5-2018

Does Debt Matter?

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An Abstract of a Thesis
In
Applied Economics

Submitted in Partial Fulfillment
Of the Requirements
For the Degree of

Master of Arts

May 2018

Buffalo State College
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Abstract

National debt is a popular topic, since people have a lot of different views on national debt. For example, many people think that there is a positive relationship between national debt and GDP per capita. In other words, the national debt has also increased with the growth of GDP per capita. However, some people feel that there is an inverse relationship between them, so much so that the topic has been discussed. Based on my interest in this topic, I decided to discuss this question. This paper will discuss their influence and importance by analyzing national debt, GDP per capita, Initial debt-to-GDP ratio, and Change in debt-to-GDP ratio. I will make predictions on the results. I am going to explore the positive or negative effects between them through data research and analysis. This thesis will also compare the data and results of the three countries in the United States, China, and Germany to find out the correlation between them. This will let us know if debt matters.

Key words: Debt, Treasury bill rate, and GDP.

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Acknowledgement

It is a great pleasure to acknowledge my deepest gratitude to my thesis advisor and committee chair, Dr. Theodore Byrley, who has given me great help. Without his guidance, this dissertation would not have been possible. He has a profound knowledge the word ‘understanding’ would work well here of economics, he always gives me valuable advice and guidance.

I would like to express the sincere appreciation to Dr. Frederick Floss, Chairperson of the Department of Economics and Finance, for giving his time to help guide me in writing my thesis and judge my thesis defense. He was an expert in econometrics, and he gave a lot of effective guidance on the data analysis of the thesis.

I would like to express my deepest thanks to the thesis committee members, and for Professor Eugene Chaas, for his effort in reading my thesis and judging my thesis defense. All of his encouragement and suggestions, which made me more confident in my thesis and defense.

In addition, I am honored to be a graduate student in the Department of Economics and Finance at Buffalo State College State University of New York. I would also like to thanks Professor Kevin Miller, Dean of the Graduate School, for taking his precious time to reading my thesis.

Last but not the least, sincere gratitude to my family and friends for their love and support. They all kept me going and encouraged me, and this dissertation would not have been possible without them.

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Chapter 1: Introduction

National debt is the amount of total funds owed to creditors by a government. It is separated into two categories: external debt and internal debt. External debt is financed by foreign creditors, who include: multilateral organizations, International Development Association, European Economic Community, International Fund for Agricultural Debt (IFAD), World Bank, European Investment Bank, International Monetary Fund (IMF) and the African Development Bank (AfDB). External debt is also financed by private institutions and bilateral creditors such as China, Germany etc. Internal debt is an instrument of implementing monetary policy through open market activities to stabilize local currency and regulate market liquidity. The government can also build investor confidence by issuing debt instruments to provide the message of a robust economy able to finance debts.

The government sets an upper boundary to execute its expenditure. An upper boundary is established to prevent use of funds which the government cannot payback. Budgets in most European countries and U.S. are drawn by the government and presented in the legislature for approval in every fiscal year. Over the past decade, the U.S. Treasury has borrowed trillions of dollars[1]. Most of the borrowed funds come from foreign investors. These funds are used to the financial system from degrading which could lead to destabilization of the economy. They are also used to promote economic growth through economic stimulus. The U.S. uses a debt ceiling in an attempt to control the level of borrowing. Once a debt ceiling has reached the maximum value, the

[1] Goodness C. Aye, Frederick W. Deale, and Rangan Gupta, "Does Debt Ceiling and Government Shutdown Help in Forecasting the US Equity Risk Premium?," *Panoeconomicus* 63, no. 3 (02 December 2014): 273-91, accessed May 15, 2018, https://repository.up.ac.za/bitstream/handle/2263/56143/Aye_Does_2016.pdf?sequence=1&isAllowed=y.

department of the U.S. treasury cannot issue a declaration for more treasury bills, bonds or bank notes. This has always caused Congress to be continuously called upon to permit the issuance of fresh debt space.

If a government loses its ability to increase debt, the treasury department can only pay bills as it acquires tax revenues. Once the revenue is not enough, the secretary of the treasury has to choose between paying the salaries of employees, their social benefits or the interest accumulated on the national debt[2]. This is similar to the limit that the credit companies place on the expenditure of their clients. The congress has the power to impose the debt ceiling on the limit of the statutory debt. This is the outstanding debt in terms of the U.S. notes in the wake of making the necessary adjustments. Such adjustments include the unamortized discounts, old debts and debts that are guaranteed. The U.S. is unlikely to default on its obligations. A nonpayment would be an unparalleled catastrophe. The debt ceiling therefore has to be raised if the country comes close to hitting its limit. This implies that the debt ceiling has a potential impact on the debt ratings of the U.S. and the economy at large. However, Congress has increased the cap more than seventy times since 1962. There is a lot of debate about debt, and this paper will analyze if debt matters.

Chapter 2: Review of literature

2.1 History of United States National Debt

National debt has been a reality since the United States gained independence in 1776. Leaders were financing wars in the fledging nation by borrowing. A practice that

[2] Goodness C. Aye, Frederick W. Deale, and Rangan Gupta, "Does Debt Ceiling and Government Shutdown Help in Forecasting the US Equity Risk Premium?," *Panoeconomicus* 63, no. 3 (02 December 2014): 273-91, accessed May 15, 2018, https://repository.up.ac.za/bitstream/handle/2263/56143/Aye_Does_2016.pdf?sequence=1&isAllowed=y.

saw the debt grow to above $75 million after the American Revolutionary War between 1775 and 1783, and grew considerably to $120 million over the decades[3]. It wasn't until the President Andrew Jackson era, that the debt shrank to zero and this has been the only time the United States has been a debt free nation. Now 200 years later, after the country's inception, a crash in stock markets, failed investments by big companies, rising unemployment rates, tech bubbles bursting, and several other factors the federal debt stands at $21 trillion and is still rising as of March 2018.

2.2 U.S. Treasury bill rate and country interest rates

Increased debt will considerably lower the demand for treasuries in the long-run and put pressure on the U.S dollar. This is because the value of treasury securities is tied to the dollar. A decline in the dollar would result in worthless currency payments to foreign holders. The National Debt is sold to foreign and domestic investors as well as other governments and corporations in the form of securities. Bonds affect the economy as they determine the country's interest rates and affect the liquidity amount. With an increased national debt, bonds will have an impact on credit availability in the economy, education loans, houses, and expansion businesses.

The interest payment burden is the real risk that the government faces with increased federal debt. Economists have said that if interest payments hit 12% of GDP there are high chances of the U.S. government defaulting its debt. For instance, it is evident that the United States is not currently paying its outstanding debts. New treasuries are being issued to refinance the existing ones. For instance, in a case where $100 billion

[3] Alanna Ritchie, "Timeline of U.S. Federal Debt Since Independence Day 1776," Debt.org, July 04, 2013, accessed May 17, 2018, https://www.debt.org/blog/united-states-federal-debt-timeline/.

treasuries are matured, the treasury borrows $100 billion additional from revenues through $100 billion new treasury issuances rather than paying back the initial $100 billion from government revenues. It is more likely that interest rates will vary when new treasuries are issued from those of existing treasuries. The U.S. is exposed to interest rate risk as the interest rates are greatly determined by the treasury demand in the market. Actual borrowing in the country often depends on the market and the government must continue to borrow to finance its deficits and existing debts. Payments on interest are expected to sharply increase in the future. In 2015 Federal net interests costs were at 1.3% GDP and are expected to rise to 1.95% of GDP by the year 2020[4].

2.3 The holdings of U.S. government debt in other countries

By December 2017, $1.2 trillion of U.S National debt was owned by China. China is the largest U.S Treasury security foreign holder followed closely by Japan at $1.1 trillion[5]. Arguably, both China and Japan would want to maintain the dollar value higher than their currency value with an effort to have their exports to United States affordable, enhancing the growth of their economy.

China has received a lot of attention by being biggest holder in U.S. debt with about 19.8% of the total foreign holdings. China year-over-year has trimmed its holdings by 2.4%, making its total percentage 6.4% of the total U.S. government debt. Japan which is not far behind China has trimmed its position over the resent years but to a

[4] Kimberly Amadeo, "U.S. Debt Crisis: Summarly, Timely and Solutions." the balance. March 19, 2018. Accessed May 17, 2018. https://www.thebalance.com/us-debt-crisis-summary-timeline-and-solutions-3306288

[5] Kimberly Amadeo, "U.S. Debt to China: How Much Does It Own?," the balance, May 14, 2018, accessed May 17, 2018, https://www.thebalance.com/u-s-debt-to-china-how-much-does-it-own-3306355.

greater extent. However, Japan's holdings have fallen from $1.2 trillion, 4.1% in June 2015. It now owns a 18.3% of total ownership by foreigners and 5.9% of the United States total debt[6].

2.4 The Possible Impacts of Debt

2.4.1 The Value of Currency (Dollar)

Current account surplus countries like Japan see U.S. as the most secure investment place. In history, the U.S. Treasury marketplace is to be perpetuated by massive savings from these nations. And China keeps buying treasuries from the U.S. to keep their currency lower than the dollar. If the debt market becomes untrustworthy, the foreign creditors are forced to withdraw vast portions of their shares. Hence other investors get induced to do so. The unloading of the holdings can cause a run on the dollar in the international markets.

