2019

An Empirical Analysis of Debt/GDP+ Ratios

Lucas Po

Skidmore College, lpo@skidmore.edu

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This thesis is submitted in partial fulfillment of the requirements for the course Senior Seminar (EC 375), during the Spring Semester of 2019

While writing this thesis, I have not witnessed any wrongdoing, nor have I personally violated any conditions of the Skidmore College Honor Code

Name: Lucas Po

Signature: Lucas Po
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Abstract
This thesis reviews past works that measured separately how public debt and private debt and household debt specifically affects GDP growth for both advanced and emerging economies for years generally up to 2009. This paper is meant to continue these analyses and update results for the years 2010-2015. This paper incorporates different factors including population, investment and dummy variables considered from each previous work as well as the some of the econometric analytical frameworks used. After conducting successful robustness checks, this paper concluded that private debt is beneficial to GDP growth in advanced countries once debt surpasses 120 percent of a country’s GDP. It can’t be concluded, however, that increases in public debt, household debt or population will continue to harm growth when either of these debt types reach past 90 percent of GDP due to insignificant results being calculated. It can be concluded, however, that public debt will cause inflation to decline when public debt is above 120 percent of GDP.

Section I: Introduction
How does public debt, as well as private and household debt, effect GDP growth in current times? How does public debt affect other factors such as inflation? The speculations regarding the inverse relationship between public debt and GDP growth continue to ponder economists since the early 21st century, especially determining which certain rates of public debt exceeding percentages of GDP would be more detrimental. Before and during the Great Recession, different economists and IMF researchers argued different levels of debt would lead to different growth rates.

Many scholarly papers generally arrive at the same conclusion of public debt negatively affecting growth in the short and long run to both advanced and emerging markets. Because of their formula differences, however, they conclude with different amounts of public debt that would lead to significant declines in growth for advanced and emerging economies. However, to focus only on public debt affecting growth obscures economic thought. Private debt has played an important role in analyzing debt levels of private entities/nonfinancial corporations. Economists have also analyzed empirically the negative impacts of private debt and household on GDP growth,
using different analytical methodologies. Generally, they all concluded that private debt and household debt fundamentally damage GDP growth for both advanced and emerging markets in the long run. Growth isn’t the only factor at risk when both debts increase. Economists have also concluded that public debt policies that lead to increasing deficits will in turn stimulate inflation rates to levels unnecessary for a country’s growth. This ultimately reveals as public and private debt continues to increase, factors such as GDP growth and inflation will suffer as a result. These papers, however, all conduct their own research focusing on only of the two debt types but rarely both. These papers also only focus on their effects on one or few select factors such as growth.

The purpose of this paper is to review and update the works of some of these economists regarding growth and the different debt types. This thesis will conduct its own analysis on how harmful public debt is to growth for both advanced and non-advanced countries. This thesis will conduct the same analysis for both private debt and household debt and their effects on GDP. Similar regressions will be conducted regarding the relationships between public debt and inflation. This paper will also consider factors such as increases/decreases in investment, population increases/decreases in formal models depicting the effects of the different debt types on GDP growth. By analyzing the different methodologies conducted by the different researchers, specific econometric analyses will be considered and used to determine these relationships. Like many previous papers, this paper will take into account that advanced and non-advanced countries don’t possess the same economic strengths/weaknesses and will have to be calculated at different standards.

The contributions to this work are to consider both public and private debt in one thesis as opposed to most researchers focusing on only one type of debt and how it affects growth. This paper will use econometric work and analysis. Few of the past works noted in this thesis based their work on analyzing historical data series. As stated, many of these papers conducted this research considering many years up to 2009; very few papers analyzed debt and growth after the Great Recession and the eurozone crisis. This paper understands that these two economic events caused debt levels to increase significantly to levels that may have been preceded by the previous papers. Each previous economist engaged in this argument applied different formulas and statistical techniques to reach their conclusions, such as imputing public debt and other factors such as population and investment as linear model while others prefer implicating polynomial equations. Also, some econometricians created groups for the different debt levels and determine
how each group impacted growth. Other econometricians did analyze debt levels up to 2017 but included original econometric methods to achieve their results. This work will focus more on developing simple linear and quadratic equations to answer these questions and construct graphs to determine the different slopes in growth rates when debts increase.

The robustness checks conducted in this paper proved the data and variables are BLUE according to the Gauss Marko Theorem. This paper concluded that increasing private debt could stimulate GDP growth in advanced countries if it continues to increase to significant levels. It couldn’t be concluded, however, that increases in public debt, household debt or population will harm growth when either of these debt types increase to extreme levels due to the statistically insignificant results that emerged. From this paper, public debt will cause inflation to decline when public debt reaches substantial levels.

Section II reviews the literature. Section III discusses the data collected and the linear econometric models developed. Section IV analyzes the robustness checks conducted on the linear models to ensure the dataset and variables aren’t biased in any way. Section V discusses the results that emerged from regressing the linear models and addresses the introduction of the quadratic models. Section VI revisits the robustness checks after the polynomial models were presented in this paper. Section VII discusses the final results of the polynomial regressions and considers the limitations in the analytical work that could have caused the results to appear as they did. Section VIII concludes with a discussion on future research possibilities.

Section II: Literature Review

The main purpose of this thesis is to analyze fiscal policies and their impacts on economic growth and inflation. However, analyzing GDP growth and its relationship when a country’s public debt increases takes priority in this thesis. There are two papers that discuss the relationship between public debt, GDP growth and inflation. The first paper discussed a [slightly] inverted relationship between public debt and GDP growth between multiple countries while the second replicated the research but discovered a different relationship and discussed the errors of the first paper. These two papers serve as the core literatures review for this thesis, with each referencing numerous papers in their research. The data they use dates back from 1916 to 2009. Another paper discusses public debt and growth in 2010. Hopefully, these papers will be deciphered to conduct a
separate research on the relationship between public debt and GDP growth during and after 2010 and update the theses outlined by these literatures. To go a step further than these two literatures, the other kinds of debt, including private and household debt, will be investigated and their relationships against GDP growth will be analyzed.

Public debt is mainly defined as government expenditures with spending exceeding taxation. The fiscal policies made by countries to spend its income at a greater rate than receiving revenue via taxation is an epidemic many countries have faced since World War I. Economic Professor Robert J. Barro has written many papers focusing on the theory of public debt and notable shifts in the rate of public debt throughout time, as well as the causes for these shifts. One of his research papers theorized how the government should monopolize in producing bond “liquidity services” to have public debt issue increase net wealth (thus, reduce government debt) rather than [imperfect] private capital markets. This discovery then helped Barro conclude that uncertainty in tax liabilities leads to the issue of public debt more likely risking household balance sheets and household wealth to be compromised. Citation: Barro (1974). GDP is a good measurement of a country’s wealth and economic state. If household wealth faces risk of being compromised when public debt accelerates, what would become of GDP growth and inflation in that country? This research is, of course, is outdated as this paper expressed fear during the 1970s. The global economy has much evolved since then and while public debt continues to increase for many countries, GDP growth and household wealth has gradually increased at the same time for developed countries at least. Citation: Federal Reserve of Economic Data (2019). Papers detailing the empirical relationship between GDP growth and public debt have been constructed since then by specialists, showing that there was no immediate threat to GDP and wealth by rising public debt.

Researchers Carmen M. Reinhart and Kenneth S. Rogoff analyzed fiscal policies relating to government expenditure and increasing debt. They have studied the public debt, including external debts for these countries, GDP growth, and inflation of 44 countries and measured changes in debt/GDP ratio when public debt increases. They find that when a country’s debt is above a threshold of 90 percent of GDP, the growth rates decline by about one percent. When the threshold is below 90 percent, the relationship is weak. Citation: Reinhart and Rogoff (2010). This paper also concluded that for emerging markets, when the threshold was 60 percent, annual GDP
growth rates fall by approximately two percent. When debts were higher percentages of GDP, growth declines at half the rate. **Citation:** Reinhart & Rogoff (2010).

Another discovery from this paper is that while GDP growth deteriorates when public debt increases, there seems to be no clear relationship between inflation and public debt. The US alone faced high inflation when debt/GDP was high. However, when developed countries are grouped together, their high public debts don’t directly lead to higher or lower levels of inflation. On the other side, when emerging markets experiences high levels of debt, inflation rises in a similar pattern. **Citation:** Reinhart and Rogoff (2010). Inflation remains indifferent for developed countries when their debts rise or fall each year. This should make some sense as it rather monetary policies (specifically money supply) that control the growth rate of inflation for a developed country. Overall, this paper seemed to have definitively proven that when a developed country increases its deficit annually, its economic growth rate decreases at a slower rate, indicating that a higher debt/GDP ratio is healthy for its economy (and vice versa for a developing country). This argument would gain many supporters until they read updated papers on the same topic that illustrates flaws made by Reinhart and Rogoff.

