The impact of public debt on economic growth: Evidence from Thailand

Miss Kanpimon Chaisaard

An Independent Study Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in Business and Managerial Economics
Field of Study of Business and Managerial Economics
FACULTY OF ECONOMICS
Chulalongkorn University
Academic Year 2021

ผลกระทบของหนี้สาธารณะต่อการเจริญเติบโตทางเศรษฐกิจ: กรณีศึกษาของประเทศไทย

น.ส.กานต์พิมล ไชยสอาด

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต
สาขาวิชาเศรษฐศาสตร์ธุรกิจและการจัดการ สาขาวิชาเศรษฐศาสตร์ธุรกิจและการจัดการ
คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2564

Independent Study Title	The impact of public debt on economic growth: Evidence from Thailand
By	Miss Kanpimon Chaisaard
Field of Study	Business and Managerial Economics
Thesis Advisor	Assistant Professor NIPIT WONGPUNYA, Ph.D.

Accepted by the FACULTY OF ECONOMICS, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Arts

INDEPENDENT STUDY COMMITTEE

..... Chairman
(Assistant Professor SAN SAMPATTAVANIJA, Ph.D.)

..... Advisor
(Assistant Professor NIPIT WONGPUNYA, Ph.D.)

..... Examiner
(Assistant Professor PANUTAT SATCHACHAI, Ph.D.)

กานต์พิมล ไชยสอาด : ผลกระทบของหนี้สาธารณะต่อการเจริญเติบโตทางเศรษฐกิจ: กรณีศึกษาของประเทศไทย. (The impact of public debt on economic growth: Evidence from Thailand) อ.ที่ปรึกษาหลัก : นิพิฐ วงศ์ปัญญา

-

สาขาวิชา	เศรษฐศาสตร์ธุรกิจและการจัดการ	ลายมือชื่อนิสิต .....
ปีการศึกษา	2564	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

6384003429 : MAJOR BUSINESS AND MANAGERIAL ECONOMICS
KEYWO RD: Public debt, Economic Growth, Personal Income Tax, Thailand

Kanpimon Chaisaard : The impact of public debt on economic growth: Evidence from Thailand. Advisor: Asst. Prof. NIPIT WONGPUNYA, Ph.D.

This study investigates how public debt affects Thailand’s economic growth, covering 2005 to 2019. The model runs through 3 macroeconomic indicators; namely, Public debt, Personal Income Tax, and Real Gross Domestic Product, which represent economic growth. All of them are examined by Vector Error Correction Model and Granger Causality approach. The evidence shows that public debt and income tax are related to Thailand’s growth in different directions; the former is favorable while the latter is negative at a 5% significance level. Likewise, the speed of adjustment is at 15%. The paper suggests that the government can run up the national debt, however, they should confirm transparency of objectives and the process, maintain their fiscal discipline, and monitor it to the proper Debt-to-GDP ratio.

Field of Study:	Business and Managerial Economics	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

ACKNOWLEDGEMENTS

The completion of this undertaking could not have been possible without the participation and assistance of many people.

First of all, I would like to express my deep appreciation to our advisor, Assistant Professor Nipit Wongpanya Ph.D., for every practical recommendation and the appropriate solution can be my proper guideline and make me enjoy conducting the independent study.

Secondly, I would like to express my deep gratitude to all professors in our program. During a hard time due to Covid-19 circumstance, I know how hard to deal with the teaching methods to accommodate different learning styles. As a result, acquiring knowledge in this program is my considerable value, and I value every moment I spent during this time. Meanwhile, I am also able to adapt it to my work, and that important reason I am interested in this program and would like to recommend it program to others so much.

Other persons that I could not forget to say special thanks to are my family. They are always concerned about my physical and mental health because working full time while studying simultaneously is stressful. Thanks for your warmth, kindness, and belief in me for as long as I can remember., and I cannot thank you enough.

Last but not least, my beloved friends whom I study with, you guys are one of my favorite memory when I think of the reason why I enjoy pursuing a master's degree.