The dollar depreciation will increase the demand for goods by the foreign countries thus becoming beneficial to many U.S. exporters. However, these firms will suffer high borrowing costs as well as a result of the increased interest rates. In the short run, the US economy will benefit from the federal debt because it will boost the growth of the economy. On the other hand, a growing public debt ceiling will lead to an increase of the debt-to-GDP ratio[7]. This ratio will impose a high demand for more considerable interest by the debt holders to compensate for the increased risks. The low demand for U.S. treasury securities will raise interest rates as well, slowing America's economy.

[6] Andrew Sebastian, "5 Countries That Own the Most U.S. Debt," Investopedia, September 06, 2016, accessed May 17, 2018, https://www.investopedia.com/articles/markets-economy/090616/5-countries-own-most-us-debt.asp.

[7] Martin L. Blank, "The Impact of National Debt on U.S. National Security," (diss., U.S. Army War College, 2011), 1-19, accessed May 17, 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/a564995.pdf.

Since there is a connection between the dollar's value and Treasury securities, there will be a consequent downward pressure on the dollar[8]. The decline of the dollar decreases demand given so that there is a compensation of foreign holders in worthless currencies. The effects of an increasing federal debt on the dollar can unquestionably result in debt crisis when it reaches a point where the government can borrow no more funds from other countries. Eventually, there could be a government default if the treasury is unable to borrow more capital.

2.4.2 Impact on Consumer Confidence

From economic theory, increasing amounts of government debt, can lower stock prices, can increase spread risks resulting in adverse effects on the system of private spending. Debt ceiling impasses can reduce consumer confidence, and it can also weaken the economic expansion. For instance, the consumer confidence in the U.S. fell by 22% in 2011, while the confidence in business fell by 3%[9]. The measures of both the household and consumer confidence had already begun to fall early in 2011 as a result of the growth in the debt. It is imperative to note that these confidence levels are not exact measures of the system of spending, neither are they straight expenses of carrying out trade.

[8] Eduardo Borensztein, Kevin Cowan, and Patricio Valenzuela, "Sovereign ceilings 'lite'? The impact of sovereign ratings on corporate ratings." *Journal of Banking & Finance* 37, no. 11 (2013): 4014-4024.

[9] Goodness C. Aye, Frederick W. Deale, and Rangan Gupta, "Does Debt Ceiling and Government Shutdown Help in Forecasting the US Equity Risk Premium?," *Panoeconomicus* 63, no. 3 (02 December 2014): 273-91, accessed May 15, 2018, https://repository.up.ac.za/bitstream/handle/2263/56143/Aye_Does_2016.pdf?sequence=1&isAllowed=y.

2.4.3 Impact on the Financial Markets

Debt impacts the financial markets. The conditions of financial markets have a direct impact on the economic activities within a country. The best display of domestic prosperity is part of the monetary possessions, while the majority of the system of expenditure on households as well as that for businesses is through borrowing.

This implies that lower cost of assets and relatively higher borrowing costs would weigh on the private system of spending. The equity prices fell by about 17% during the year 2011, while the debt limit debate did not depict any form of recovery until the following year. Businesses are influenced by the changes in stock values since they tend to depend on the equity, as well as, debt as forms of funding. The fall in stock prices means that the investments and other forms of spending on business expansion are costly.

If the treasury fails on its interest payments, there could be consequences to that action. In the first place, the federal government would be unable to make the monthly payments. The employees within the public sector would be furloughed, while pension schemes would not function. The beneficiaries of the Social Security fund, the Medicare, and Medicaid payments would not receive their payments. This would also lead to the closure of the federal buildings as well as their services. On the other hand, the yields of the treasury notes that are sold in secondary markets would be higher[10]. This would mean any default of government debt would slow down economic growth within the country.

Economists from the White House and other members of the administration predict the severity of the effects of a complete default of the government. According to the Ben Bernanke, the Federal Reserve Chairman from 2006 to 2014, the non-payment

[10] Srinivas Nippani and Stanley D. Smith, "The Impact of the October 2013 Government Shutdown and Debt Ceiling on U.S. Treasury Default Risk," The Journal of Fixed Income 24, no. 2 (2014): 79-91, accessed May 15, 2018, https://www.cfapubs.org/doi/abs/10.2469/dig.v45.n1.10.

could become a recovery-ending event that will significantly cause more financial crisis on the entire economy. Besides, there is a warning that any government delay in paying interest on government debt will impose a significant harm to the country's financial status. Analysts perceive that the congressional congestion over the debt levels can not only increase the upper pressure on the interest rates, but they also can place a remarkable doubt in the bond marketplaces.

The mounting force on the interest charges can have significant impacts on the economy. Reason being: the rate increase can perhaps hike the expected borrowing costs of the federal government in the coming years. Besides, the U.S. businesses and the cash-strapped homebuyers will incur an increase in the costs of capital. The government will also not be able to undertake the most critical investments like schools, healthcare, and infrastructure due to the diversion of the taxpayer money to other uses.

For example, when the federal debt ceiling is not raised several days before the treasury exhaustion of the extraordinary procedures and cash reserves, there will be a likelihood of a downgrade[11]. The downgrade is as a result of the expected official assessment of the U.S. sovereign ratings hence a negative picture on the Country's AA+ rating. Failure of the government to permit the yearly expenditure quota at the onset of the fiscal year can drag the economic growth due to the partial shutdown of the government's services. Controversies, therefore have adverse effects on economic growth.

[11] Srinivas Nippani and Stanley D. Smith, "The Impact of the October 2013 Government Shutdown and Debt Ceiling on U.S. Treasury Default Risk," The Journal of Fixed Income 24, no. 2 (2014): 79-91, accessed May 15, 2018, https://www.cfapubs.org/doi/abs/10.2469/dig.v45.n1.10.

2.4.4 Impact on the National Security

Because of increasing levels of national Debt, national security can be compromised since the government will spend less money on defense systems. The United States will be unable to raise the required funds to manage the security system. It will be harder to finance the programs that protect national security when there is the economic crisis. As a result, the policies that advocate the reduction of debt will have negative impacts on the safety when they don't take into account the consequences.

The federal debt can also affect the national security through the budget cuts. The budget cut will involve reducing the number of air forces staff, decreased army manning both civilian and military personnel, the decrease of the naval power and destruction of submarine aircraft. Although these cuts of the defense budget will reduce the debt level, there will be a weaker and inferior national security. Also, there will be decreasing capabilities in responding to the concerns related to national security. When the U.S. partners such as Japan and China lose confidence in American ability to protect U.S. interests, there will be a low influence in governmental affairs causing a negative impact on the national security. Moreover, when the dollar currency becomes devalued, the economy can be viewed at weak. U.S. adversaries will, therefore, take advantage of this to challenge America's power and influence. The growing national debt will pose more effects on the national security because of the use of soft power[12]. These include diplomacy, foreign aid, humanitarian, assistance and the economic development which are usually employed by the military forces. All these will result in weak national defense

[12] Martin L. Blank, "The Impact of National Debt on U.S. National Security" (diss., U.S. Army War College, 2011), 1-19, accessed May 17, 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/a564995.pdf.

system in the U.S.. It will not be in a position of giving out the best in the protection of national treasuries.

2.4.5 Impact on the Taxes

Keynesian school of thought asserts that high debt levels increase taxes, levied by the government as it seeks to collect adequate reserves for debt repayment purposes. This dispels private investors as firms perceive low returns due to high taxation of the operating profit earned, this further decreases private investment, reduce employment, economic growth and lower consumption.

On a daily basis, the Treasury collects revenues in the form of taxes, which are used to cater for bills ranging from the social security to the utilities in the federal buildings. If the debt is held at its current level, the Treasury would run out of cash. There would be no money to pay these bills. This implies that political turmoil related to government debt, determines the availability of money meant to pay for the government obligations[13]. There has been a rampant debate on the debt limit, which is technical but in close relationship with the level of government spending. This tactic has evidently proven to be difficult in the long-run.

2.4.6 Impact on the stock market

The other economic impact of the debt debate is volatility of the stock market. In fact, the standard degree of uncertainty in the fiscal marketplaces is instability, a measure of the normal charges that VIX provides. During the debt ceiling of 2011, the measure

[13] Srinivas Nippani and Stanley D. Smith, "The Impact of the October 2013 Government Shutdown and Debt Ceiling on U.S. Treasury Default Risk," The Journal of Fixed Income 24, no. 2 (2014): 79-91, accessed May 15, 2018, https://www.cfapubs.org/doi/abs/10.2469/dig.v45.n1.10.

doubled and remained high for some time. Greater levels of volatility can make investors to pull back from the risky businesses, a development that could see an increase in the levels of the costs of borrowing and household. On the other hand, volatility could aid most firms and also households in paring back outlay in order to accrue higher cash reserves for buffering the conceivable imminent negative growths.

2.4.7 Influence on the others aspects

It is also evident that the debt debate influences the spread of the corporate credit risk. In this case, the willingness of investors to loan to non-financial corporations is a summary of the spread in credit risks. From the perspective of the borrowers, a widespread in the credit means that the funding cost for the particular levels of the capital will be advanced. Once the prices of funding are high, there would be lower levels of spending on all forms of investment, and other outlays that may require any form of financing.