While there was [some] empirical evidence that public debt seemed to have a negative relationship with GDP growth, there was still skepticism in the theory that public debt being 90 percent of a country’s GDP would lead to a fall in overall economic growth. John Irons and Josh Bivens illustrated the lack of theory or data that supports this claim for the United States. They even went as far to explain that economic growth is at most risk when policymakers fail to act out of fear of facing higher deficits. **Citation:** Irons and Bivens (2010). Markets in almost every [developed] economy despise uncertainty and it is this lack of uncertainty that cause fear and value of stocks to fall. No major decision could be made, due the overwhelming fear of facing any potential repercussion. It is then when economic growth might start to decline. Irons and Bivens exquisitely explained that while impeding high deficits should be noted, there would still be no alarming point that the global economy would commence to decline for the worst.

It was impressive initially with the detailed analytical research Reinhart and Rogoff conducted on debt/GDP ratio. However, it was then discovered that Reinhart and Rogoff selected exclusive data to support their conclusions. They also conducted coding errors and weighted summary statistics improperly. Analysts Thomas Herndon, Michael Ash and Robert Pollin reviewed Reinhart and Rogoff’s paper and undercut their methodology of measuring debt/GDP
ratio, claiming that their mistakes led to horrible miscalculations and misrepresentations of the relationship between public debt and GDP growth. Reinhart and Rogoff based their data collections of different countries and different periods of time on public debt/GDP ratios for each country. When they collated their data in this manner, non-linear relationships between GDP growth and public debt were revealed. Citation: Herndon et. al. (2014). These analysts gained access to Reinhart and Rogoff’s working spreadsheet and were able to approximate closely the published results, leading them to discover the errors of the previous paper. These analysts replicated what Reinhart and Rogoff conducted using the same data, except this time they filled in the time gaps that were previously excluded, they included countries that were previously excluded, and they start to use a weighting methodology of one observation per country. They focused their research on a country’s debt levels that exceed 90 percent of its GDP. They determined that GDP growth increases by about 2.2 percent in advancing economies. This seems more in line with the macroeconomic theory outlined earlier. They take into consideration that not every country has the same economic state and states vary over the period of time.

Ash and Pollin have taken an additional step and published a supplementary article critiquing the paper of Reinhart and Rogoff and their methodology. They start off by explaining in detail the coding errors made by Reinhart and Rogoff that led them to serious miscalculations in their measurements and that they even [unintentionally] excluded Austria, Australia, Belgium, Canada and Denmark from their research. RR’s coding errors for calculating the median for certain lines in cells resulted in GDP growth declining by -0.3 percentage points in their public debt/GDP category of 90 percent and above. Citation: Ash and Pollin (2011). This miscalculation alone inflated the inverse relationship between GDP growth and public debt by 0.6 percentage points when computing medians. Citation: Ash and Pollin (2013). This paper explains how crucial it is to input data codes carefully as mistakes like this results in horrible miscalculations for a thesis. It might not have been deliberate for Reinhart and Rogoff to make mistakes as such. Nevertheless, their oversights cost them severely and led them to construct a thesis with various holes in their research. The data must be collated carefully to conduct future theses related to this topic.

As Ash and Pollin explained Reinhart and Rogoff’s methodology with skepticism, they continued RR’s research by adding more categories in their regression analysis; Ash and Pollin added a category where public debt was between 90 and 120 percent of a country’s GDP and another category where public debt exceeded 120 percent of GDP. This decision revealed that
GDP growth is still positive in the face of high public debt, albeit at a lower rate. When public debt was between 90 and 120 percent of GDP, the growth rate of average real GDP was 2.5 percent, yielding the same results as the 60-90 percent bracket. When public debt surpassed 120 percent of GDP, average growth was 1.6 percent. Citation: Ash and Pollin (2013). This analysis led Ash and Pollin to rebuff Reinhart and Rogoff’s claim that there is a decline in GDP growth when public debt/GDP ratio is 90 percent. After reaching to this conclusion, Ash and Pollin investigated the relationship between public debt and GDP growth during the 21st century in much more detail. They determined that GDP growth increased when public debt was above 90 percent of GDP compared to the 60-90 percent public debt/GDP category. The relationship between these two variables might be weaker when comparing more recent data to earlier data. Citation: Ash and Pollin (2013).

Interestingly, Ash and Pollin did not note the Great Recession in their paper and how this could have prejudiced their data and results. Could this have been an overstep in their analysis, or did the Great Recession truly not shock the relationship between public debt and GDP. This would be surprising as the Great Recession had a significant impact on inflation for most countries, which could have sparked a new relationship between this and public debt. Perhaps that relationship could, in turn, have influenced Ash and Pollin’s results and illustrate a different relationship between public debt and GDP growth during the 21st century.

The literatures written above discuss public debt and its effects on GDP growth and wealth for the last few decades. They do not, however, explain the recent changes in fiscal policy after the Great Recession. Many countries were hit significantly by the financial crises and thus, had to develop different policies to fight and recover from this recession. Economists have come to an agreement that increases in deficits are allowable during a recession if and only if they are followed by increases in surpluses during booms. Citation: Alesina (2012). Certain countries, however, took different approaches on how to control these increases in deficits/surpluses during economic periods. Particularly, economists debate whether it’s more effective to reduce taxation or increase government spending. Citation: Alesina (2012). Alberto Alesina explains here that economists dispute over how to increase public debt for the betterment of a country. Alesina interestingly claimed that if a country were to reduce interest rates and first cut spending, taxes would be cut in the near future, boosting consumption, investment and labor supply. This in turn would build GDP growth through a recession. This fiscal decision mapped out by Alesina reveals a potential scenario.
in which it would actually be cost effective to control government spending before government revenue. Compared to the tax side, this adjustment on the spending side is significantly less expensive. Citation: Alesina (2012). The US controlled its spending by raising and lowering government expenditures in certain quarters. Citation: FRED (2019). This in turn led to lower tax receipts in the US and thus, it was able to better recover compared to European countries, many of which launched austerity policies and reduced government spending while raising taxes. This decision, unfortunately, contributed to many European countries facing the eurozone debt crisis after the Great Recession.

As countries had to revise their strategies on fiscal policies to respond to the financial crisis, public debt levels in turn have changed after these policy adjustments. At the same time, GDP growth altered significantly within countries. In the US alone, real GDP growth has rapidly fluctuated between years after 2010 to 2018, Citation: IMF (2019), indicating new trends on GDP growth. If the theses by RR and Herndon were tested now with this recent development, would there be a new relationship between public debt and GDP growth? As different countries enforced different fiscal policies, would their debt/GDP ratios be different despite both achieving higher public debt? The US and European countries imposed diverse fiscal policies that resulted in very different economic outcomes. This new data could also empirically reveal which fiscal policies are better suited for times of financial crises and which policy would lead to higher GDP growth.

It wasn’t until 2011 that Reinhart and Rogoff decided to examine public debt and GDP further during the Great Recession and the sovereign debt crisis. Reinhart and Rogoff decided to expand their thinking and examine private debt as well as public debt to illustrate the escalating banking crisis within each country. The banking sectors faced huge amounts of private debt and that the convergence of private to debt to public debt would not stop. Citation: Reinhart and Rogoff (2011). The Reinhart and Rogoff examined how private debts from private sector banks soared and became public and how this contributed to many countries facing the sovereign debt crisis. They revealed foreboding information that higher debts lead to lower economic growth, and that they lack evidence to suggest that the United States is equally as susceptible as other developed countries when facing high debt. Citation: Reinhart and Rogoff (2011). It is not surprising here to see that Reinhart and Rogoff arrived at conclusions that are linear to those outlines in their previous papers. Reinhart and Rogoff, once again, took a detailed analytical approach to examine the relationship between rising public debt and GDP growth. However, remembering that Reinhart
and Rogoff conducted their previous analyses improperly, it is hard to side with these two economists and conclude that high levels of debt leads to certain decline in GDP. What would Herndon, Ash and Pollin think of this paper? If they try to analyze public and private debt and GDP growth from 1916 to 2010 using their method, would they reveal alternative relationships? It is curious to examine changes in other forms of debt (private, household, etc.) before and after the Great Recession and reveal any information regarding their relationships with GDP growth.

