-5.1478 to 5.5696)
Growth Revenue	-0.0137 (-0.43)	(-0.0666 to 0.06)	-0.022 (-0.74)	(-0.0693 to 0.0484)	-0.0189 (-0.6)	(-0.0703 to 0.0532)
Growth Expenditure	-0.0059 (-0.35)	(-0.0433 to 0.0228)	-0.0085 (-0.51)	(-0.045 to 0.0202)	-0.0051 (-0.31)	(-0.0433 to 0.0207)
Growth Interest Rate Paid	0.0199 (1.3)	(-0.0105 to 0.0499)	0.0085 (0.43)	(-0.0251 to 0.0522)	0.0188 (1.12)	(-0.019 to 0.0471)
Growth Long Term Bond Interest Rate	0.0005 (0.86)	(-0.001 to 0.0013)	0.0006 (0.92)	(-0.0013 to 0.0011)	0.0006 (1.01)	(-0.0012 to 0.0011)
Growth Institutional Quality	0.0239 (0.74)	(-0.0612 to 0.0666)	0.0152 (0.48)	(-0.0351 to 0.0905)	0.0118 (0.36)	(-0.0544 to 0.0758)

Note= Threshold Equation 1= segmented; 2= hinge, 3=step and 4= stegmented

Note. * = p-value below 0.1; **= p-value below 0.05; *** = p-value below 0.01. Values inside parentheses represent the t-values

The regression estimates are shown in Table 22. Firstly, we will analyze the segmented model. The coefficient of our primary explicative variable, debt, has different effects on growth before and after the threshold point, a positive 0.11 effect before the threshold point. However, a negative slope penalizes this positive effect separated by the threshold point (point break) of 2.65 after the

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threshold, a negative -0.14 effect exacerbated by the slope. The bootstrap p-value is low, with a significance of 1% level, and the lower and upper bound does not take include zero. As a result, the debt variable is statistically significant. The rest of the explicative variables, Growth Revenue, Growth Expenditure, Growth Interest Rate Paid, Growth Long Term Bond Interest Rate, and Growth Institutional Quality, are not statistically significant in the Threshold regression model with segmented effects.

Four advanced threshold regressions were conducted applying the threshold regression models developed by Fong et al. (2017) to test the four most common threshold effects: step, hinge, segmented and stegmented. The estimations show a segmented threshold effect model, and the threshold value of 2.5 split the observation into two regimes, with the coefficient of the lower and upper regimes being significant. We provide evidence of the presence of a threshold growth rate of 2.5 percent for the United States of America.

The policy implications should support the tradeoff theory that the United States of America should seek debt growth below 2.5 percent, contributing to cumulative effects on economic growth per capita. However, beyond the threshold value of 2.5%, debt has a net negative impact on growth, its marginal costs on economic growth that exceed the marginal benefits on growth.

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6. Conclusions

We examined whether the is a long-run stable relationship between external debt and economic growth that countries take to finance their development needs. We use ten regression models to analyze cross-country data of 103 countries and time series analysis of the United States of America. Our cross-country analysis involves using panel quantile regression, threshold regression for non-dynamic panels, threshold regression with sample splitting to show the presence of negative statistical impact of debt on economic growth in all countries. Meanwhile, the within-country analysis involves applying time-series quantile regression, autoregressive distributed lag model, and the threshold change-point regression model. The results show a long-run relationship between external debt and economic growth in each of the models used.

For the panel data estimations, the results show debt is statistically significant adverse effects on economic growth in the long run. This study shows that high debt levels can play an important role in constraining economic growth in an advanced and developing country. We confirmed stationarity with the unit root tests, implying that the trend is entirely predictable and not variable.