The adverse effects on business has also been hushed as a result of the slowdown in the rise of the total cost of borrowing, relative to the wider spread in the risks[14]. The treasury yields are projected to rise this year, while the corporate spreads are mostly applicable to the system of borrowing costs for large institutions. There are also similar corporate credit risks that may lead to the widening of mortgage rates, relative to treasury yields, such mortgage spreads may increase the cost of purchasing a home for the citizens. The increased rates may also imply that refinancing may not improve the levels of cash flow, which may restrain the rates of consumption spending.

[14] Eduardo Borensztein, Kevin Cowan, and Patricio Valenzuela, "Sovereign ceilings 'lite'? The impact of sovereign ratings on corporate ratings." *Journal of Banking & Finance* 37, no. 11 (2013): 4014-4024.

Even though the U.S. is still the greatest power in the world, it faces an economic challenge. The U.S. will only achieved an international supremacy economy wise when such a challenge is overcome. The failure to overcome such a challenge will even lead to more issues like diminishing in economic eminence. It will also lead to lower influence that U.S. has in the rest of the world and a fall in international standards. The greatest economic challenge the United States faces today is its national debt, so it's clear that destiny of a nation often rests on its ability to command a strong economy and maintain economic superiority over its rivals. This advantage allows a country to outpace its adversaries in equally economic antagonism and international matters. With economic dominance lies the potential for a nation to mostly and ambitiously device its instruments of national power in support of its economic and national security objectives[15].

2.5 Economic Impacts of not paying the debt

Nonpayment of government debt would negatively affect the U.S. economy. The effects will range from a sharp economic decline to a long time depression. The US Treasury will not be able to repay federal bills which include support for the US agencies such as payrolls for army, navy, and marines. Those who depend on the social security, Medicare, government contractors and the federal employees will go without payments. Other government expenditures like interest and principal payments on the U.S. bonds will also turn down due to failure to pay the bills.

The U.S. Businesses that rely on government purchases will have their stock prices fall causing the overall stock market to fall. The turn down will be significant as a

[15] Martin L. Blank, "The Impact of National Debt on U.S. National Security" (diss., U.S. Army War College, 2011), 1-19, accessed May 17, 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/a564995.pdf.

result of the shock to investor's confidence who view the US as the safest investment place in the world. Consequently, with time, the stock will get diluted and the effects will spread to the entire economy[16]. The result of this will be a devaluation of the U.S. dollar as compared to the other countries thus making it hard for the U.S. government and everyone else to purchase homes, take loans or even to arouse the financial system.

Defaulting on U.S. Debt would be a terrible thing for people who own investments in U.S. dollars. It will also impact the rating of the debt by those who buy it and the local agencies. From my point of view, the evaluation of the government's credit will be downgraded which lead to high will cost of raising finance through bonds in coming years. When the government fails to build the bond, I suppose America will have a default, and this will make it hard to operate.

2.6 Positive Economic Impacts of Borrowing

Raising the debt ceiling is not a guarantee for the government to spend more money. Instead, it poses positive effects on the U.S. economy. For instance, a higher debt enables the Treasury to keep borrowing money that the government can use to make its payments that are approved by the Congress[17]. Therefore, it will be easier for the treasury to pay the national bills such as social security and Medicare among others. Those who are employed by the government will get paid due to the financial stability.

[16] Sanket Mohapatra, Manabu Nose, and Dilip Ratha, "Impacts of Sovereign Rating on Sub-Sovereign Bond Ratings in Emerging and Developing," The World Bank, March 30, 2016, accessed December 10, 2017, http://documents.worldbank.org/curated/en/841091467995047270/pdf/WPS7618.pdf.

[17] Goodness C. Aye, Frederick W. Deale, and Rangan Gupta, "Does Debt Ceiling and Government Shutdown Help in Forecasting the US Equity Risk Premium?," *Panoeconomicus* 63, no. 3 (02 December 2014): 273-91, accessed May 15, 2018, https://repository.up.ac.za/bitstream/handle/2263/56143/Aye_Does_2016.pdf?sequence=1&isAllowed=y.

Raising the debt level can have positive impacts on the stock market or other business that relies on the government. Reason being, it is a lawful act that enables the country to borrow money from other countries. When budgeting, duties are acquired, and in case of a planned shortage, the only way to fill the gap will be through borrowing loans to get additional funds. So importantly, when the government has gone through a budget with a deficit and gets it approved, there is an understood authorization to borrow more.

On the other hand, the stock market can be negatively affected if the rise in debt is not perceived at positive event. When this happens, the faith and credit of the U.S. government will be questioned, and this will impact the whole financial system[18]. The negative impact of this would be the nonpayment of either both direct debit and the implied obligations. As much as it would not lead to the collapse of the economy, there will give an outlook that America is incapable of dealing with the essential functions of the government.

In other words, when the federal debt is not paid, the citizens will be affected negatively since the country will not be in a position to get the additional funds from other lenders. With this, there will be a shortage in the stock market. This will lead to a fall in the stock market which will impact the whole economy[19]. Everyone, including the small business owners, will be affected. The result of this will be high-interest rates, devaluation of the dollar and high taxation resulting into a poor economic status of the individuals.

[18] Eduardo Borensztein, Kevin Cowan, and Patricio Valenzuela, "Sovereign ceilings “lite”? The impact of sovereign ratings on corporate ratings." *Journal of Banking & Finance* 37, no. 11 (2013): 4014-4024.

[19] Riley E. Dunlap, "Clarifying anti-reflexivity: conservative opposition to impact science and scientific evidence." *Environmental Research Letters* 9, no. 2 (2014): 021001.

Essentially, the rising of the federal debt can be highly beneficial to the U.S. citizens since when the country has money, the economy will be stable. The homebuyers or other small businesses in the state will undoubtedly have the advantage due to the consistency of financial flow. And also, the government will be in a position to finance those activities that entirely depend on it. There will be reduced taxation, and the interest rate will be low making the products sold by these companies to be consumer friendly.

Similarly, the government gain the ability to recompense the federal costs such as the payrolls for the army, navy, and marines. Those who are employed by the government will also receive their salaries. These national debts will also enable the government to finance essential needs like schools, hospitals, and infrastructure. All these services offered by the government will benefit everyone, and this can play a prominent role in reducing poverty.

Chapter 3: Methodology

3.1 Empirical Evidence

The global economy has seen an increased focus on fiscal stability, as countries seek to build strong economic foundations to steer sustainable development. A major factor which has attracted the attention of World bank and International Monetary Fund and credit rating agencies, such as, Moody's and S&P is deficit financing. Some governments have increased their debt levels leading to speculation of the impact of such actions on the economy. This part looks at several empirical works aligned to the study.

Serdar et al. (2015) investigated the casualty between public debt and economic growth in G-7 countries over the period 2000-2012. The study used panel integration and

causality approaches. Panel integration showed that in the long run relationship among public debt, capital stock and economic growth. In the long-run causality, capital stock and public debt cause changes in economic growth. In the short-run, G-7 countries growth performance is not affected by debt structure, but in the long run it affects economic growth due to crowding out effect.

Ugo et al. (2012) used panel time series econometric techniques to conduct study on public debt and economic growth in advanced economies and found out that a high level of debt establishes alter investors' perspective of the economy which would push the country towards a bad equilibrium.

Ferreira (2009) used Granger causality analysis to study 20 OECD countries to determine the nexus between economic growth and public debt. It found a negative relationship between public debt and economic growth, implying high public debt reduces economic growth.

Ghura and Hadjimichael (1996) used panel data analysis to investigate growth determinants in 29 Sub Saharan countries. Prudent public expenditure policy was found to steer growth without reducing the level of investment. This finding was favored by huge infrastructure deficit existing in developing countries, as any public expenditure on infrastructure: roads, transport, energy and housing had a direct impact on the level of employment in these economies.

Rother and Checherita (2010) deployed panel fixed effects model to determine the effect of government debt and economic growth in 12 European countries for a period of 40 years. The study found a concave relationship between public debt and rate of economic growth. As high public debt -GDP ratio lowered long term growth rate.

3.2 Research Gap

Rother and Checherita (2010) found a concave relationship between public debt and economic growth rate, Presbitero (2012) found no relationship between the two, while Serdar et al (2015) found that debt structure does not affect economic growth in developed countries in the short run. Ghura (1996) found a positive relationship between debt and economic growth. These studies provide divergent findings on the effect of debt on economic growth, therefore, this paper seeks to delve deeper into the study and fill this research gap.

3.3 The source of data

The study period was from 1947 to 2017. It was chosen due to changes in an economic trend which had direct implications on the macroeconomic variables in the USA. It used annual data because they are readily available from federal government sources.

The research used SAS system to aid in data analysis. Descriptive analysis was deployed to analyze the data. Data analysis is the process of transforming, gathering and modeling data with the objective of taking useful information, suggesting applicable conclusions and decision-making support. The study used Regression analysis method to determine the economic impact of the federal debt ceiling; by establishing the relationship between the survey, variables include: T-bill rate, GDP/Population, Initial debt/GDP, and Change in debt/GDP. The Regression analysis model is shown in the

equation below. Inferential analyses such as t-test, F-test, and Durbin-Watson d Test were also used.