While Reinhart and Rogoff and Herndon, Ash and Pollin conducted Debt/GDP ratio testing, IMF researchers Kumar and Woo decided to analyze the effects of public debt on growth as well. However, Kumar and Woo decided to conduct this experiment using econometric analysis and consider other factors such as investment, labor productivity, population human capital, government consumption share of GDP, net exports, inflation and trade rates. They build non-linear models using data of these factors for 38 countries for the years 1970-2008. They conduct robustness checks to ensure their estimations weren’t biased. They constructed dummy variables for advanced and emerging economies and three dummy variables to classify different levels of public debt: Dum_30 for public debt below 30 percent of GDP, Dum_30-90 for debt between 30 and 90 percent of GDP and Dum_90 for debt over 90 percent of GDP. This econometric method led Kumar and Woo to conclude that public debt begins to affect growth negatively when public debt reaches to 90 percent of GDP. A ten-percentage point increase would lead to growth slowing to 0.2 percentage points each year for emerging economies and 0.15 percentage points for advanced countries. Over 90 percent of public debt would result in even lower growth results. They concluded this for both advanced and emerging economies with emerging economies suffering greater than advanced economies. They also concluded that debt leads to slower investment which in turn leads to lower labor productivity. Kumar and Woo proceeded to write a similar econometric paper in 2015 in reaction to the increasing public debt levels for many countries. However, this work is not easily accessible to the general public. It is insightful how Kumar and Woo developed dummy variables for the different debt levels to get accurate results of how much debt would lead to lower growth. This method would ideally be considered and used when analyzing both public and private debt in this thesis, as well as the variables of investment and population.

These papers analyze excruciatingly the positive/negative relationships between GDP growth and public debt. However, what makes their arguments narrow-minded is that they
exclusively discuss only the relationship with public debt and GDP growth. None of these papers discuss the direct relationship between GDP growth and private or household debt. Would there be a different relationship if private debt was considered as opposed to public debt? It is compelling to test if the relationships would be the same if private debt/GDP ratio were to be measured.

More literatures pertaining to private and household debts and their impact on the American economy came to light. The first two papers, both written by economist Steve Keen, discusses how private and household debts have continued to rise to levels that exceed those that led America to face the Great Depression. Citation: Keen (2009). Keen believed that high private and household debt levels will contribute to America facing a devastating economic recession. In both of his papers he looked at private debt levels and growth data in the United States and Australia with years dating back from 1860 until the start of banking crisis in 2007. In his first paper, he constructed a model of measuring output and employment. It expressed how the financial system lends the maximum capacity of credit debt business and households can accept. Citation: Keen (2009). The different factors that could contribute to private debt (loans, prices, wages and payments, for instance) were plugged as both exogenous and endogenous variables to show how private debt increased. As private debts continued to increase, output and employment fell dramatically in the U.S. and if private debt is not reduced, the United States could face another Great Depression. Citation: Keen (2009).

In Keen’s second paper, written shortly after his initial analytical works, he expands his model to incorporate Minsky’s “Financial Instability Hypothesis”, specifically discussing the theory of borrowing money to fund ‘Ponzi’ speculation on asset prices. This procured the growth of the household debt in the U.S. starting from 1990. This addition to his model led Keen to observe private debt increasing further and the threat of economic collapse would be even more serious. Keen believes that a collapse would have occurred in 1987 with minimal effects. However, this recession was delayed by the government intervening, causing private debt levels to rise continuously which would result in a cataclysmic collapse in the future. Since the government intervened in 1987, this depression was postponed, and a catastrophic depression occurred at the time of this paper’s publication. It seemed that Keen was partially correct in that the Great Recession did occur, but it did not possess as destructive effects as the Great Depression, despite private and household debts being higher. Perhaps, since private and household debts are higher
now compared to when this paper was written, these two forms of debt will contribute to shortening GDP growth and another recession may occur, but this will not happen for some time.

The second paper, composed by researchers Lombardi, Mohanty and Shim, discusses both the short and long run impact of household debt and GDP growth. They concluded that more household debt is beneficial for advanced economies in the short run but harmful in the long run; for emerging markets increasing household debt is always negative for growth. Citation: Lombardi et al. (2017). They examine this using both simple and complex STATA regression formulas, including an original empirical approach. This thesis, however, will use more/different countries in the dataset and other factors including population and investment will be included in this analysis. Dummy variables will be developed for the different private and household debt levels.

Although Herndon, Ash and Pollin decided not to replicate/correct Reinhart and Rogoff’s experiment on public debt affecting inflation, other papers claimed that high deficits contribute to high inflation. Monetary advisor Preston J. Miller explains in his works as simply as possible that deficits are equated as money created combines with net private bond sales, or the rise of its money’s value and bonds that are held in the private sector. Citation: Miller (1983). Miller goes on to examine the current and future deficits of his time to determine if the government would be able to continue funding public debt or face insolvency. Miller decided to look at an economic period where growth occurred smoothly/consistently with no rapid stimulus/decline. Deriving formulas to determine a simple equation of government spending – taxation (both being constant proportions of real output), he attempts to predict inflation when these two factors lead to consistent increase in deficit. Miller recalls a legal restrictions theory and considers three causes for higher deficits leading to higher inflation: when the Federal Reserve monetizes the deficits by accommodating increases in money and bonds to prevent interest rates increasing to levels that would cause the government to face insolvency. Thus, lowering the interest rate would be essential here, meaning inflation would rise. Citation: Miller (1983).

Another cause for high inflation is when crowding out occurs. With decreasing returns to capital (resulting from more bonds being sold to private investors in the open market), real output begins to decline while real rate of interest would rise, leading to higher prices or inflation. Citation: Miller (1983). Finally, when deficits rise, private sectors would be inclines to privately monetize government debt. This would cause private corporations to evade legal restrictions by holding government bonds as opposed to money out desire to maximize profits. Citation: Miller
These firms would use bonds for spending instead of money and increase inflation. Deficit and public debt are related to each other in the sense that the government generates public debt by borrowing money to compensate for years of deficit. This relation can be used to conclude that increases in public debt would in turn lead to higher inflation. Of course, this theory was developed 30 years prior to the years considered in this thesis. Public debt and deficit have increased since then for almost every country considered in this thesis. However, the fundamental theorem of deficits causing more inflation would remain intact; economic activity continued to grow at a consistent rate for many countries except for those who fell victim to the Great Recession as well as the sovereign debt crisis. The latter crisis, however resulted in few European countries facing rapid increases in public and private debts; this didn’t affect every major country.

The years studied in this thesis are particularly notable as they were the years after the Great Recession. Major countries such as the US and many eurozone countries faced crashing markets that began with the collapse of the subprime mortgage market in the US, eventually developing into a complete international banking crisis. This crisis was transformed into the global economic decline infamously known as the Great Recession, followed by a crisis in the banking system of the European countries using the euro. Many countries were still facing the repercussions of the financial crisis years after, such as Spain, Greece, Ireland and Portugal. They attempted to fix their public debts by implementing austerity policies including cutting government spending and/or increasing taxation. Citation: Mckee et. al (2014). This decision, however, backfired on these countries and they fell into a second financial crisis deemed as the sovereign debt crisis or the eurozone crisis.

For some eurozone countries, in Spain’s case especially, the economic effects of the crisis seemed worse compared to the rest of the Eurozone. Due to a high amount of liabilities of businesses and households, Spain’s main problems stemmed from high private debt. Spain’s increasing rate in the private sector’s debt was five times larger than that of the Eurozone.

Some of the Spanish banks, such as ES, had 155,175 million euros exposed to the sovereign debt crisis. European countries such as Germany, Belgium and France had big IB banks that were most exposed to Spain as well as Italy. Citation: Blundell-Wignall (2012). Prices of Spain’s securities oscillated, which negatively affected collateral values. The solvency of Spain’s banks was brought into question and its inability to meet collateral calls lead to a liquidity crisis; the Spanish banks were unable to recapitalize through earnings in a timely manner. Citation: Blundell-
Wignall (2012). Private debt levels reached to a record of 215.98 percent of GDP in Spain in 2010. While private levels slowly decreased to almost 175 percent of GDP, growth continued to decline until 2013 when it increased -1.7 to 3.6 by 2015. This supports the theory of private debt negatively affecting GDP according to Keen. Citation: Keen (2009). During this time, public debt continued to increase which seemed irrelevant as it did almost nothing to help increase growth in Spain. At the end of 2010, Spain’s public debt amounted to 60.1 percent of its national GDP, which was 25 percentage points lower than the Eurozone’s average [which was 85.1 percent at the time]. Citation: Carballo-Cruz (2011). These countries are considered as “advanced” by the International Monetary Fund, yet they have produced enough private debt levels that were actually detrimental to their GDP growth despite public debt increasing concurrently. This will have to be considered when calculating the magnitude of the impact public debt has on GDP; even though it may rise, GDP might still fall due to the rise in private debt for “advanced” economies such as Spain.