Kanpimon Chaisaard

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

1. Introduction and Objectives

1.1. Introduction

Fundamentally, to maintain a robust economy, the federal government seeks to complete three primary goals of an economic system; namely, price stability, low employment rate, and economic growth.

Unfortunately, it is hard to succeed multiple goals simultaneously because of unpredictable situations, for instance, outbreaks of pandemics, financial crises in other counties, political instability, and wars. Ultimately, many countries experience a budget deficit, which means government spending exceeds government revenue.

To stimulate the economy in these specific circumstances, the government will likely maintain the expenditure plan but increase the budget by generating funds to finance the deficit, as a consequence, raising public debt becomes a noticeable resolution for closing the gap. Nevertheless, it comes with the cost of repayment and interest payment. The state debt exerts a direct effect to impose a burden on the taxpayer in the future generation. When the payment due date is upcoming, they will pay a higher tax and reduce their consumption. Hence, keeping on a large debt cannot help but diminish the standard of living for the future generation.

An increase in state borrowing will also lead to a reduction in investment, and this effect of public borrowing is known as crowding out. When the budget deficit occurs, it represents a negative public saving. Thus, if the government budget deficit declines the supply of loanable funds, it drives up the interest rate and diminishes investment.

In particular, household and firm reduce their consumption of capital goods, it decreases Net Capital Outflow, reduces the local currency supply, and drives the real exchange rate to appreciate. Furthermore, less capital stock also affects a slowdown of productivity and the real wage, which means when the government decides to make a state borrowing, the next to generate have to face a difficult situation because their taxation will be higher while their income is lower.

Increasing the future taxation occurs with other problems; for instance, people might decrease the current consumption because they are concerned about the higher tax rate in the future. Consequently, this behavior leads to diminishing national consumption and directly considerably reduces the current real GDP. Moreover, to place this burden on the future generation also affects the present and the future situations, many countries support and provide a pension system to benefit older people. Additionally, some of these funds are supported by some revenue that is generated from the current taxpayer, meaning that they might experience a budget deficit again in the future. At the same time, they cannot raise the individual income tax rate anymore because it is the maximum level that taxpayers can spend. To make matters worse, several countries have to face the most significant demographic concerning of aging society and the declining birth rate. Thus, it can be predicted the number of taxpayers drops over time and it impacts a downfall on government revenue which is generated by personal income tax.

For the reasons mentioned before, incurring public borrowing appears with negative thoughts and perceptions for most individuals, but it seems reasonable in specific circumstances. Supporting the government wants to select another choice; to cut their expenses instead of raising their revenue, the results from that strategy might worsen. For

example, if the government of Thailand would like to lower the budget by canceling the compulsory education policy, it is unnecessary to provide financing help to the education sector. As a result, numerous children will not be able to access basic knowledge, leading to a crisis in the labor market that is lack of skilled laborers in the future.

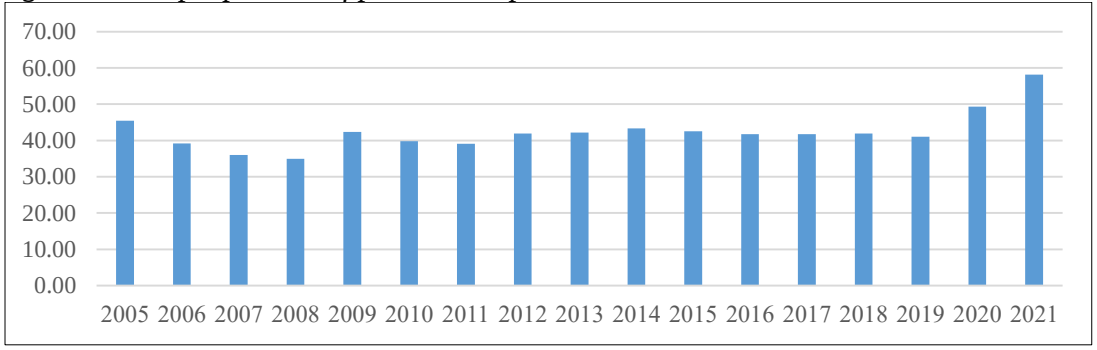
In addition, this problem influences not only in terms of quantity but also quality because educated people know how to adapt their knowledge to their work and create more productivity when compared to an uneducated person. In terms of technology transfer, skilled laborers have more potential to absorb the new knowledge and further develop, affecting higher domestic goods and services and higher real wages. Thus, cutting the expenditure is another appropriate alternative, but not a permanent solution, when the government has to deal with a fiscal deficit.