3.4 Theory

In the year 2016, the United States national debt stood at around 107.11% of the GDP. Since the 1990s, the public debt has dramatically increased; however, in the last few months the changes have been quite stable. It is clear that each time the US government runs a deficit in a given year; the borrowed money from the public always outweighs the revenue balance. For instance, if $3 trillion in revenues were collected in 2013 by the treasury, but expenditures are recorded as $5 trillion, then the $2 trillion deficit must be financed through borrowing[20].

The debt held by the public in the year 2016 was $13.62 trillion representing 75% of the preceding 12 months of Gross Domestic Product. Holdings by intergovernmental agencies stood at $5.34 trillion, reporting a total gloss national debt combined of $18.96 trillion, representing 104% of the preceding 12 months of Gross Domestic Product. The change in national debt is represented by the surplus or the annual deficit conceptually. However, in the United States differences in how various programs are treated affect the deficit figure. They include; treasury borrowing, social security programs and supplemental programs usually outside the process of budgeting.

The growing federal debt has seen an increase in debt-to-GDP ratio. Because of this, debt holders will demand higher payments on interests. Holders will want high

[20] Alan Axelrod, "Full Faith and Credit: The National Debt, Taxes, Spending, and the Bankrupting of America," U.S. Debt Forum, September 27, 2016, accessed May 17, 2018, http://usdebtforum.com/sources/books-articles-and-white-papers/.

compensation for the increasing risk that is likely not repayable. The Initial Debt-to-GDP ratio (ig) is expected to have a positive effect on the T-bill rate for a country. The population worries that the growth of the economy will slow as a result of further increased interest rates and demand of diminished of treasuries. Economists are measuring the national debt size as the ratio of federal debt held publicly to the current GDP level. This excludes the government owned bonds such as the social security administration platform. The GDP debt resulting ratio will show that a larger debt is more easily sustainable in the larger economy. This will result in a negative relationship between the T-bill rate for a country and GDP per capita. The GDP stability has been dramatically upset by recent recessions and an increase in the federal debt leading to income shortfalls and lower tax receipts. There has been a rise in the unemployment rate, poverty, and increased cost of social insurance. One more statement changes in debt and the T-bill rate. Additionally, the Change in debt-to-GDP ratio will have a large effect on the T-bill rate.

3.5 Hypotheses

At the first, we assume all variables have impact on Treasury bill rate. The theoretical model is:

$$tbr = f(-gp, +ig, +cg)$$

For econometric model, this is a four variables function:

$$tbr = \beta_0 + \beta_1(gp) + \beta_2(ig) + \beta_3(cg) + \varepsilon$$

Where:

tbr = Treasury bill rate

gp = GDP per capita (GDP/Population) = gross domestic product divided by the population

ig = the Initial debt-to-GDP ratio (Initial Debt/GDP) = the ratio between a country's government debt (a cumulative amount)

cg = the Change in debt-to-GDP ratio (Change in Debt/GDP) = the annual ratio between a country's government debt

ε = error term

The above multiple regression model: illustrate the relationship between T-bill rate (tbr) and various variables, such as, GDP per capita (gp), Initial debt-to-GDP ratio (ig) and Change in debt-to-GDP ratio (cg). These variables were used due to their impact on interest rates, especially GDP which is a metric used to measure economic output, population was key in because change in population translates to higher demand for government financing on social programs, such as, Medicaid. Change in Debt/ GDP, depicts variation in debt accumulated by the government over the country ability to grow its economy.

3.6 Econometric Analysis United States (U.S.)

US

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
tbr	tbr	71	0.0410115	0.0305022	0.000300000	0.1430000
gp	gp	71	21045.96	18676.98	1806.12	60828.92
ig	ig	71	0.5740168	0.2161123	0.2963187	1.0353047
cg	cg	71	0.0185137	0.1290088	-1.0257649	0.1434798

From the U.S. data collected, the Treasury bill rate average was 4.1%, the highest T-bill rate was 14.3% and lowest was 0.03% in 1947. Economic theory argues that the T-

bill rate is affected by increased demand for government financing through capital markets. The government competes for funds with private sector firms. The government should have to increase the returns, in order, to attract investors. The average GDP per capita was 21045.96, the lowest was 1806.12 and the highest was 60828.92. GDP per capita increased sharply during 1947 to 2017. The Initial debt-to-GDP ratio(ig) average was 57.4%, the highest ig was 103.5% and the lowest ig was 29.6%. The Change in debt-to-GDP ratio (cg) average was 1.9%, the highest cg was 14.3% and the lowest cg was -102.6%.

Correlation of Estimates

Variable	Label	Intercept	gp	ig	cg
Intercept	Intercept	1.0000	0.1411	-0.8569	-0.2560
gp	gp	0.1411	1.0000	-0.5451	-0.0044
ig	ig	-0.8569	-0.5451	1.0000	0.1900
cg	cg	-0.2560	-0.0044	0.1900	1.0000

Correlation of estimates was used to obtain the correlation coefficient of the variables under study. Coefficients above +0.7 to +1 are said to be having a strong positive correlation while those that have coefficients below +0.5 to 0 are said to be having a weak positive correlation and vice versa. It was determined that T-bill rate had a weak positive correlation (0.1411) with GDP/population, nut a weak negative relationship (-0.8569) with initial debt/ GDP and strong weak relationship (-0.2560) Change debt/GDP.

Parameter Estimates										
							Heteroscedasticity Consistent			
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	Intercept	1	0.10636	0.00684	15.56	<.0001	0.00778	13.67	<.0001	0
gp	gp	1	3.325227E-7	1.483576E-7	2.24	0.0283	1.272711E-7	2.61	0.0111	1.44361
ig	ig	1	-0.12563	0.01306	-9.62	<.0001	0.01381	-9.10	<.0001	1.49764
cg	cg	1	-0.01264	0.01834	-0.69	0.4930	0.00550	-2.30	0.0248	1.05273

From above the parameter estimates of the model are: $\beta_0 = 0.10636$, $\beta_1 = 3.325227\text{E-}7$, $\beta_2 = -0.12563$, $\beta_3 = -0.01264$. For every unit increase in GDP per capita, T-bill rate increases by 3.325227E-7; decreases by -0.12563 and -0.01264 for every increase in Initial debt-to-GDP ratio and Change in debt-to-GDP ratio respectively. The results from the regressions for the United States are contrary to what was expected.

As we know from the result, this is multiple regression analysis and we use the method of ordinary least squares (OLS). The sample regression function is:

$$\text{tbr} = 0.10636 + (3.325227\text{E-}7)\text{gp} + (-0.12563)\text{ig} + (-0.01264)\text{cg} + \varepsilon$$

Let us now interpret these coefficients: The coefficient 3.32522E- 7 is the partial regression coefficient of GDP per capita, that with the influence of the initial debt-to-GDP ratio and the Change in debt-to-GDP ratio held constant, as GDP per capita increase one unit, Treasury bill rate goes up 3.325227E- 7 percent. The coefficient -0.12563 tells us holding the influence of GDP per capita and the Change in debt-to-GDP ratio constant.

(1) t-test

We tested three estimated coefficients one by one using t-tests. The hypothesized true coefficient $\beta_1 = 0$. Our estimated value for $\hat{\beta}_1 = 3.325227\text{E-}7$ and the standard

error of this estimate is se $(\hat{\beta}_1) = 1.483576\text{E-}7$. The degrees of freedom are 67. If we assume $\alpha = 5\%$ and $t_\alpha = 1.9966$, $H_0: \beta_1 = 0$ and $H_1: \beta_1 \neq 0$. $t = (3.325227\text{E-}7 - 0)/1.483576\text{E-}7 = 2.24$. Absolute value of t is 2.24. Absolute value of t larger than $t_\alpha = 1.9966$, so we reject null hypothesis.

The hypothesized true coefficient $\beta_2 = 0$. Our estimated value for $\hat{\beta}_2 = -0.12563$ and the standard error of this estimate is se $(\hat{\beta}_2) = 0.01306$ and degree of freedom is 67. If we assume α = 5% and $t_\alpha = 1.9966$, so $H_0: \beta_2 = 0$ and $H_1: \beta_2 \neq 0$. $t = (-0.12563 - 0)/0.01306 = -9.62$. Absolute value of t is 9.62 larger than $t_\alpha = 1.9966$, so we reject null hypothesis.

The hypothesized true coefficient $\beta_3 = 0$. Our estimated value for $\hat{\beta}_3 = -0.01264$ and the standard error of this estimate is se$(\hat{\beta}_3) = 0.01834$ and the degree of freedom is 67. If we assume $\alpha = 5\%$ and $t_\alpha = 1.9966$, so $H_0: \beta_3 = 0$ and $H_1: \beta_3 \neq 0$. $t = (-0.01264 - 0)/0.01834 = -0.69$. Absolute value of t is 0.69 lesser than $t_\alpha = 1.9966$, so we do not reject null hypothesis.

We chose α=5% because when α=5%, the results are significant.