After the Great Recession, except for Austria, Czech Republic, Denmark, Israel, Luxembourg, and Switzerland, almost every major country included in this thesis was split between facing escalated public and private debts or seeing rapid declines in these factors. During this time, GDP growth continued to decrease for many European countries. Citation: Carballo-Cruz (2011). By observing the data, countries such as the US faced a period where GDP growth fluctuated between 2.6 to 1.6 percent GDP growth and finally settled to 2.9 percent in 2015. At the same time, however, public debt continued to rise from around 95 percent to almost 105 percent of its GDP. Private declined from 158 percent to 147 percent (over 10 percent) while household debt similarly declined from 91 percent to almost 78 (almost 20 percent decrease). This also seems to be in contrast with the economic works of Herndon, Ash and Pollin where they proved that advanced economies facing higher levels of government debt would stimulate growth for their country. Citation: Herndon et. al. (2014). It’s also been outlined earlier that both private and household debt possess negative effects for GDP growth. The data for the US show that the country entered in an economic period after the financial crisis where the specific levels of debt that were increasing/decreasing would result in constant growth in GDP. All of these debts should curve the US economy into a state of continuous growth, yet this is not the case. Some economists theorize that employment began to stagger due to a slow in growth in education attainment; this would mark the beginning of growth gradually deteriorating in the long run. Citation: Fernald and Jones (2014).
The financial crisis began in the United States, but it migrated towards Europe due to Europe’s investment in the US mortgage market. European countries, including Spain, began overinvesting in US mortgage-backed securities that were based on valuations of risky mortgages, which were ultimately poorly [and fraudulently] administered. Citation: Karanikolos et. al. (2013). As a result, an inevitable rise in US interest rates led to borrower defaults and then to bank defaults. This chain reaction initiated the start of the crash in the housing and stock markets. The value of US mortgage-backed securities plunged, leading to the collapse of the US housing market. However, because many of these mortgage-backed securities were sold in Europe, the collapse in the US housing market quickly affected European banks, including Spain’s. Citation: Karanikolos et. al. (2013). This led to a domino effect between each national economy until it resulted into an international economic disaster.

While debt levels are shifting to quantities that should bolster/hinder economic growth in the US, the data for this thesis shows fluctuations with GDP growth. Researchers John G. Fernald and Charles I. Jones began analyzing a model equating new ideas emerging for research and business. This model takes output per person, education attainment and stock of ideas which is “inferred” from the “flow” of investment (ie population and the strength of research) as well as other factors into consideration. In the years between 1950 and 2007, the main factor driving the development of new ideas is education attainment whereas the other factors remained constant. Citation: Fernald and Jones (2014). Fernald and Jones classified this dataset as education attainment by birth cohort and observe that the slope of education attainment is getting flatter, signifying reduced contribution from this factor. With all other factors staying constant, GDP growth might decline as a result in the decline of education attainment. This factor will not be used in the regressions but could be used in future theses regarding debt and growth. Similarly, Fernald and Jones argue that population is increasing at slower rates compared to historical increases, leading to slower growth in the United States. Should population have a constant positive relationship with GDP growth? In the years analyzed in this thesis, population grows/declines in dissimilar patterns as GDP growth for both advanced and non-advanced countries. However, this is only true for the six years in this dataset; this does not reflect the overall growths in population and GDP growth for the past 140 years. This does not necessarily mean that population no longer has a linear relationship with GDP growth. This will have to be taken into account when conducting the regression on this relationship.
After reading these literatures, the data used in these papers (or relatable data) should ideally be used in this thesis and this thesis should ideally be simply updated using more recent data released after the Great Recession. I need to replicate (to the best of my availability) the research done by Reinhart and Rogoff with updated data and repeat the analytical framework of Herndon, Ash and Pollin and determine which argument holds for the developed and emerging markets. I can test the relationship between GDP growth and public debt, as well as private debt and household debt. What relationship do these types of debt have with inflation? Will it be similar to public debt or will my analyses reveal new relationship information? Only then will the relationship between debt/GDP ratio and unemployment and contribute further in this thesis.

Section III: Analytical Framework and Initial Models Developed

What was very peculiar for Reinhart and Rogoff was that they based their analysis on examining historical data series. They said they calculated public debt/GDP ratio while using certain coding, but they did not specify what kind of regression analysis they performed. For this thesis, the relationship between public debt and GDP for both advanced and emerging markets will be determined. This will be examined by performing a multitude of regression analyses. It was desirable to replicate Reinhart and Rogoff’s thesis using the methodologies of Herndon, Ash and Pollin, but unfortunately that might be very complicated as finding the exact data needed might be difficult and it could be difficult to code everything exactly as Herndon, Ash and Pollin did.

The observations were to include all of the countries used between the papers of Reinhart and Rogoff, and Herndon, Ash and Pollin. They used 40 countries (20 advanced and 20 emerging) and analyzed their public debts and GDP growth rates for years dating back to 1790 up to 2009 with some data for 2010. They then created five groups based on how much public debt was a certain percentage of a country’s GDP. This thesis ideally is to update the debt/GDP ratio for the years 2010-2017.

Here, regression analyses will be conducted. Numerous models will be formed, including models depicting the direct relationship between public debt and GDP. Advanced and emerging economies cannot be analyzed at the same standards; the literatures noted depict debt/GDP ratios calculated for both advanced and emerging countries separately as opposed to being grouped. Thus, dummy variables need to be formed for advanced and non-advanced economies. As public
and private debt are polarizing variables, they will not be included in a model together; this extends to the intentionally separation of public debt and household debt as well. Since household debt is a subsection of private debt, these variables will also not be calculated simultaneously. The aim is to prove whether more public/private debt types will lead to growth increasing/decreasing at different rates. Thus, quadratic models are necessary for this analysis; all debt types will be collected as both normal and squared. Total population for each selected country will be included in almost every model as well as total investment to analyze how much these variables influence the statistical significance of the debt variables. Total investment will be marked as a ratio of total investment in current local currency and GDP in current local currency. This considers investment from both the government and all corporations for each country. The Investment data is calculated by the aggregate value of the gross fixed capital formation and changes in inventories and acquisitions excluding removals of valuables for a unit or sector (IMF 2019). It will be measured as a percentage of the country’s GDP for each year. The variables data for the regression analysis would be labelled as followed:

- Real GDP growth for both advanced and emerging economies (y-variable)
- Public debt for both advanced and emerging economies (x-variable)
- (Public debt)$^2$ for both advanced and emerging economies (x-variable)
- Private debt for both advanced and emerging economies (x-variable)
- (Private debt)$^2$ for both advanced and emerging economies (x-variable)
- Household debt for both advanced and emerging economies (x-variable)
- (Household debt)$^2$ for both advanced and emerging economies (x-variable)
- Total population for both advanced and emerging economies (x-variable)
- Total investment for both advanced and emerging economies (x-variable)
- Inflation rate for both advanced and emerging economies (y-variable)

The Real GDP growth for both advanced and emerging markets will be the dependent variables while all the public debt categories will serve as the independent variables for this analysis. These groups will be constructed in the long run. Public, private and household debt are calculated as a percentage of their country’s GDP. The population dataset was measured as millions of people until it was decided to multiply each data by a million to not get it confused as a percentage
representation for STATA. Total investment is measured as a percent of GDP and inflation is measured as annual percent change. All data was collected from the International Monetary Fund.

To recap, the main part of this thesis was to conduct an analysis of the relationship between real GDP growth and different types of debt (public, private and household). This paper was to initially include the 40 countries used between the papers of Reinhart and Rogoff, and Herndon, Ash and Pollin; 20 of these countries were advanced and 20 were emerging. They created five groups based on how much public debt was a certain percentage of a country’s GDP (this is still planned). The plan was to update the debt/GDP ratio for the years 2010-2017. However, after finally gathering the data, some of the countries do not have data yet for variables such as private debt or household debt. In addition, some of these countries did not have data on its public debt for 2016-2017 yet. Ultimately, this paper collected data on real GDP growth, public, private and household debt, population, total investment and inflation. Not many countries have this data for 2016 and 2017 yet so to ensure there are enough observations, the data was collated for the years 2010-2015. The countries selected were countries that had data on all of these variables for the determined years; if one country had public and private debt information but no household debt for the selected years, that country would be excluded. Finally, 57 countries will be used in this paper – some of these countries were used in the referenced papers but most were countries excluded by Reinhart and Rogoff. In total, there are 342 observations in this experiment.