Another resolution to fix a government deficit is raising taxation in the current generation, however, raising the revenue generated by boosting personal income tax might hurt people when the recession occurs because they have faced lower income in that situation. Likewise, rising other types of taxation, e.g., Corporate Income Tax and Petroleum Income Tax, which directly increases government revenue, also affect similar results because entrepreneurs have to carry the burden of the higher cost. Moreover, business sectors might decrease their cost by lowering their production capacity or dismissing some employees, leading to a decrease in GDP and employment rate, respectively.

Thus, to make a decision, the government needs to comprehensively consider each option's benefits and drawbacks. In general, people believe that high public debt levels can damage economic stability and growth. Some evidence suggests that several countries experience a large debt per gross domestic product ratio, which might lead to a greater probability of default risk, however, GDP per capita is expected to grow simultaneously. For example, Japan's GDP growth rate from 1980 to 2021 averaged 0.43 %, with 237% for debt-to-GDP proportion in 2019, and Singapore's GDP growth rate from 1975 to 2021 averaged 1.52 percent, with a 126% of debt-to-GDP ratio.

Therefore, the following concerning point is what the suitable level of national debt to GDP should be. According to Thailand Fiscal Responsibility Act B.E. 2561, the percentage of public debt per GDP is set under the act of unpermitted to exceed 60%. Whereas, nowadays, the ratio of debt to GDP has announced raising the public debt ceiling to allow high borrowing to assist the economy recovering in the wake of the pandemic from 60% to 70%. Hence, the government needs to prioritize fiscal discipline and ensure transparency.

Figure 1: the proportion of public debt per GDP in Thailand



Source: The Public Debt Management Office

Therefore, to clarify this issue in the case of Thailand, this study will investigate three macroeconomic indicators; namely, Public debt, Individual Income Tax, and Real Gross Domestic Product which are covered between 2005 -2019. The data is secondary data which is given by three central departments, i.e., The Office of the National Economic and Social Development Council, The Public Debt Management Office, and Fiscal Policy Office.

1.2. The objective of the study

The primary aims of this research are concentrate at:

1. To examine the degree of a causal relationship between Thailand's public debt, personal income tax, and economic growth.
2. To empirically analyze how public debt affects economic growth in Thailand and its relationship.

1.3. Scope of the Research

To analyze the influence of public debt on Thailand's growth, the estimation procedure is designed to apply the VECM and Granger causality approaches. Furthermore, the model is run through three indicators mentioned before and covers the period from 2005 to 2009; all of them are put into the model in terms of the natural logarithm. More details are provided in part 5 (Methodology and Data Gathering Process).

2. Literature reviews

2.1. The theoretical literature review

The concept of government borrowing is one of the concerning issues that have been examined for a very long time. In general, the government could maintain its budget and stabilize its economy, but sometimes could not achieve the target due to several causes. As a result, they will have to run a fiscal deficit which means their spending exceeds revenue. However, they do not have enough budget, running up the public debt is one of the financial choices. Therefore, this part will explain the principle perceptions of running a deficit and the effect of public borrowing based on two economic thoughts; namely, Classical and Keynesian