(2) R square

Root MSE	0.01929	R-Square	0.6170
Dependent Mean	0.04101	Adj R-Sq	0.5999
Coeff Var	47.04739		

From the regression model, R square provides an estimate of the strength of the relationship between your model and the response variable. From the regression model, R square shows that 61.7% of the plots fit along the line of regression but since the

variables were more than one, adjusted R squared provides a better picture of the overall fit. It shows that of the plots fit along the regression line. This implies that only 59.99% of the changes in the response variable are explained by changes in the predictor variables.

(3) F test

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.04018	0.01339	35.98	<.0001
Error	67	0.02494	0.00037229		
Corrected Total	70	0.06513			

From the table, we can see F value =35.98, Pr > F is < 0.0001. Due to the value of F is larger, obtaining a relatively insignificant probability of < 0.0001 indicates that the null hypothesis is rejected. This confirms the relevance of the modeled equation. The above F-test confirms that the results are significant. The significance F value obtained from the F test is lower than the required significance level of 5% which shows that the model was suitable in explaining the relationship between the variables under study.

From the above test, it was determined that an increased GDP/Pop had a positive impact on interest rate under study. This is not what was expected, one explanation is as GDP/Pop increases, there is an increase in demand for government financing on both infrastructure and social programs due to population growth. However, an increase in initial debt/GDP and changes in debt/GDP had unexpected negative impacts on the T-bill rate. The t- test showed that all predictor variables had a significant linear relationship

with the t bill rate under study which was the GDP/Pop, Initial debt/GDP and Change debt/GDP because they had a required significance level of 0.05.

(4) Durbin-Watson d Test

The Durbin- Watson statistic is used to detect autocorrelation.

$H_0 : \rho \leq 0$

$H_1 : \rho > 0$

H_0 (No positive serial correlation) H_1 (Positive serial correlation)

In our regression model, the numbers we used were:

$$\mathrm{K} = 3 \ \mathrm{n} = 71 \ \alpha = 0.05$$

Where：

K is number of independent variables

n is sample size

α is level of significance

Finding critical values of the Durbin Watson from Durbin Watson critical table, d_{L} represents the lower critical value, and $\mathrm{d_U}$ represents the upper critical value. The test D is compared to d_{L} and d_{U}:

If D is lower than d_{L}, there is evidence of positive autocorrelation among the residuals

If D is lower than d_{U}, there is evidence of positive autocorrelation among the residuals

If D is between d_{L} and $\mathrm{d_U}$, test is inconclusive.

From Durbin Watson critical tables, we could know $d_{\mathrm{L}} = 1.55771$ and $d_{\mathrm{U}} = 1.67331$.

US

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.435
Number of Observations	71
1st Order Autocorrelation	0.772

From the regression results, the Durbin Watson statistics D = 0.435 < d_L shows positive autocorrelation.

(5) Auto regression

Through the autoregressive model, we can predict the value for the next time step When we use this time series model, we can observe a regression equation from previous time steps, then use it to predict the value at the next time step[21].

[21] Jason Brownlee, "Autoregression Models for Time Series Forecasting With Python," Machine Learning Mastery, January 02, 2017, accessed May 17, 2018, https://machinelearningmastery.com/autoregression-models-time-series-forecasting-python/.

US

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00972885	DFE	66
MSE	0.0001474	Root MSE	0.01214
SBC	-407.85911	AIC	-419.17251
MAE	0.00891318	AICC	-418.24944
MAPE	54.2771813	HQC	-414.67353
Durbin-Watson	1.5267	Transformed Regression R-Square	0.2675
		Total R-Square	0.8506

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.1027	0.0149	6.89	<.0001	
gp	1	3.1832E-7	3.367E-7	0.95	0.3479	gp
ig	1	-0.1171	0.0246	-4.76	<.0001	ig
cg	1	-0.009816	0.0117	-0.84	0.4061	cg

From this regression model, response variables have become predictive variables in the previous period. There are a change from 0.1064 to 0.1027 in the T- bill rate, and GDP per capita (gp) is decreases from 3.3252E-7 to 3.1832E-7, Initial debt-to-GDP ratio (ig) is increases from – 0.1256 to – 0.1171, and Change in debt-to-GDP ratio (cg) is decrease from – 0.0126 to –0.009816.

3.7 Econometric Analysis Germany (GER)

Germany

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
tbr	tbr	27	0.0281293	0.0250557	-0.0032860	0.0961000
gp	gp	27	34992.21	8532.42	23491.70	47819.42
ig	ig	27	0.6258752	0.1111734	0.3913260	0.8087053
cg	cg	27	0.0025462	0.1329130	-0.5702125	0.1675881

From the data collected, Treasury bill rate average was 2.81%, the highest T-bill rate was 9.61% and the lowest was -0.33%. Germany T-bill rate has been increasing at a moderate level, due to its sustainable fiscal structure which is supported by formidable export markets for its services and machinery. The average GDP/Population was 34992.21, the highest gp was 47819.42 and the lowest was 23491.70. The Initial debt-to-GDP ratio(ig) average was 62.59%, the highest ig was 80.87% and lowest was 39.13%. The Change in debt-to-GDP ratio (cg) average was 0.25%, the highest cg was 16.76% and lowest was -57.02%.

Correlation of Estimates

Variable	Label	Intercept	gp	ig	cg
Intercept	Intercept	1.0000	0.0362	-0.6116	-0.0497
gp	gp	0.0362	1.0000	-0.8063	0.4999
ig	ig	-0.6116	-0.8063	1.0000	-0.3640
cg	cg	-0.0497	0.4999	-0.3640	1.0000

It was determined that T-bill rate had a weak positive correlation (0.0362) with GDP per capita (gp), but a weak negative relationship (-0.6116) with Initial debt-to-

GDP ratio (ig) and strong weak relationship (-0.0497) with Change in debt-to-GDP ratio (cg) .

Parameter Estimates										
							Heteroscedasticity Consistent			
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	Intercept	1	0.14262	0.01305	10.93	<.0001	0.01500	9.51	<.0001	0
gp	gp	1	4.04261E-8	4.86155E-7	0.08	0.9344	4.317502E-7	0.09	0.9262	3.32423
ig	ig	1	-0.18545	0.03470	-5.34	<.0001	0.03814	-4.86	<.0001	2.87460
cg	cg	1	0.06313	0.01982	3.18	0.0041	0.01560	4.05	0.0005	1.34084

From above the parameter estimates of the model are: $\beta_0 = 0.14262$, $\beta_1 = 4.04261\text{E-}8$, $\beta_2 = -0.18545$, $\beta_3 = 0.06313$. For every unit increase in GDP per capita (gp), T-bill rate and Change in debt-to-GDP ratio (cg) increase by $4.04261\text{E-}8$ and 0.06313; decreases by -0.18545 for every unit increase in Initial debt-to-GDP ratio (ig) respectively. The results from the regressions for the Germany are some differences to what was expected.

Our econometric model is a four variables model that has three independence variables and one dependence variable. Here is our result after analysis:

$$\text{tbr} = 0.14262 + (4.04261\text{E-}8)\text{gp} + (-0.18545)\text{ig} + 0.06313\text{cg} + \varepsilon$$

(1) t test

We tested three estimated coefficients one by one using t-tests. The hypothesized true coefficient $\beta_1 = 0$. Our estimated value for $\hat{\beta}_1 = 4.04261\text{E} - 8$ and the standard error of this estimate is se $(\hat{\beta}_1) = 4.86155\text{E} - 7$. The degrees of freedom are 23. If we assume α = 5% and t_α= 2.0739, so $H_0 : \beta_1 = 0$ and $H_1 : \beta_1 \neq 0$. $t = (4.04261\text{E} - 8 -$

$0)/\ 4.86155\text{E}-7 = -0.08$. Absolute value of t is 0.08. Absolute value of t lesser than $t_\alpha = 2.0739$, so we do not reject null hypothesis.

The hypothesized true coefficient $\beta_2 = 0$. Our estimated value for $\hat{\beta}_2 = -0.18545$ and the standard error of this estimate is se $(\hat{\beta}_2) = 0.03470$ and degree of freedom is 23. If we assume α = 5% and $t_\alpha = 2.0739$, so $H_0 : \beta_2 = 0$ and $H_1 : \beta_2 \neq 0$. $t = (-0.18545 - 0)/0.03470 = -5.34$. Absolute value of t is 5.34 larger than $t_\alpha = 2.0739$, so we reject null hypothesis.

The hypothesized true coefficient $\beta_3 = 0$. Our estimated value for $\hat{\beta}_3 = 0.06313$ and the standard error of this estimate is se $(\hat{\beta}_3) = 0.01982$ and the degree of freedom is 23. If we assume α = 5% and $t_\alpha = 2.0739$, so $H_0 : \beta_3 = 0$ and $H_1 : \beta_3 \neq 0$. $t = (0.06313 - 0)/0.01982 = 3.18$. Absolute value of t is 3.18 larger than $t_\alpha = 2.0739$, so we reject null hypothesis.

We chose α = 5% because when α = 5%, the results are significant.

(2) R square

Root MSE	0.01160	**R-Square**	0.8104
Dependent Mean	0.02813	**Adj R-Sq**	0.7856
Coeff Var	41.24098		

From the regression model, R squared shows that 81.04% of the plots fit along the line of regression. Adjusted R squared provides a better picture of the overall fit. This implies that only 78.56% of the changes in the response variable are explained by changes in the predictor variables.