Reinhart and Rogoff simply stated that they used government and external debt, without going into further detail of how they’re defining these variables. This paper defines government debt variable as general government debt recorded from the International Monetary Fund. The IMF defines this variable as “the total stock of debt liabilities issued by the general government as a share of GDP.” Citation: Global Debt (2018). The private debt variable is comprised of private debt, loans and debt securities. The household debt variable is similarly compiled of household debt, loans and securities. The IMF defines private debt variable as ‘total stock of loans and debt securities issued by households and nonfinancial corporations as a share of GDP.” Citation: Global Debt (2018). Likewise, the household debt variable is defined by the IMF as ‘total stock of loans and debt securities issued by households as a share of GDP.” Citation: Global Debt (2018). All of these variables are measured as a percentage of a county’s GDP for each year. The GDP dependent variable is also measured in annual percent changes.
It was advisable to start small and conduct simple population regressions first. Numerous models will still be formed, including quadratic models depicting the direct relationship between public debt and GDP. To start conducting regression trials, eight simple models were constructed to test real GDP and debt: a model depicting the relationship between GDP growth and public debt, population and total investment, a model calculated the effects private debts, population and total investment growths on real GDP growth, and a model analyzing GDP and household debt with population and total investment. To test direct relationships between growth and the debt variables, models will be constructed excluding the population and investment variables. Since “advanced” and “non-advanced” countries were treated differently in the literatures, dummy variables have to be constructed and then variables that calculate the interactions between the dummy variables and the different types of debt. Everything needs to start small; thus, models depicting the types of debt for each country is classified as linear as opposed to being in polynomial forms for now.

\[
RGDP_{it} = \alpha_1 + \beta_0 + \beta_1 \times pubdebt_{it} + \beta_2 \times population_{it} + \beta_3 \times invest_{it} + \beta_4 \times dummy_{it} + \varepsilon_{it}
\]

\[
RGDP_{it} = \alpha_1 + \beta_0 + \beta_1 \times privdebt_{it} + \beta_2 \times dummy_{it} + \varepsilon_{it}
\]

\[
RGDP_{it} = \alpha_1 + \beta_0 + \beta_1 \times privdebt_{it} + \beta_2 \times dummy_{it} + \varepsilon_{it}
\]

\[
RGDP_{it} = \alpha_1 + \beta_0 + \beta_1 \times housedebt_{it} + \beta_2 \times dummy_{it} + \varepsilon_{it}
\]

Where \( \beta_1 \) is the unknown population parameter for each variable (\( \beta_0 \) is the intercept of the regression line with the y-axis), \( \varepsilon \) is the population error. These models and all subsequent models will be both a time series data and a cross sectional data or a panel dataset. This whole analysis is to update and contribute to the works of Reinhart and Rogoff as well as Herndon, Ash and Pollin. The date for this thesis will be created; the data that was conducted between the two core papers will not be touched.

Dummy = 1 if the country is deemed as “advanced” by the IMF (2016) and Dummy = 0 if the country was not indicated as such by the IMF. Typically, the interaction between the debt and the dummy variables would be analyzed in conjunction with the other variables. However, this could complicate the models as there are already numerous variables considered; the interaction variables, otherwise known as the slope dummy variables, could start influencing the other
variables the point where their outcomes would no longer be statistically significant. As a result, these slope dummy variables will not be considered in any of the constructed models in this thesis.

After recalling that Reinhart and Rogoff also examined the relationship between public debt and inflation, data on inflation rates using average consumer prices and their annual percent changes was collected, with the IMF as the source. Reinhart and Rogoff concluded that there was no real relationship between these two variables. Citation: Reinhart and Rogoff (2010). However, their research was disproved by Herndon, Ash and Pollin and they didn’t replicate this part of the initial paper. Another thing to consider is that this relationship was tested for years prior to those included in this data. Hopefully, there is indeed a relationship between these two variables had Reinhart and Rogoff implemented their data correctly and continued their research. Thus, the fifth model was constructed to see if a definite relationship between public debt and real GDP ultimately exists with the dummy variable and interaction. Thus, the initial models for the inflation/public debt relationship and connection between inflation and public debt, population, as well as investment was formed as followed:

\[
Inflation_{it} = \alpha + \beta_0 + \beta_1 \cdot pubdebt_{it} + \beta_2 \cdot population_{it} + \beta_3 \cdot invest_{it} + \beta_4 \cdot dummy_{it} + \epsilon_{it}
\]

\[
Inflation_{it} = \alpha + \beta_0 + \beta_1 \cdot pubdebt_{it} + \beta_2 \cdot dummy_{it} + \epsilon_{it}
\]

Reinhart and Rogoff discussed in one of their papers that private debts from the banking sectors migrated to the public sector and transformed into public debt. Citation: Reinhart and Rogoff (2011). They did not, however, analyze the relationship between GDP growth and private debt itself. It would be very interesting to examine what kind of relationship these two variables have with each other. The same will be done for household debt and GDP. As such, the variables will be labelled as identical to the ones outlined for public debt/GDP relationship but this time it will be for private debt and household debt.

Reinhart and Rogoff claimed that public debt had little to no impact on inflation for advanced countries and inflation rose when public debt rose. However, this was when they conducted many coding errors as pointed out by Herndon, Ash and Pollin. They did not test the relationship for debt and inflation themselves. For this thesis, there will be no model testing the relationship between inflation and private debt or household debt.
The first two figures show the trends in each variable for the countries Albania and USA, an emerging economy and an advanced country, respectively. Not surprisingly, real GDP growth had declined from 2010-2015 and public debt increased simultaneously for Albania. Growth faced a rapid decline until 2014 when growth began to increase but at a lower level compared to 2010. During this time, public debt continued to increase. As a developing country faced increasing public debts, the GDP growth rate declined in the long run. On the other side, however, GDP growth has fluctuated in the US while public debt continuously rose. This almost goes in line with the hypotheses of this paper. There doesn’t appear to be a linear relationship between GDP growth and any of the debt categories, but further testing is essential to confirm these assumptions.

Based on reading the literatures regarding each variable, many predictions have been made: As more public debt increases for advanced countries, GDP growth will continue to rise until public debt reaches levels above 120% of a country’s GDP and then decline. For non-advanced countries, public debt will continue to be detrimental to economic growth. Private debt will have negative consequences on GDP growth for both advanced and non-advanced countries if they continue to increase. Similar hypotheses can be conjectured regarding household debt and growth; as household debt is a subsection of private debt, it will negatively impact GDP growth for both advanced and emerging economies. As public debt negatively affected inflation historically in the U.S., an advanced country, public debt should continue to raise inflation for both advanced and emerging economies. However, it should be stated clearly that the United States is a unique economy where it can print more money and distribute the U.S. dollar to foreign countries without depreciating the dollar value. This country is unique, and it should be noted that it will still be regarded at the same standard as another advanced country such as Spain in this analysis, despite the economic differences between these two economies.

The Gauss Marko Theorem states that if all classical assumptions are true, then OLS estimates are Best Linear Unbiased Estimates (BLUE). The classical assumptions include assumptions of population errors having a normal PDF (i.e. there are at least 30 estimates in a population regression function), the errors being homoscedastic and the lack of a linear relationship among the independent variables (no multicollinearity). To test to see if my OLS estimates are BLUE, the following robustness checks must be conducted:
Test for multicollinearity
Hausman Test

Before any regression can be conducted, these two tests must be completed first to ensure the variables are BLUE. Since the dataset is both a cross section and a time series, the Hausman test must be used here.

Section IV: Robustness Checks 1
Initial Tests for Multicollinearity

After running regression tests on GDP and the eight models, for public debt and GDP, no $R^2$ value was calculated above 0.35; these are not high values and thus there is no imperfect multicollinearity present in this model. When analyzing the values of the vifs for each model, they were all below the value of 5 as seen in Table 2. The results are displayed in table 2 at the bottom of this thesis. Interestingly, when the population and investment variables were coupled with the debt and dummy variables, the debt variables received higher vifs that risked imperfect collinearity. When the model would only include growth/inflation and the different debt and dummy variables, the vifs for the debt variables only decreased to equal the dummy variable for each “simplified model”. The dummy variables would remain unchanged with their respective debt models. There is no sign of imperfect multicollinearity with any these models. Hopefully, the initial hausman tests will reveal no bias either and determine whether to use the fixed effects or random effects model for each equation.