2.1.1. the overview of public debt: Classical theory

The classical principle concept of the state is just the responsibility of maintaining the smooth continuance of economic association. Following the idea of the laissez-faire ideal, a policy of the lowest governmental intervention, in other words, public sectors not being permitted to meddle in the economy and the regulated parties are leaded by market forces. The national debt perceptions from Classical theory are discussed and concentrated on three prominent classical economists: Smith, Ricardo, and J.S. Mill. The main idea is that borrowing to finance government spending damages the economy and its ability to generate wealth. (Tsoulfidis, 2007)

Smith gives some perceptions that the government budget should not run a deficit; the government should maintain their expenses to do not exceed their revenue. Even though all of them are in debt of domestic investors, increasing debt accumulation is still harmful to the economy. In Addition, if expenses are needed, the preferable method of supporting them is taxes. Therefore, he also clearly express that taxes are primarily paid

by present earned income and reduce private consumption without influencing the countries to accumulate wealth.

Ricardo supports Smith's on the point that ineffective qualities of government expenditures and public. Borrowing diminishes the appropriate products as an investment. Hence, this approach leads to the slowdown of national capacity to accumulate wealth.

Whereas J.S. Mill provides a different perception, he mentions that running up the public debt might not affect malignant results. Supposing they would like to lend out from a domestic source, they will absorb the saving surplus. Thus, there is downward pressure on the interest rate, which is forced to reduce by pressing. In addition, the lower interest rate also leads to an unproductive investment, and people tend to invest more in the foreign markets because the interest rate is higher than the domestic market. Thus, incurring the public debt from unfamiliar sources or funding through public sectors might be the better choice, and the downward pressure on interest rate is eliminated.

2.1.2. the overview of public debt: The Keynesian theory

After the global financial crisis shows that government action may be required to address market faults and enhance people's overall well-being, Keynes argues the classic theory that only self-balancing functions cannot be sufficient to lead to full employment in open markets. According to Keynesian economists, government interference which is forced by public guidelines, is a practical approach to achieve full employment and price stability.

Keynes mentions that the interest rate, which is the major loan cost, is relatively low during the financial crises, still, the economy may not recover for diverse reasons. Consequently, the government must participate in new finance sources. (Keynes, 1982)

Additionally, Keynesians believe that investment volatility will become the following problem when the state faces financial crises. From that result, the government should intervene to stabilize the economy; due to the unstable market economy, investors are negatively influenced by unpredictable expectations about future directions. In a common situation, the government should foster budget surpluses. In contrast, the budgetary deficit is another fascinating policy to stabilize the economy instead of only concentrating on growth.

2.2. Empirical reviews

After the financial crises, increasing public debt has become an interesting solution to resolve when the government experiences a fiscal deficit. Therefore, to find out the effect of this approach, several papers try to investigate their relationship in both the short term and the long term. Hence, the literature's differing perspectives on the link between these variables could divide into three primary streams: negative, positive, and no relationship.

Most individuals believe that debt is harmful to economic expansion for general perception. Furthermore, there are further reports which support this viewpoint. The empirical evidence confirms that the national debt is statistically negatively related to growth. They analyze the outcomes from the panel regression model, which is examined by the OLS method, and a dynamic panel regression model analyzed by the GMM method. Then, both estimate approaches provide similar results; there is a statistically negative link between the national debt and African countries' growth. (Lartey et al., 2018) The same result appears in the seven western countries; namely, Austria, France, Germany, Italy, the Netherlands, Portugal, and the United States of America, a non-linear association within the dataset is under consideration.