(3) F test

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.01323	0.00441	32.76	<.0001
Error	23	0.00310	0.00013458		
Corrected Total	26	0.01632			

From the table, we can see F value = 32.76, $Pr > F$ is < 0.0001. Due to the value of F is larger, obtaining a relatively insignificant probability of < 0.0001 indicates that the null hypothesis is rejected. This confirms the relevance of the modeled equation. The above F-test confirms that the results are significant. The significance F value obtained from F test is lower than the required significance level of 5% which shows that the model was suitable in explaining the relationship between the variables under study.

(4) Durbin-Watson d Test

The Durbin- Watson statistic is used to detect autocorrelation.

$H_0 : \rho \leq 0$

$H_1 : \rho > 0$

H_0 (No positive serial correlation) H_1 (Positive serial correlation)

In our regression model, the numbers we used were:

$$K = 3\ n = 27\ \alpha = 0.05$$

Where：

K is number of independent variables

n is sample size

α is level of significance

Finding critical values of the Durbin Watson from Durbin Watson critical table, d_L represents the lower critical value, and d_U represents the upper critical value. The test D is compared to d_L and d_U:

If D is lower than d_L, there is evidence of positive autocorrelation among the residuals

If D is lower than d_U, there is evidence of positive autocorrelation among the residuals

If D is between d_L and d_U, test is inconclusive.

From Durbin Watson critical tables, we could know $d_L = 1.23991$ and $d_U = 1.55620$.

Germany

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.904
Number of Observations	27
1st Order Autocorrelation	0.478

From the regression results, the Durbin Watson statistics D = 0.904 < d_L shows positive autocorrelation.

(5) Auto regression

Through the autoregressive model, we can predict the value for the next time step When we use this time series model, we can observe a regression equation from previous time steps, then use it to predict the value at the next time step[22].

Germany

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00219236	DFE	22
MSE	0.0000997	Root MSE	0.00998
SBC	-160.94108	AIC	-167.42026
MAE	0.00745841	AICC	-164.56312
MAPE	80.9088046	HQC	-165.49366
Durbin-Watson	1.1595	Transformed Regression R-Square	0.6915
		Total R-Square	0.8657

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.1465	0.0183	8.02	<.0001	
gp	1	-2.504E-7	6.0782E-7	-0.41	0.6844	gp
ig	1	-0.1749	0.0418	-4.18	0.0004	ig
cg	1	0.0442	0.0200	2.21	0.0379	cg

From this regression model, response variables have become predictive variables in the previous period. There are a change from 0.1426 to 0.1465 in the T-bill rate, and GDP per capita (gp) is decreases from 4.0426E-8 to - 2.504E-7, Initial debt-to-GDP ratio

[22] Jason Brownlee, "Autoregression Models for Time Series Forecasting With Python," Machine Learning Mastery, January 02, 2017, accessed May 17, 2018, https://machinelearningmastery.com/autoregression-models-time-series-forecasting-python/.

(ig) is increases from – 0.1854 to – 0.1749, and Change in debt-to-GDP ratio (cg) is decrease from 0.0631 to 0.0442.

3.8 Econometric Analysis China (CHN)

China

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
tbr	tbr	26	0.0493749	0.0276573	0.0158583	0.1035000
gp	gp	26	2805.34	2697.35	358.8268306	8166.76
ig	ig	26	0.2119064	0.0964107	0.0390287	0.4104022
cg	cg	26	0.0255271	0.0960593	-0.4104022	0.1678953

From the China data collected, Treasury bill rate average was 4.94%, the highest T-bill rate was 10.35% and lowest was 1.59%. China borrowing is average, due to its complex economic approach compared to the USA. The average GDP/Population (gp) was 2805.34, the highest gp was 8166. 76 and the lowest was 358.83. The Initial debt-to-GDP ratio (ig) average was 21.19%, the highest ig was 41.04% and lowest was 3.90%. The Change in debt-to-GDP ratio (cg) average was 2.55%, the highest cg was 16.79% and lowest was -41.04%.

Correlation of Estimates

Variable	Label	Intercept	gp	ig	cg
Intercept	Intercept	1.0000	0.5215	-0.8671	-0.3649
gp	gp	0.5215	1.0000	-0.8374	-0.0316
ig	ig	-0.8671	-0.8374	1.0000	0.2122
cg	cg	-0.3649	-0.0316	0.2122	1.0000

It was determined that the T-bill rate had a weak positive correlation (0.5215) with GDP per capita (gp), but a weak negative relationship (-0.8671) with Initial debt-to-GDP ratio (ig) and a strong weak relationship (-0.3649) with Change in debt-to-GDP ratio (cg).

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Heteroscedasticity Consistent			Variance Inflation
							Standard Error	t Value	Pr > |t|	
Intercept	Intercept	1	0.10697	0.01251	8.55	<.0001	0.00824	12.98	<.0001	0
gp	gp	1	0.00000723	0.00000286	2.53	0.0191	0.00000256	2.82	0.0099	3.61878
ig	ig	1	-0.36220	0.08172	-4.43	0.0002	0.06429	-5.63	<.0001	3.78556
cg	cg	1	-0.04375	0.04485	-0.98	0.3399	0.02048	-2.14	0.0441	1.13184

From above table, the parameter estimates of the model are: $\beta_0 = 0.10697$, $\beta_1 = 0.00000723$, $\beta_2 = -0.3622$, $\beta_3 = -0.04375$. For every unit increase in GDP per capita (gp), T-bill rate increases by 0.00000723; decreases by -0.3622 and -0.04375 for every unit increase in Initial debt-to-GDP ratio (ig) and Change in debt-to-GDP ratio (cg) respectively. The results from the regressions for China are contrary to what was expected.

Our econometric model is a four variables model, that has three independence variables and one dependence variable. Here is our result after analysis:

$$\text{tbr} = 0.10697 + 0.00000723\text{gp} + (-0.36220)\text{ig} + (-0.04375)\text{cg} + \varepsilon$$

(1) t test

We tested three estimated coefficients one by one using t-tests. The hypothesized true coefficient $\beta_1 = 0$. Our estimated value for $\hat{\beta}_1 = 0.00000723$ and the standard

error of this estimate is se $(\hat{\beta}_1) = 0.00000286$. The degrees of freedom are 22. If we assume $\alpha = 5\%$ and $t_\alpha = 2.0796$, so $H_0 : \beta_1 = 0$ and $H_1 : \beta_1 \neq 0$. $t = (0.00000723 - 0)/0.00000286 = 2.53$. Absolute value of t is 2.53 and absolute value of t larger than $t_\alpha = 2.0796$, so we reject null hypothesis.

The hypothesized true coefficient $\beta_2 = 0$. Our estimated value for $\hat{\beta}_2 = -0.36220$ and the standard error of this estimate is se $(\hat{\beta}_2) = 0.08172$ and degree of freedom is 22. If we assume $\alpha = 5\%$ and $t_\alpha = 2.0796$, so $H_0 : \beta_2 = 0$ and $H_1 : \beta_2 \neq 0$. $t = (-0.36220 - 0)/0.08172 = -4.43$. Absolute value of t is 4.43 larger than $t_\alpha = 2.0796$, so we reject null hypothesis.

The hypothesized true coefficient $\beta_3 = 0$. Our estimated value for $\hat{\beta}_3 = -0.04375$ and the standard error of this estimate is se $(\hat{\beta}_3) = 0.04485$ and the degree of freedom is 22. If we assume $\alpha = 5\%$ and $t_\alpha = 2.0796$, so $H_0 : \beta_3 = 0$ and $H_1 : \beta_3 \neq 0$. $t = (-0.04375 - 0)/0.04485 = -0.98$. Absolute value of t is 0.98 lesser than $t_\alpha = 2.0796$, so we do not reject null hypothesis.

We chose α = 5% because when α = 5%, the results are significant.

(2) R square

Root MSE	0.02025	**R-Square**	0.5284
Dependent Mean	0.04937	**Adj R-Sq**	0.4640
Coeff Var	41.00790		

From the regression model, R squared shows that 52.84% of the plots fit along the line of regression but since the variables were more than one, adjusted R squared

provides a better picture of the overall fit. It shows that 46.4% of the plots fit along the regression line. This implies that only 46.40% of the changes in the response variable are explained by changes in the predictor variables.

(3) F test

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.01010	0.00337	8.22	0.0007
Error	22	0.00902	0.00040997		
Corrected Total	25	0.01912			

From the table, we can see F value =8.22, Pr > F is 0.0007, so this indicates that the null hypothesis is rejected. This confirms the relevance of the modeled equation. The above F-test confirms that the results are significant. The significance F value obtained from the F test is lower than the required significance level of 5% which shows that the model was suitable in explaining the relationship between the variables under study.

(4) Durbin-Watson d Test

The Durbin- Watson statistic is used to detect autocorrelation.

$H_0 : \rho \leq 0$

$H_1 : \rho > 0$

H_0 (No positive serial correlation) H_1(Positive serial correlation)

In our regression model, the numbers we used were:

$$K = 3 \; n = 26 \; \alpha = 0.05$$

Where：

K is number of independent variables

n is sample size

α is level of significance

Finding critical values of the Durbin Watson from Durbin Watson critical table, d_{L} represents the lower critical value, and $\mathrm{d_U}$ represents the upper critical value. The test D is compared to d_{L} and d_{U}:

If D is lower than d_{L}, there is evidence of positive autocorrelation among the residuals

If D is lower than d_{U}, there is evidence of positive autocorrelation among the residuals

If D is between d_{L} and d_{U}, test is inconclusive.