Initial Hausman Tests

The Hausman tests revealed peculiar results as evidenced in Table 3; all of the p-values for each variable for each model were lower than the level of significance for the two-tail test (2.5 percent). Naturally, the fixed effects models should be selected. However, each time the fixed effects models were plugged in, the dummy variables were omitted because of collinearity. Could the dataset be more biased than perceived when the tests for multicollinearity were conducted? Whenever the random effects models were tested, however, all of the variables were accounted for and not omitted. Ideally, the fixed effects model should be selected for these regressions. To get
around this conundrum, there should be dummy variables implemented for every country (or country code) to eliminate collinearity. 57 new dummy variables were generated to account for each country used in this dataset. After these new dummy variables were generated, no variables were omitted, and the p-values were still lower than the level of significance for the two-tail test. Thus, the fixed effects models could now be selected when running the regressions without any influences in the data.

Section V: Initial Sample Regressions

Initial Linear Models

Model 1: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times pub_{it} + \beta_2 \times population_{it} + \beta_3 \times invest_{it} + \beta_4 \times dummy_{it} + \epsilon_{it} \)

Model 2: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times dummy_{it} + \epsilon_{it} \)

Model 3: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times priv_{it} + \beta_2 \times population_{it} + \beta_3 \times invest_{it} + \beta_4 \times dummy_{it} + \epsilon_{it} \)

Model 4: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times priv_{it} + \beta_2 \times dummy_{it} + \epsilon_{it} \)

Model 5: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times house_{it} + \beta_2 \times population_{it} + \beta_3 \times invest_{it} + \beta_4 \times dummy_{it} + \epsilon_{it} \)

Model 6: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times house_{it} + \beta_2 \times dummy_{it} + \epsilon_{it} \)

Model 7: \( Inflation_{it} = \alpha_i + \beta_0 + \beta_1 \times pub_{it} + \beta_2 \times population_{it} + \beta_3 \times invest_{it} + \beta_4 \times dummy_{it} + \epsilon_{it} \)

Model 8: \( Inflation_{it} = \alpha_i + \beta_0 + \beta_1 \times pub_{it} + \beta_2 \times dummy_{it} + \epsilon_{it} \)

The results of the estimates of the sample regression functions are illustrated in Tables 5 and 6. The sample slope coefficients of each variable except for population, dummy and investment variables for models 1, 3, 4, 5 and 7 respectively are significant. All of the debt variables were significant in each of their models. Almost all of the estimates followed expectations with the exception of the public debt variable. Public debt did negatively affect GDP by 0.6-0.9 percent for every 1 percentage point increase. However, the dummy variables indicated that advanced countries suffered growth drops greater than non-advanced countries by 0.95-4.6 percent. The first percentage point, however, proves to be statistically insignificant so these results cannot accurately reflect the real differences between advanced and non-advanced countries. This could have to the fact that all of the variables are pooled together as opposed to being grouped in percentage brackets which would have been ideal. Another thing to consider is that some European countries fell into what was called the eurozone debt crisis after the Great Recession. Countries such as Greece, Portugal, Ireland, Italy and Spain that are deemed as “advanced economies” had their public as well as private debts accelerate, and GDP growths fluctuated greatly between each
country. **Citations:** Blundell-Wignall and Slovik (2011), Blundell-Wignall (2012). Some factors relating to this event are not accounted for in this thesis and this could result in the dummy negatively affecting real GDP growth for advanced countries to unprecedented levels despite established economic theories.

On the flipside, private debt resulted in being detrimental to both country types by 0.04-0.05 with the dummy variable significantly illustrating emerging economies suffering heavier losses of growth. Household debt similarly negatively affected real GDP growth as hypothesized (0.23-0.26), but some of the other variables are not significant, namely population. Interestingly, when household debt was coupled with population and investment, the dummy variable indicated advanced countries suffering less loss of growth with increasing debts compared to non-advanced countries. When these two variables were eliminated, however, the opposite occurred with the dummy variable while still being significant. While it is true that the population variable was never significant, the investment variable was significant. How much could investment have affected the dummy results between the two models? Hopefully when the debts are squared and added to the models, similar results will emerge but with more results being significant.

Public debt did cause inflation to rise as expected; this makes sense as a country sometimes needs to monetize public debt to prevent the country becoming insolvent. **Citation:** Miller (1983). The dummy variable indicated that advanced countries face higher inflation when public debt increases. However, none of the dummy variable results were statistically significant. Thus, no conclusions can’t be drawn as to how the two country types differ when public debt affects inflation. R² yields values anticipated for all models. Since there’s no multicollinearity in the regression models, each R² is meant to have an appropriately low value; the goodness of fits of the models came as expected. It important to note that the investment variable produced beneficial results for countries’ growth rates.

Up to this point, this analysis was based on linear models between the dependent and independent variables. The dataset was not yet grouped in the percentage brackets as outlined by Reinhart, Rogoff, Herndon, Ash, Pollin Kumar and Woo. After grouping and analyzing the data with this method, the majority of public debt was between 30-120 percent of a country’s GDP for advanced economies each year; few countries had public debt below 30 percent and above 120 percent of GDP. For non-advanced economies, however, the majority of the datasets were between under 30 percent and 60 percent of GDP. Public debt was rarely higher than 85% of GDP and no
public debt was higher than 90 percent for each year. In order to regress the different debts and real GDP growth with this organization of the data, polynomial forms (or a quadratic models) and graphical models must be constructed. This means the new variable of (public debt)$^2$ must be introduced to this thesis. It was mentioned by Fernald and Jones that population growth has slowed down in the recent decades, leading to slower growth; this could imply that a squared variable of total population for each country is possible to introduce. However, this could overcomplicate each formula and result in higher p-values for each variable, making them statistically insignificant. The same argument applies for the investment variable for similar reasons mentioned by Kumar and Woo. Thus, the only variables that will be both squared and linear are the debt variables. The models that will incorporate these new variables are outlined below:

\[
\begin{align*}
\text{RGDP growth}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{pubdebt}_{it} + \beta_2 \cdot \text{pubdebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\text{RGDP growth}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{privdebt}_{it} + \beta_2 \cdot \text{privdebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\text{RGDP growth}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{housedebt}_{it} + \beta_2 \cdot \text{housedebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\text{RGDP growth}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{houseusedebt}_{it} + \beta_2 \cdot \text{houseusedebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\text{InflationR}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{pubdebt}_{it} + \beta_2 \cdot \text{pubdebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\text{InflationR}_{it} &= \alpha_i + \beta_0 + \beta_1 \cdot \text{privdebt}_{it} + \beta_2 \cdot \text{privdebt}^2_{it} + \beta_3 \cdot \text{population}_{it} + \beta_4 \cdot \text{invest}_{it} + \beta_5 \cdot \text{dummy}_{it} + \epsilon_{it} \\
\end{align*}
\]

Similar to the simple linear models outlined earlier, there will still be eight models depicting both the direct relationships between growth/inflation and the different debt types and the relationships between these variables when investment and population are also considered. To ensure that all variables are still BLUE, the Hausman test must be conducted again with this new variable. The tests for multicollinearity are not necessary for these newly introduced variables as they are merely the debt variables squared.

Section VI: Robustness Checks 2
Second Hausman Tests

The Hausman tests revealed similar results in Table 4 yielded from the previous tests; the p-value was lower than the level of significance for every two-tail test. Again, this should lead to the conclusion that the fixed effects model should be considered for the final regressions. However,
the dummy variable was omitted again in each model because of collinearity. This didn’t happen when the random effects model was tested. Once again, to resolve this issue, the dummy variables for the country codes had to be used to eliminate collinearity. Similarly, the p-values were all lower than the level of significance with no variables being omitted. For the polynomial models, the fixed effects model will again be selected.

Section VII: Final Regressions and Discussions

Final Polynomial Forms

Model 9: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{population}_{it} + \beta_4 \times \text{invest}_{it} + \beta_5 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 10: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_5 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 11: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{population}_{it} + \beta_4 \times \text{invest}_{it} + \beta_5 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 12: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 13: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{population}_{it} + \beta_4 \times \text{invest}_{it} + \beta_5 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 14: \( RGDP_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 15: \( \text{Inflation}_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{population}_{it} + \beta_4 \times \text{invest}_{it} + \beta_5 \times \text{dummy}_{it} + \epsilon_{it} \)

Model 16: \( \text{Inflation}_{it} = \alpha_i + \beta_0 + \beta_1 \times \text{pubdebt}_{it} + \beta_2 \times \text{pubdebt}_{it}^2 + \beta_3 \times \text{dummy}_{it} + \epsilon_{it} \)

The results of the estimates from these regressions are listed in tables 7 and 8 and graphs 3 and 4. The results were somewhat similar to the linear regressions. Again, public debt proved to be damaging to a country’s growth by 0.12-0.16 percentage points. Unfortunately, in both models, \((\text{public debt})^2\) proved to be statistically insignificant and showed positive results in growth. The dummy variables showed for advanced countries to be facing larger losses in growth as public debt increases while being insignificant in the first model but significant in the second model. How could advanced countries be suffering greater than non-advanced countries? Could it be because countries such as Spain, Ireland, Greece, Italy and Portugal faced debt levels higher than some emerging economies when they were facing the eurozone crisis? Could this economic event effect debt and growth enough for these results to be shown as calculated? Graph 3 illustrates how increasing public debt lowers growth until debt reaches about 90 percent of GDP that the decline rate begins to slow down. When debt reaches nearly 100 percent growth declines to zero percent and continuing debt results in negative growth. However, when debt nears 175 percent growth begins to increase again. If these values were significant and showed similar results, this violates the works of Herndon, Ash and Pollin as well as Kumar and Woo. They did not consider, however,
debt levels that would greatly surpass 120 percent of a country’s GDP, such as Japan facing 236 percent public debt or Greece facing 180 percent during its sovereign debt crisis. It can almost be concluded that enough public debt could lead growth to increase. Ultimately, however, this analysis cannot definitively conclude that public debt would increase growth when it reaches past 175 percent of GDP.