The study runs the debt-to-GDP ratio, the economic growth rate, state borrowing, and other macroeconomic indicators such as the initial real GDP per capita, foreign trade, inflation rate, and population through three approaches: the pooled model, FEM, and REM. Moreover, the condition of duration is another important factor for considering, and then they separate the period into three parts to represent the different proxies: the short-run, the medium-run, and the long-run. The results verify that the public debt affects the negative outcome for seven countries in the western area with a statistical significance for the period of one year and three-year. (Bökemeier & Greiner, 2013) Another study supports the same conclusion; their findings can indicate that public borrowing hurts the economy in the long term. Nonetheless, there is a slightly dissimilar outcome because they find out the benefits when the government decides to incur the national debt for the short term to contribute to the economy in the whole OECD model covered in 37 OECD countries. (Abubakar & Mamman, 2020)

Due to the different conditions in each country, this research question is also investigated in a specific area. Malaysia's public debt damages its economic growth by analyzing a multivariate regression analysis from 1991 to 2013. The data indicates that Public debt hurts economic growth measured by GDP per capita. (Lee & Ng, 2015) The same conclusion reveals in the case of India when examining both variables in India by using the autoregressive distributed lag (ARDL) model, covering 1980 to 2011. The findings demonstrate that the internal and external debts have a negative impact on India's growth with statistical significance. Therefore, it means that an increase in national debt, wherever the sources of financing come from, will lead to a slowdown of India's economic growth in the long run. This conclusion is unsurprising, especially in the context of India, where the vast majority of government borrowing spend on consumption, and just a tiny amount is used to create new effective capitals. In contrast, public debt has become a significant financial source for economic development in some countries (Bal & Rath, 2014). Similar to Jordan, the empirical evidence reveals that public debt, population growth, and inflation rate significantly impact Jordan's economic growth, population growth has a strong, negative, and significant association with the economic boom in Jordan, whereas public debt and inflation rates have a significant positive association (Al-Zeaud, 2014). In contrast, the national debt seems like a useful financial source in some countries, in the case of Swaziland, to illustrate how economic development is influenced by domestic debt, external debt, inflation, and government spending. The findings demonstrate a positive association between domestic debt, external debt, and inflation. This paper suggests that a large percentage of government spending has been diverted to non-growth-oriented expenditures and has been ineffectively spent. On the other hand, public debt and inflation, have a beneficial influence on the economy. (Ntshakala, 2015) Another result appears in the case of Thailand, the study confirms that there is a significant positive relationship between short-term external debt and Real GDP in Thailand, with a bi-directional Granger-causality. (Butts et al., 2012)

When the empirical evidence reveals the different results, the U-Shape concept is found, which means the national debt can stimulate the economy under the condition of the proper debt-to-GDP ratio. Meaning that it will hurt the economy when the government holds the state borrowing exceeds the critical level. The first evidence is investigated based on 1983 to 2013 in Israel; the study is demonstrated by the quadratic regression. In this situation, the variable's coefficient indicating the national debt per gross domestic level is positive, in contrast, the coefficient of the square of it is negative, which means the regression curve describes an inverted-U shape. The results demonstrate that increasing debt would boost long-term growth at low levels of the debt-to-GDP, but running up debt until over

the appropriate debt threshold will interrupt the economy in the long term. Furthermore, the paper also adds the dummy variable to find the different situations when the total national debt is over a certain threshold; it reveals that public debt influences long-run growth and diminishes when the ratio hits 130%. (Shahor, 2018) The same results are confirmed by Southern Africa's case, to study how national debt influences its growth in the economic term. Consequently, the findings show a long nonlinear relationship and suggest that when public debt reaches a critical level, it stimulates economic expansion before negating it. However, there is no effect of public borrowing on Southern Africa's growth when the same technique is used in the short run, and there is no nonlinear trend in the sample under consideration. (Sanusi et al., 2019)

For the last conception, some studies use the term "zero relationships" to describe the association of national debt and economic growth does not exist. The study applies the condition of wage rigidities and the AK endogenous growth model. The study reveals that the most remarkable finding is that public debt is neutral in having no long-term impact on economic growth and unemployment. However, it does have an impact on economic stability. As a result, when governments do not place a high enough priority on debt-to-GDP ratio stabilization, the economy may suffer. (Greiner, 2013)

Since the unclear pattern of the effect of public debt from the different conditions, such as period of data, other economic indicators, politics, and law enforcement, and two main mechanisms, fiscal and monetary policies. For that reason, this paper will study how national debt influences growth by the condition of Thailand’s economy, provided that Personal Income Tax is also included in the model.