From Durbin Watson critical tables, we could know $d_{\mathrm{L}} = 1.22358$ and $d_{\mathrm{U}} = 1.55281$.

China

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.543
Number of Observations	26
1st Order Autocorrelation	0.720

From the regression results, the Durbin Watson statistics D = 0.543 < d_{L} shows positive autocorrelation.

(5) Auto regression

Through the autoregressive model, we can predict the value for the next time step When we use this time series model, we can observe a regression equation from previous time steps, then use it to predict the value at the next time step[23].

China

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00360796	DFE	21
MSE	0.0001718	Root MSE	0.01311
SBC	-140.14383	AIC	-146.43431
MAE	0.00907915	AICC	-143.43431
MAPE	25.2408856	HQC	-144.62288
Durbin-Watson	1.2780	Transformed Regression R-Square	0.2095
		Total R-Square	0.8113

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.0799	0.0167	4.80	<.0001	
gp	1	3.3795E-6	3.7794E-6	0.89	0.3813	gp
ig	1	-0.1868	0.0923	-2.02	0.0560	ig
cg	1	-0.009268	0.0312	-0.30	0.7692	cg

From this regression model, response variables have become predictive variables in the previous period. There are a change from 0.107 to 0.0799 in the T- bill rate, and GDP per capita (gp) is decreases from 7.2271E-6 to 3.3795E-6, Initial debt-to-GDP ratio

[23] Jason Brownlee, "Autoregression Models for Time Series Forecasting With Python," Machine Learning Mastery, January 02, 2017, accessed May 17, 2018, https://machinelearningmastery.com/autoregression-models-time-series-forecasting-python/.

(ig) is increases from – 0.3622 to – 0.1868, and Change in debt-to-GDP ratio (cg) is increase from – 0.0437 to – 0.009268.

3.9 Results

In the United States, an important factor in the increase in Treasury bill rates is GDP per capita. Through SAS analysis, the T-bill rate is positively correlated with GDP per capita(gp), and it has a negative correlation with Initial debt-to-GDP ratio (ig) and the Change in debt-to-GDP ratio (cg). The means that as GDP per capita grows, the T-bill rate increases, and as Initial debt-to-GDP ratio (ig) or Change in debt-to-GDP ratio (cg) decrease, the T-bill rate will increases.

In Germany, GDP per capita is an important factor in the change in the T-bill rate. Through SAS analysis, there is a positive correlation between Treasury bill rates and GDP per capita (gp) and Change in debt-to-GDP ratio (cg), and it has a negative correlation with Initial debt-to-GDP ratio (ig). The means when GDP per capita (gp) or Change in debt-to-GDP ratio (cg) grows, the T-bill rate also increases, and when Initial debt-to-GDP ratio (ig) decrease, the T-bill rate will increases.

In China, GDP per capita is an important factor for the change in the interest rate of the national debt. Through SAS analysis, GDP per capita has a positive correlation with the T-bill rate, and Initial debt-to-GDP ratio (ig) and Change in debt-to-GDP ratio (cg) have a negative correlation with the T-bill rate. That means that the T-bill rate has also increases when GDP per capita (gp) grows, and the T-bill rate has an increases when Initial debt-to-GDP ratio (ig) or Change in debt-to-GDP ratio (cg) have a decrease.

3.10 Researcher Shortcomings

No test is perfect, and the flaw in this test is the fault tolerance rate which is the relationship between GDP and the amount of change in the T-bill rate and debt. Additionally, we ignore other possible effects, such as unemployment, government policies and so on. These factors may also inhibit our regression analysis.

Chapter 4: Implication and prediction

By regression analysis, we can see there is a positive relationship between the T-bill rate and GDP per capita. Initial debt/ GDP and the change in debt/ GDP negatively impacts the T-bill rate which is primarily driven by the strained ability of the government to pay high rates when its debt burden is increasing. We boldly predict that the GDP per capita of the United States, Germany and China will be higher and higher with the development of the society and the passage of time. Moreover, with the increase of GDP per capita, the development and progress of a country cannot be separated from its people. The improvement of people's living standard also indicates the prosperity of the country. Similarly, the growth of the national economy is reflected in the growth of GDP per capita, while the interest rate of national debt (T-bill rate) will increase.

Chapter 5: Conclusion

The results of the empirical research were contrary to the normative economic theory. Only in the case of Germany, did changes in government debt relative to GDP have a significant positive effect on Germany’s short-term borrowing rate as predicted by the economic theory. For the United States and China, there is a negative effect. For

Initial debt-to-GDP ratio (ig), all three countries have obvious consequences, and Initial debt-to-GDP ratio (ig) and T-bill rate have obvious negative effects. By regression testing, we can see that the relationship between GDP per capita and interest rate of national debt is positively correlated in the United States, Germany and China. Economic theory argues that GDP per capita should be negative. In other words, as GDP per capita grows, government debt should be reduced, and the T-bill rate should be lower.

However, the result of the test was that they were positively correlated. What caused this result? I think the reason for this result is that the government has invested the debt and grew as a result of that investment. When national debt rises, countries have more money to create and invest with, leading to higher profits and higher GDP per capita. When GDP per capita goes up, in order to stabilize people's living standards, and to try to create a better life, to make the country stronger, the country continues to issue debt and invest in making more money. As national debt rises, the interest rates paid by the state are also higher. It's a cycle, so GDP per capita and T-bill rate are positive relationships. It fits perfectly with our analysis.

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Appendixes

U.S. data

Year	tbr	gp	ig	cg
1947	0.005675	1806.121033	0.987288184	-0.019208
1948	0.010225	1914.029093	0.897896357	0.003563
1949	0.011025	1816.392739	0.933634458	0.014761
1950	0.011725	2111.758656	0.802322677	-0.006244
1951	0.014775	2311.140926	0.715129046	0.011218
1952	0.016725	2428.998305	0.679360300	0.018361
1953	0.018925	2422.341992	0.688190292	0.012936
1954	0.009625	2465.33367	0.676911087	0.007493
1955	0.0166	2648.839812	0.625875140	-0.002284
1956	0.02555	2742.09522	0.591833992	-0.004336
1957	0.0323	2777.310041	0.569709532	0.010511
1958	0.017775	2873.418666	0.551580799	0.017986
1959	0.03255	2988.324959	0.538424626	0.001889
1960	0.03045	2993.267316	0.528589092	0.005545
1961	0.022675	3165.438495	0.496884585	0.015474
1962	0.027775	3285.985315	0.486029110	0.013048
1963	0.0311	3459.270998	0.467289720	0.009163
1964	0.03505	3639.008581	0.446720044	0.007159
1965	0.039025	3977.956953	0.410035390	0.003880
1966	0.0484	4246.532281	0.383295962	0.007187
1967	0.043325	4443.7339	0.369111901	0.024909
1968	0.0526	4832.643403	0.358715181	0.006185
1969	0.065625	5133.479007	0.340142264	0.016335
1970	0.06685	5321.894397	0.339911055	0.024737
1971	0.0454	5746.899255	0.333449231	0.024297
1972	0.039525	6345.263048	0.320565035	0.023273
1973	0.06725	6978.748602	0.309654249	0.011494
1974	0.077775	7494.24492	0.296318662	0.036182
1975	0.0599	8176.029373	0.301834736	0.049268
1976	0.0497	8888.29636	0.319849279	0.040755
1977	0.051275	9844.867424	0.322310528	0.033660
1978	0.069325	11149.30669	0.311019560	0.022158
1979	0.099375	12130.75173	0.302852194	0.029663
1980	0.1122	13145.29303	0.303321335	0.030065
1981	0.143	14275.74693	0.303940630	0.043855

1982	0.1101	14675.04672	0.335112580	0.068959
1983	0.084475	16199.68592	0.362738701	0.051368
1984	0.096125	17545.30995	0.379013821	0.060517
1985	0.074875	18670.83008	0.409377277	0.067818
1986	0.06035	19400.60578	0.455090980	0.046044
1987	0.057225	20682.78682	0.465887665	0.052163
1988	0.0645	22087.20686	0.480720112	0.047111
1989	0.0811	23297.27916	0.495710551	0.065239
1990	0.0755	24075.89705	0.536746107	0.071721
1991	0.0561	24767.46736	0.583664156	0.063701
1992	0.03405	26068.42933	0.606938086	0.051661
1993	0.029825	27020.09359	0.627200035	0.040098
1994	0.03985	28379.2716	0.627686610	0.037584
1995	0.05515	29256.72949	0.637733760	0.032182
1996	0.050225	30725.42768	0.630499677	0.022686
1997	0.050525	32196.60167	0.615931145	0.012858
1998	0.047275	33769.74442	0.592559232	0.013940
1999	0.0451	35535.64627	0.569810845	0.001813
2000	0.057625	37083.42481	0.541811076	0.012700
2001	0.036725	37518.86055	0.542643490	0.039341
2002	0.016575	38561.00432	0.560887348	0.049983
2003	0.0103	40659.90999	0.574011958	0.050437
2004	0.012275	42835.97261	0.587398842	0.044101
2005	0.0301	45209.27522	0.592827674	0.042895
2006	0.046775	47073.36907	0.604775788	0.035617
2007	0.046425	48675.91881	0.613401265	0.069253
2008	0.01585	47776.337	0.689005851	0.129554
2009	0.00135	47410.85471	0.817628875	0.143480
2010	0.0013	49161.26158	0.919225791	0.065659
2011	0.0003	50575.46922	0.950250461	0.067531
2012	0.0005	51840.14416	0.985804501	0.041234
2013	0.00066	53700.41918	0.984594722	0.074236
2014	0.00053	55618.23781	1.014888814	0.008514
2015	0.0021	56938.86472	0.992550756	0.077759
2016	0.0051	58460.3313	1.035304721	0.035545
2017	0.0139	60828.92137	1.025764914	-1.025765