Private debt, on the other hand, produced significant results for both of its models with private debt being harmful to growth with advanced countries suffering less than non-advanced countries. However, this was only true when debt wasn’t squared (-0.13 to -0.15 percentage points). When (private debt)$^2$ was introduced in the model, this variable produced very small but positive quantitative results for growth in both models (0.00015-0.00016 percentage points). This is a similar predicament with the public debt variables. However, all of the variables with the exception of population were statistically significant, yielding more accurate results with private debt. Graph 4 displays comparable results as Graph 3 but with higher levels of private debt. Once private debt reaches approximately 130 percent of GDP, growth falls to zero and continues to decline until debt reaches to 450 percent of GDP. Similarly, with household debt, the polynomial models produced results with household debt yielding negative effects on growth initially but as it jumped quadratically household debt formed positive results; this was the case in both household models (-0.28 to -0.26 for regular and 0.00035 to 0.00032 for debt$^2$). However, the squared variable of household debt was still insignificant statistically so this may not represent the actual relationship between growth and household debt. If that was the case, this would show opposite results of Lombardi and his [econometric] analysis of debt and growth. Household debt is supposed to be initially beneficial and then detrimental as debt continuously increases. Graph 5 illustrates growth declining almost completely linearly until household debt reaches to 150 percent of GDP where growth rises very little. How can private debt and household debt specifically be beneficial for growth as private debt increases? Could there be other economic factors hidden in these models that could account for positive growth when debt increases? Of course, this is analyzed in quadratic models as opposed to dummy groupings of different debt levels. This could also factor in the results produced.

Investment was always positive in all of the models with the exception of inflation being the endogenous variable as evidenced in tables 6 and 8. This insignificance, combined with population facing insignificance concurrently, the public debt variables produced similar results
for inflation as the growth variable. Debt was harmful initially (0.17-0.15) but when squared (or elongated), negative coefficients formed (-0.00061 to 0.00063). However, when investment and population were eliminated in the next model, similar results were shown. Graph 6 shows inflation rising as public debt increases until it reaches over 120 percent of GDP. After 120 percent, inflation begins to decrease. This goes against the legal restrictions theory illustrated by Miller in 1983. It seems that public debt wouldn’t necessarily have as negative of an effect on inflation as hypothesized by Miller in 1983. It is obvious however that this was theorized 30 years ago; over time, the global economy has evolved drastically to endure countries facing higher levels of public debt and events such as the Great Recession and the eurozone crisis. Miller based his results on the economy that occurred in the 1980s which would no longer hold in 2015. It could be possible that the changes in the economic structure for many countries after 30 years could influence public debt having different effects on inflation in the 21st century.

The variables must be controlled in each model and further testing may be required to figure out which variables to include/omit in the models to ensure more significant results. At this point, it can’t be concluded that increased public debt would lead to lower levels of economic growth for advanced countries and significant drops in growth for non-advanced countries. It also can’t be definitively concluded that more household debt would cause growth to rise or fall.

Few limitations must be addressed when evaluating the econometric works of this thesis. What was ideal and brilliant about Kumar’s and Woo’s analysis was that they created dummy variables for their three groups of public debt levels. This paper merely produces a quadratic model to demonstrate how more public debt would lead to diminishing growth; this time, however, the public debt variable squared failed to be statistically significant in both models. This is a serious limitation when estimating how much public debt would cause growth to fall drastically.

The biggest limitations, however, was the amount of the statistically insignificant results revealed when the regressions were conducted. In the linear models, the population and dummy variables were insignificant for many of the models while investment was insignificant only for the inflation experiment. When the polynomial models were calculated, population was insignificant for every model that included this variable. The public debt variable was also insignificant when it was squared. Due to these insignificant results, the graphs that were constructed produced figures that contradict the dominant theories of debt negatively affecting growth and stimulating inflation. In the graphs,
The main purpose of this thesis is to update the analysis of the different debt types and their effects on GDP growth/inflation since 2009 by Reinhart and Rogoff, Herndon, Ash and Pollin and Kumar and Woo. However, in their works they analyzed many countries over a span of decades whereas this thesis focuses only on six years. Each variable might not have had enough time to develop quantities that would lead to significant changes/results in their relationships with growth and inflation. Fernald and Jones concluded that population growth has declined in the years of their study, leading to similar declines in GDP growth. Citation: Fernald and Jones (2014). In this thesis, the year gap for the data is only six years compared to the 140+ year gap in their analysis. This thesis does not take into account the rate at which population, debt and investment growth increased/decreased for each country. This could be another limitation in the dataset.

Because of these limitations, the results from these regressions revealed relationships that contradict the previous works/theories developed by the literatures mentioned in this thesis. Either these limitations influenced the data enough to produce the results presented in the tables or the economic shocks between the sequential recessions since 2010 have caused the variables to relate differently with each other.

Section VIII: Conclusions

The econometric works depicted in this thesis yielded both statistically significant and insignificant results. Public debt insignificantly proved to be damaging to GDP for advanced countries by 0.12-0.16 percentage points for every percent increase in public debt. In the play of (public debt)^2, however, results were insignificant with growth rising by 0.0003 percentage points. The dummy variable indicated advanced countries would face larger levels of decline in growth with increasing debt compared to non-advanced countries. This could be due to many advanced countries suffering from both the Great Recession and the sovereign debt crisis during the years selected. It can’t be concluded if increasing public debt would lead to higher/lower growth when debt reaches levels of over 120 percent of a country’s GDP.

Private debt procured similar results as public debt for both private debt and (private debt)^2, however results were significant for each model. The dummy variable indicated advanced countries would face smaller levels of decline in growth with increasing debt compared to non-advanced countries. This leads to the conclusions that private debt could help growth very
minimally once private debt is over 400 percent of a country’s GDP. This would be true for only advanced countries; non-advanced countries would always face lower levels of growth when private debt increases. It can’t be concluded, however, that household debt would have positive/negative impacts on growth for all country types. Household debt may be harmful to growth initially, but it can’t be accepted/rejected that continuous increases in this debt type would lead to higher growth for either type of country.

Public debt, however, proves to be risk inflation as this debt increases. However, once public debt surpasses 120 percent of GDP, inflation will begin to decline for advanced countries. This leads to the conclusion that if public debt is controlled in advanced countries, inflation will reach levels beneficial to their economy, depending on the economic state.

It can’t be concluded whether increases in population is beneficial/harmful for growth and inflation based on these econometric works. Investment, however, should be encouraged amongst both advanced and non-advanced countries to boost economic growth.