The first statistical method applied was a panel quantile regression with fixed effects in Model 1 and provided the insights that gross domestic product per capita is influenced by debt to the gross domestic product at some percentiles. Debt has a statistically significant harmful effect on changes in GDP per capita at the 25th percentile at a 10% significance level. Initial GDP per capita and Population are significant in all the percentiles. The institutional quality is relevant to economic growth in the 10th, 25^{th,} and 50th percentile, with a positive effect at 1%, 1%, and 10% significance levels. Our results suggest a varied behavior across percentiles for 103 countries, indicating the dynamic behavior of debt on economic growth rate is asymmetric depending on GDP per capita

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growth. Our results provide insights into the inconsistent effects on linear models and the sensitivity to the country selection period.

The second method applied was Threshold Regression developed by B. E. Hansen (1999) to endogenously identify a statistically significant change in the coefficient in debt variable towards economic growth. As shown in both regression Model 2 Threshold effects in non-dynamic panels, debt has a significant triple threshold effect, with four regimes. Debt has an inverse relationship towards growth except at the third regime.

Model 2 supports the existence of are triple threshold; the threshold estimator is 30.39, with a 95 percent confidence interval between 14.65 and 105.11. Additionally, the model is highly significant, with a p-value of 0.0. The F_3 statistics of 30.39 is more prominent than its critical value at a 1% significance level of 23.1. As a result, F-statistic, the $F_3 = 30.39$, is highly significant with a p-value of 0.01, and the thresholds are 39.26%, 48.9%, 125.22%, with a 99% confidence interval.

Our results demonstrate that the influence of governmental debt per capita growth may vary depending on the debt threshold. Governments should investigate whether their debt levels are too big or small; policymakers should take a step to adjust their debt levels towards the debt regime at which debt has no or less negative impact on growth.

The third method was the threshold regression model with sample split effects to understand the influence of institutional qualities in effect between real GDP per capita growth and Debt magnitude measured to the gross domestic product. Our results imply that there is an optimal debt threshold level at 92.15 percent of Debt to GDP. Model 3 and Model 4 show a negative and statistically significant relationship when countries have a debt magnitude above 92.15%

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measured to the gross domestic product. Both models offer a negative statistically significant relationship when countries have an indebtedness level above 92.15% indebtedness and have low institutional scores, either institutional quality or democratic quality. Meanwhile, when governments have an indebtedness above 92.15% but have solid institutional scores, the effects of debt on growth are inconclusive.

Model 3 finds that when countries have a debt level beyond 92.15, the impact of debt differs when countries have an institutional score below or above the Institutional threshold of -6. Countries with bad institutions (below the threshold -6) debt have a negative statistical impact on growth. Meanwhile, when governments have good institutions (above the threshold of -6), the effect of debt is not statistically significant. The confidence interval of the institutional threshold is large, implying a substantial degree of uncertainty about the threshold level. There is at least two possible conjecture to we can make. First, different institutional strengths may have the ability to mobilize resources more efficiently—the efficiency of public investment. Second, we studied many countries that differ in income levels, economic systems, and welfare systems and may cause this outcome.

Model 4 used an alternative secondary threshold variable, Democratic quality, and found that the threshold estimate is 7 Democracy index Score. While debt is below the threshold level, debt has a slight negative statistical effect on growth; debt rates above the democratic threshold level do not significantly impact growth.

Our results suggest that governments should bolster their institutional qualities to mitigate the negative relationship between debt to gross domestic product and gross domestic product per capita. Prudent debt management and strong institutions seem to complement each other to promote economic growth.

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Regarding the within-country study, unit root tests confirmed that our data for United States of America time series analysis has a stationary trend process. The movement is entirely predictable and not variable. The usage of growth rates enabled us to obtain realistic estimates for the regression models.

The fourth regression model was a cointegration technique or ALRD bound test to determine the long-run changes of economic growth explained by the changes in governmental debt to detect the presence of steady-state equilibrium between variables. The cointegration allows confirming long-run equilibrium among underlying economic time series variables that converge over time. Finally, the Error Correction Model provides statistically significant results for Model 5 of the short-run dynamic and long-run relationship of the underlying variables. Debt and growth have a meaningful short-run and long-run relationship, and the error correction term is significantly negative, indicating convergence. We find evidence that supports the view that debt has a positive impact in the short term of 0.0727% but negatively impacts the long-term -0.0192% with a correction speed of 37.3%.