Germany data

Year	tbr	gp	ig	cg
1991	0.0961	23,492	0.39132600	0.082631
1992	0.084	26,592	0.41618504	0.022900
1993	0.0591	25,705	0.45155684	0.056051
1994	0.051	27,320	0.47517844	0.167588
1995	0.0335	31,934	0.54779019	0.008736
1996	0.0319	30,760	0.57645734	-0.055865
1997	0.0351	27,261	0.58688873	0.013945
1998	0.030934	27,564	0.59422554	-0.006601
1999	0.035368	27,035	0.59925505	-0.076927
2000	0.047558	24,000	0.58834324	-0.011899
2001	0.033571	23,944	0.57743254	0.058245
2002	0.026875	25,566	0.59480104	0.164354
2003	0.020706	30,734	0.63093301	0.097703
2004	0.021384	34,547	0.64796882	0.031311
2005	0.026004	35,096	0.66903347	0.028058
2006	0.038182	36,854	0.66490021	0.064773
2007	0.043621	42,347	0.63654697	0.076053
2008	0.019431	46,470	0.65109107	0.009513
2009	0.006617	42,323	0.72682036	0.081128
2010	0.010867	42,320	0.80870527	0.055344
2011	0.010483	46,472	0.78647522	-0.034193
2012	0.002234	43,741	0.79793685	0.021049
2013	0.002881	46,191	0.77366067	0.000343
2014	0.000482	47,819	0.74558020	-0.131537
2015	-0.001836	41,334	0.70849226	-0.007113
2016	-0.003286	42,474	0.68083301	-0.076634
2017	-0.003285	44,896	0.57021254	-0.570213

China data

Year	tbr	gp	ig	cg
1991	0.0738	358.826831	0.0652448	0.007887
1992	0.0720	423.032150	0.061318899	-0.012260
1993	0.0885	525.708548	0.03902872	0.027044
1994	0.1008	472.649979	0.072672741	-0.012085
1995	0.1035	608.375096	0.046576737	0.167895
1996	0.0948	708.580019	0.182234348	0.030353
1997	0.0889	780.838982	0.190984337	0.013498
1998	0.0685	827.643254	0.191163653	0.013799

1999	0.0366	872.221869	0.192902775	0.023766
2000	0.0260	958.563392	0.195664377	0.032321
2001	0.0252	1053.144711	0.206072925	0.037763
2002	0.0215	1150.212918	0.221822518	0.035609
2003	0.0262	1293.129145	0.227608386	0.038219
2004	0.0279	1512.618857	0.225924018	0.035885
2005	0.0186	1765.720885	0.222963497	0.037675
2006	0.0254	2110.574524	0.216903819	0.036906
2007	0.0351	2703.003126	0.197159642	0.093167
2008	0.0403	3467.029864	0.225200438	0.044634
2009	0.0159	3837.902585	0.242575436	0.101383
2010	0.0264	4524.055306	0.290395824	0.046724
2011	0.0514	5582.887149	0.271876894	0.064642
2012	0.0431	6329.464418	0.295359302	0.047126
2013	0.0498	7080.828532	0.304640413	0.065313
2014	0.0480	7701.690281	0.338364726	0.060730
2015	0.0439	8166.755903	0.374505732	0.036113
2016	0.0316	8123.256504	0.410402215	-0.410402

SAS system
U.S.

US

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Number of Observations Read	71
Number of Observations Used	71

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.04018	0.01339	35.98	<.0001
Error	67	0.02494	0.00037229		
Corrected Total	70	0.06513			

Root MSE	0.01929	R-Square	0.6170
Dependent Mean	0.04101	Adj R-Sq	0.5999
Coeff Var	47.04739		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Heteroscedasticity Consistent			Variance Inflation
							Standard Error	t Value	Pr > |t|	
Intercept	Intercept	1	0.10636	0.00684	15.56	<.0001	0.00778	13.67	<.0001	0
gp	gp	1	3.325227E-7	1.483576E-7	2.24	0.0283	1.272711E-7	2.61	0.0111	1.44361
ig	ig	1	-0.12563	0.01306	-9.62	<.0001	0.01381	-9.10	<.0001	1.49764
cg	cg	1	-0.01264	0.01834	-0.69	0.4930	0.00550	-2.30	0.0248	1.05273

US

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.435
Number of Observations	71
1st Order Autocorrelation	0.772

US

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00972885	DFE	66
MSE	0.0001474	Root MSE	0.01214
SBC	-407.85911	AIC	-419.17251
MAE	0.00891318	AICC	-418.24944
MAPE	54.2771813	HQC	-414.67353
Durbin-Watson	1.5267	Transformed Regression R-Square	0.2675
		Total R-Square	0.8506

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.1027	0.0149	6.89	<.0001	
gp	1	3.1832E-7	3.367E-7	0.95	0.3479	gp
ig	1	-0.1171	0.0246	-4.76	<.0001	ig
cg	1	-0.009816	0.0117	-0.84	0.4061	cg

Germany

Germany

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Number of Observations Read	28
Number of Observations Used	27
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.01323	0.00441	32.76	<.0001
Error	23	0.00310	0.00013458		
Corrected Total	26	0.01632			

Root MSE	0.01160	R-Square	0.8104
Dependent Mean	0.02813	Adj R-Sq	0.7856
Coeff Var	41.24098		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Heteroscedasticity Consistent			Variance Inflation
							Standard Error	t Value	Pr > |t|	
Intercept	Intercept	1	0.14262	0.01305	10.93	<.0001	0.01500	9.51	<.0001	0
gp	gp	1	4.04261E-8	4.86155E-7	0.08	0.9344	4.317502E-7	0.09	0.9262	3.32423
ig	ig	1	-0.18545	0.03470	-5.34	<.0001	0.03814	-4.86	<.0001	2.87460
cg	cg	1	0.06313	0.01982	3.18	0.0041	0.01560	4.05	0.0005	1.34084

Germany

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.904
Number of Observations	27
1st Order Autocorrelation	0.478

Germany

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00219236	DFE	22
MSE	0.0000997	Root MSE	0.00998
SBC	-160.94108	AIC	-167.42026
MAE	0.00745841	AICC	-164.56312
MAPE	80.9088046	HQC	-165.49366
Durbin-Watson	1.1595	Transformed Regression R-Square	0.6915
		Total R-Square	0.8657

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.1465	0.0183	8.02	<.0001	
gp	1	-2.504E-7	6.0782E-7	-0.41	0.6844	gp
ig	1	-0.1749	0.0418	-4.18	0.0004	ig
cg	1	0.0442	0.0200	2.21	0.0379	cg

China

China

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Number of Observations Read	26
Number of Observations Used	26

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.01010	0.00337	8.22	0.0007
Error	22	0.00902	0.00040997		
Corrected Total	25	0.01912			

Root MSE	0.02025	R-Square	0.5284
Dependent Mean	0.04937	Adj R-Sq	0.4640
Coeff Var	41.00790		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Heteroscedasticity Consistent			Variance Inflation
							Standard Error	t Value	Pr > |t|	
Intercept	Intercept	1	0.10697	0.01251	8.55	<.0001	0.00824	12.98	<.0001	0
gp	gp	1	0.00000723	0.00000286	2.53	0.0191	0.00000256	2.82	0.0099	3.61878
ig	ig	1	-0.36220	0.08172	-4.43	0.0002	0.06429	-5.63	<.0001	3.78556
cg	cg	1	-0.04375	0.04485	-0.98	0.3399	0.02048	-2.14	0.0441	1.13184

China

The REG Procedure
Model: MODEL1
Dependent Variable: tbr tbr

Durbin-Watson D	0.543
Number of Observations	26
1st Order Autocorrelation	0.720

China

The AUTOREG Procedure

Yule-Walker Estimates			
SSE	0.00360796	DFE	21
MSE	0.0001718	Root MSE	0.01311
SBC	-140.14383	AIC	-146.43431
MAE	0.00907915	AICC	-143.43431
MAPE	25.2408856	HQC	-144.62288
Durbin-Watson	1.2780	Transformed Regression R-Square	0.2095
		Total R-Square	0.8113

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.0799	0.0167	4.80	<.0001	
gp	1	3.3795E-6	3.7794E-6	0.89	0.3813	gp
ig	1	-0.1868	0.0923	-2.02	0.0560	ig
cg	1	-0.009268	0.0312	-0.30	0.7692	cg