If this paper is to be revisited and revised for future works, new policy prescriptions must be implemented: One econometrician/researcher constructed this thesis with both significant and insignificant results; two authors for the revision of this thesis would be ideal for achieving only significant results. Selection of data will still have to come from credible sources such as the IMF but the exact data to be selected would be confirmed by all authors. The time gap for the years to be selected must be longer than the six years examined in this thesis. Most importantly, however, dummy variables to group the different debt types into appropriate debt levels is critical to determine the exact debt levels that would stimulate/harm GDP growth and inflation.
List of Graphs

Figure 1: Debt-GDP Relationship for Albania, emerging market

![Albania: Debt-GDP Relationship](image1)

Figure 2: Debt-GDP Relationship for USA, advanced market

![USA](image2)
Figure 3: Insignificant Relationship between Real GDP Growth and Public Debt

Figure 4: Significant Relationship between Real GDP Growth and Private Debt
Figure 5: Insignificant Relationship between Real GDP Growth and Private Debt

Figure 6: Significant Relationship between Inflation and Public Debt
List of Tables

Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Descriptive Statistics</th>
<th>RGDP Growth (annual percent change)</th>
<th>InflationR (annual percent change)</th>
<th>%pubdebt (percent of real GDP)</th>
<th>%privdebt (percent of real GDP)</th>
<th>%housedebt (percent of real GDP)</th>
<th>population (measured in millions * 1,000,000)</th>
<th>%invest (percent of GDP)</th>
<th>%pubdebt² (percent of real GDP)²</th>
<th>%privdebt² (percent of real GDP)²</th>
<th>%housedebt² (percent of real GDP)²</th>
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<td>137.53</td>
<td>49.88</td>
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<td>80533350.88</td>
<td>22.83</td>
<td>5078.46</td>
<td>26541.70</td>
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<tr>
<td>Variance</td>
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<td>7650.53</td>
<td>1104.94</td>
<td>12.82</td>
<td>5798862475</td>
<td>30.60</td>
<td>63952629.59</td>
<td>120430609.02</td>
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Table 2: Calculation of Variance Inflation Factors

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<th>VIF (model 3)</th>
<th>VIF (model 4)</th>
<th>VIF (model 5)</th>
<th>VIF (model 6)</th>
<th>VIF (model 7)</th>
<th>VIF (model 8)</th>
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<td>1.21</td>
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<tr>
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<td>1.72</td>
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<td>%housedebt</td>
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<td>1.75</td>
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<td>population</td>
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<td>1.79</td>
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<td></td>
<td></td>
<td>1.99</td>
<td></td>
</tr>
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<td>1.77</td>
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### Table 3: Results of Initial Hausman Tests

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<th>Variable</th>
<th>$H_0$</th>
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<th>Level of Significance</th>
<th>$\chi^2$</th>
<th>Prob. &gt; $\chi^2$</th>
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<td>Difference in coefficients not systemic (FE = RE)</td>
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<td>0.0003</td>
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<tr>
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<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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<td>0.0000</td>
</tr>
<tr>
<td>Model 4</td>
<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
<td>5%</td>
<td>20.31</td>
<td>0.0000</td>
</tr>
<tr>
<td>Model 5</td>
<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
<td>5%</td>
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<td>0.0000</td>
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<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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<tr>
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<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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<tr>
<td>Model 8</td>
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<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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### Table 4: Results of Second Hausman Tests

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<th>$H_A$</th>
<th>Level of Significance</th>
<th>$\chi^2$</th>
<th>Prob. &gt; $\chi^2$</th>
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</thead>
<tbody>
<tr>
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<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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<td>11.66</td>
<td>0.0086</td>
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<tr>
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<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
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<td>13.22</td>
<td>0.0013</td>
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<tr>
<td>Model 11</td>
<td>Difference in coefficients not systemic (FE = RE)</td>
<td>Difference in coefficients are systemic (FE $\neq$ RE)</td>
<td>5%</td>
<td>47.86</td>
<td>0.0000</td>
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<tr>
<td>Model 12</td>
<td>Difference in coefficients not systemic (FE = RE)</td>
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<td>Model 15</td>
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Table 5: Testing the Effects of Debt Types to GDP Growth with Linear Forms

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<th>Dep Var $\Delta GDP_{growth_{it}}$</th>
<th>Model 1</th>
<th>P-Value</th>
<th>Model 2</th>
<th>P-Value</th>
<th>Model 3</th>
<th>P-Value</th>
<th>Model 4</th>
<th>P-Value</th>
<th>Model 5</th>
<th>P-Value</th>
<th>Model 6</th>
<th>P-Value</th>
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</thead>
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<td>cons</td>
<td>-2.785</td>
<td>0.402**</td>
<td>8.867</td>
<td>0.000**</td>
<td>-4.146</td>
<td>0.088**</td>
<td>6.357</td>
<td>0.000**</td>
<td>1.350</td>
<td>0.565**</td>
<td>22.742</td>
<td>0.000**</td>
</tr>
<tr>
<td>%pubdebt_{it}</td>
<td>-0.059</td>
<td>0.003**</td>
<td>-0.092</td>
<td>0.000**</td>
<td>-0.038</td>
<td>0.000**</td>
<td>-0.047</td>
<td>0.000**</td>
<td>-0.234</td>
<td>0.000**</td>
<td>-0.263</td>
<td>0.000**</td>
</tr>
<tr>
<td>%privdebt_{it}</td>
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<td>0.598**</td>
<td>-4.600</td>
<td>0.010**</td>
<td>15.186</td>
<td>0.000**</td>
<td>0.150</td>
<td>0.918**</td>
<td>22.661</td>
<td>0.000**</td>
<td>-12.975</td>
<td>0.000**</td>
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<td>0.598**</td>
<td>-4.600</td>
<td>0.010**</td>
<td>15.186</td>
<td>0.000**</td>
<td>0.150</td>
<td>0.918**</td>
<td>22.661</td>
<td>0.000**</td>
<td>-12.975</td>
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</tr>
<tr>
<td>%invest_{it}</td>
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<td>0.263</td>
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<tr>
<td>$\overline{R}^2$</td>
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<td>$\chi^2$</td>
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<td>21.79</td>
<td>20.31</td>
<td>71.39</td>
<td>75.73</td>
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</table>

All standard errors are in parentheses
* indicates significance at 10% level of significance
** indicates significance at 5% level of significance
*** indicates significance at 1% level of significance
Table 6: Testing the Effects of Public Debt to Inflation with Linear Forms

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<tr>
<th></th>
<th>Model 7</th>
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<th>Model 8</th>
<th>P-Value</th>
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<td><strong>Dep Var</strong></td>
<td>InflationR_{it}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cons</td>
<td>-4.827</td>
<td>0.260**</td>
<td>-0.926</td>
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<td></td>
<td>(4.281)</td>
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<td>%pubdebt_{it}</td>
<td>0.060</td>
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<td>(0.024)</td>
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<td>(0.022)</td>
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<td></td>
<td>(3.72e)</td>
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<td>5.23</td>
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</table>

*All standard errors are in parentheses
* indicates significance at 10% level of significance
* * indicates significance at 5% level of significance
* ** indicates significance at 1% level of significance
Table 7: Testing the Effects of Debt Types to GDP Growth with Polynomial Forms

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<th>Model 11</th>
<th>P-Value</th>
<th>Model 12</th>
<th>P-Value</th>
<th>Model 13</th>
<th>P-Value</th>
<th>Model 14</th>
<th>P-Value</th>
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<tr>
<td><strong>cons</strong></td>
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<td>1.000**</td>
<td>11.8452</td>
<td>0.000**</td>
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<td>0.618**</td>
<td>17.8199</td>
<td>0.000**</td>
<td>15.6126</td>
<td>0.000**</td>
<td>22.9081</td>
<td>0.000**</td>
</tr>
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<td>0.004**</td>
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<td>-2.78e</td>
<td>0.916**</td>
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<td><strong>%pubdebt&lt;sup&gt;2&lt;/sup&gt;&lt;sub&gt;it&lt;/sub&gt;</strong></td>
<td>0.0003</td>
<td>0.088**</td>
<td>0.0004</td>
<td>0.055**</td>
<td>0.0001</td>
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<td><strong>R&lt;sup&gt;2&lt;/sup&gt;</strong></td>
<td>0.6140</td>
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<td>0.6505</td>
<td>0.6206</td>
<td>0.6842</td>
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<td><strong>Chi&lt;sup&gt;2&lt;/sup&gt;</strong></td>
<td>11.66</td>
<td>13.22</td>
<td>47.86</td>
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</table>

*All standard errors are in parentheses

* indicates significance at 10% level of significance

** indicates significance at 5% level of significance

*** indicates significance at 1% level of significance
Table 8: Testing the Effects of Public Debt to Inflation with Polynomial Forms

<table>
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<tr>
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<th>Model 15</th>
<th>P-Value</th>
<th>Model 16</th>
<th>P-Value</th>
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<td><strong>Dep Var InflationR_{it}</strong></td>
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<td>cons</td>
<td>-9.8192 (4.7312)</td>
<td>0.039**</td>
<td>-5.3024 (2.8343)</td>
<td>0.062**</td>
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<td>%pubdebt_{it}</td>
<td>0.1732 (0.0531)</td>
<td>0.001**</td>
<td>0.1507 (0.0515)</td>
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<td>0.206**</td>
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<td>-7.08e (3.69e)</td>
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<td>-0.0006 (0.0002)</td>
<td>0.017**</td>
<td>-0.0006 (0.002)</td>
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<td><strong>Chi^2</strong></td>
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All standard errors are in parentheses
* indicates significance at 10% level of significance
* indicates significance at 5% level of significance
* indicates significance at 1% level of significance
References