The policy implications of our cointegration results are that policymakers should have prudent debt management; even though in some cases economic growth might be stimulated by debt, the long-term effects are adverse. Additionally, to test the robustness of our error-correction model, we also tested the double causality concerns exposed in the literature review. Our Granger causality test revealed a unidirectional relationship where a debt granger causes GDP per capita. For this reason, debt is relevant to information to forecast GDP per capita.

The Fifth regression method was a quantile regression to provide evidence of growth conditionality in debt to GDP per capita. Our Model 6 Time Series Quantile Regression shows that estimates are positive at the lower and upper

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percentiles and negative between the 30th and the 60th percentile; estimates show the opposite signs and are unimportant. Moreover, we find that the magnitude of the quantile regression estimates is weaker at lower extreme percentiles than the corresponding estimates in the extreme upper percentiles. Debt has positive significant correlation results at the 90th percentile

The sixth and last method used was Threshold Change Point Regression to analyze the non-linear effects of debt growth. This technique permits to test if the variables may be characterizable into four categories, segmented, hinge, step, and stegmented in regression models 7 to 10. Our results prove the influence of governmental debt per capita growth for the case of the United States of America is segmented independently of the model specification in model 7 at 2.5 debt threshold hold point.

These regression results offer several contributions. Firstly, it conducts a cross-country empirical analysis of how debt impacts economic growth in 103 countries. Different Debt growth levels can change how the governmental amount of debt influences a country's gross domestic product per capita growth to its gross domestic product. The unique aspect of our study is that debt can produce different effects below and above the threshold point and deduct the pattern before and after the threshold. These results are absent in studies reviewed on the topic. Secondly, these findings of the patterns of debt and its characterization can reference policymakers to guide their debt management strategies evaluations and develop more adequate policies.

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7. Annexes

1.1.Panel Data Country List

Table 23 Cross-Country Study List

Albania	Algeria	Argentina	Armenia	Australia	Austria
Azerbaijan	Bahamas The	Bahrain	Bangladesh	Barbados	Belarus
Belgium	Belize	Benin	Botswana	Brazil	Bulgaria
Burkina Faso	Burundi	Cameroon	Canada	Central African	Chad
Chile	China	Colombia	Comoros	Congo	Dem. Rep.
Congo	Rep.	Costa Rica	Cote d'Ivoire	Cyprus	Czech Republic
Denmark	Dominican Republic	Ecuador	Egypt	Arab Rep.	El Salvador
Estonia	Eswatini	Fiji	Finland	France	Gabon
Gambia	The	Georgia	Germany	Ghana	Greece
Guatemala	Guinea	Guinea-Bissau	Guyana	Honduras	Hungary
Iceland	India	Indonesia	Iran	Islamic Rep.	Ireland
Israel	Italy	Jamaica	Japan	Jordan	Kazakhstan
Kenya	Korea	Rep.	Kyrgyz Republic	Lebanon	Luxembourg
Madagascar	Malawi	Malaysia	Mali	Malta	Mauritania
Mauritius	Mexico	Morocco	Namibia	Nepal	Netherlands
New Zealand	Niger	Nigeria	Norway	Oman	Pakistan
Panama	Paraguay	Peru	Philippines	Poland	Portugal
Romania	Russian Federation	Rwanda	Saudi Arabia	Senegal	Seychelles
Sierra Leone	Singapore	Slovak Republic	Slovenia	South Africa	Spain
Sri Lanka	Sudan	Sweden	Switzerland	Syrian Arab Republic	Tanzania
Thailand	Togo	Tunisia	Turkey	Uganda	Ukraine
United Kingdom	United States	Uruguay	Vanuatu	Venezuela	RB
Vietnam	Zimbabwe”.				

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