As the introduction mentioned, the government can run the fiscal policy through the individual income tax policy to raise their revenue. Whereas, an increase in the personal income tax will decrease their household consumption, another factor that drives Gross Domestic Product similarly to Keynesian Theory, instead.

Besides, several studies try to investigate the effect of individual income tax and the change in the economy. In Nigeria, to examine two types of taxation; namely, Petroleum gain tax and individual income tax, and their relationship with Nigeria’s economy. Thus, the paper run those variables through the Ordinary Least Squares (OLS) process, when real gross domestic is positioned as the outcome variable and taxes are the predictor variables. The result shows that both sorts of taxes have the same direction with their economic growth. Consequently, the finding leads to the government policy suggestion that they should heighten the tax management and diversify their revenue sources because the fluctuation of Petroleum prices from the international market will be a significant problem if their revenue relies on Petroleum profit tax. (Etale & Bingilar, 2016) Likewise, the study of tax reform in Serbia in the period of 2006-2015 with the same technique as the previous research, by conducting OLS model and run through 3 main tax categories, i.e., Individual and cooperate income tax, and value-added tax, together with the gross domestic product, which is the left-hand-side variable. After all, their findings demonstrate that all of the tax categories have a positive association with Serbia’s growth, but only Value-added tax is statistically significant. (Kalaš et al., 2017) Another evidence for the positive relationship between the individual income tax and growth of the economy is examined in the case of China and Pakistan's economy. The investigation reveals a high positive correlation between individual income tax and economic growth. Furthermore, the long-run unidirectional causality exists in the model, proved by the Granger causality technique. Accordingly, increasing tax on individual income will direct to higher

government revenue and enhance economic health. (Amin et al., 2018) On the other hand, some prove the contrast between individual income tax and economic growth. Investigating how tax structure affects growth for 23 OECD countries displays that the inverse relationship between individual tax and annual growth rate with 1965 – 1990 exists in the model. Furthermore, the author also mentions that progressive tax rate, which is extensive tax administration in most Western countries, hurts annualized growth rate. (Widmalm, 2001)

Economic growth is commonly recognized as necessary as the government's goal, yet various arguments exist. To clarify the association between national debt and growth in the case of Thailand's economy, and design a suitable strategy to deal with great economic health. Hence, to identify the direction of public debt and economic growth in Thailand between 2005 - 2019, this paper will utilize Johansen cointegration to confirm their long-term connection. Meanwhile, Vector Error Correction Model (VECM) is applied to demonstrate the short-term situation, and Granger's causality can prove the causal relationship between each variable in the model.

3. Methodology and Data Gathering Process

3.1. Conceptual framework

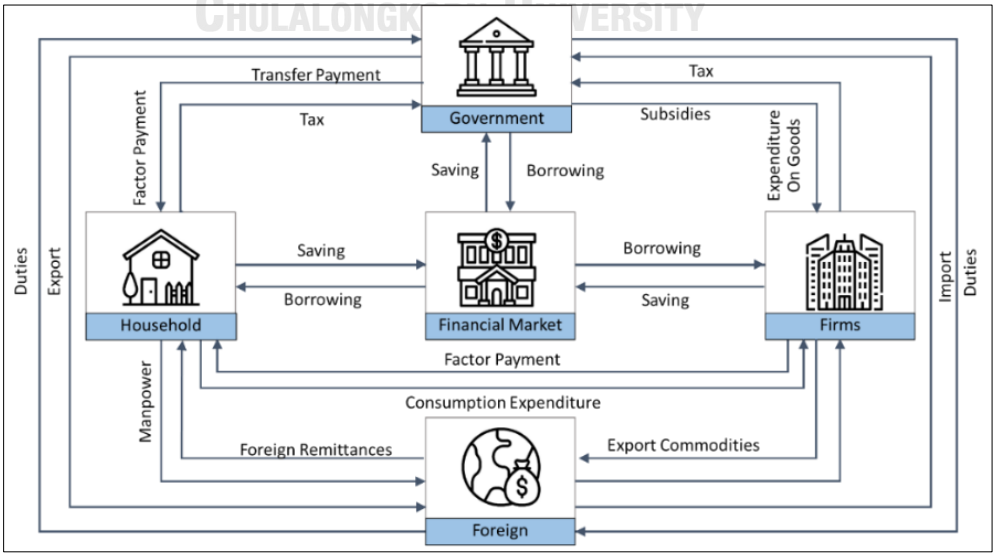
This paper applies The expenditure approach from the principle macroeconomic theoretical framework in Keynesian theory, and the equation could be expressed as:

$$Y = C+I+G+NX$$

Where Y represents Real Gross Domestic, the measurement of a national output, and which is standing for the dependent variable. Meanwhile, C, I, G, and NX refer to Private Consumption, Private Investment, Government Spending, and Net export respectively, and all of them are positioned as the independent variables in the model.

To explain their linkages in the economy, the four-sector model can reveal the details as the figure 2.

Figure 2: the four-sector model



Source: The Investors Book

From the picture, the domestic circular flow of Income for the four-sector model shows that both individual income tax and corporate income tax are one of the financial sources for the government. Therefore, the government will carefully consider them before incur enormous debt, which is another choice of the government's financial sources because they must have enough assets or income to pay back for repayments and interest payments.

When the governments decide to run a fiscal deficit, then households believe that the government will increase their budgets through taxation in the future. This perception is a vital household assumption that might change their current consumption behavior. For that reason, households will suffer when they know that the government plans to create a public debt burden.

Hence, if we concerned about taxation and include it into the household consumption equation, then it could be as:

$$C = \beta_0 + \beta_1(Y_t - T_t)$$

From the above equation, C stands for private consumption, $Y_t - T_t$ stands for the national income after-tax or disposable income, while β_0 and β_1 stand for the subsistence level of consumption and the marginal propensity to consume out of disposable income, respectively.

Therefore, if the government decides to run up the public debt, the government will expect future income tax, and the households will slow down their present consumption. Meanwhile, private consumption will decline because this element is one of the indicators included in the expenditure approach to measuring gross domestic products. Therefore, a decrease in consumption also leads to a drop in economic growth.

Consequently, the paper will focus on two main explanatory variables, national debt and personal income tax, to investigates how they influences Thiland's growth, in terms of using Real GDP as a proxy, the equation should be as:

$$RGDP = f(PDEBT, PIT)$$

Thus, the linear equation should be as a following:

$$RGDP_t = \beta_0 + \beta_1 PDEBT_{t-1} + \beta_2 PIT_{t-1} + \mu_t$$

Where RGDP refers to the real gross domestic product, PDEBT refers to public debt, PIT refers to personal income tax, while β_0 and μ_t refer to constant and error correlation term respectively.

3.2. Data description and sources

The study will explore how public borrowing influences economic growth in Thailand by using 60 observations of the quarterly time series between 2005 in 2019. The data are primary data from authoritative sources and the details are in table 1.

Table 1: List of Variables

Variable	The unit of measurement	Sources
Real Gross Domestic Product	Thai Baht	The Office of the National Economic and Social Development Council (NESDC)
Public Debt Outstanding	Thai Baht	The Public Debt Management Office
Personal Income Tax	Thai Baht	Fiscal Policy Office

Real Gross Domestic Product or Real GDP becomes the main factor this paper would like to indicate and predict as the dependent variable. The study looks at economic growth in terms of real GDP, the value of goods and services generated by an economy in Thailand over a given period, and adjusted for inflation.

Real GDP has been collected as the quarterly data, the real terms in Chain Volume Measures (CVM), and linked yearly indices using 2002 as the reference year using the annual overlap approach. In each quarter, the statistics are gathered as private final consumption spending, government final consumption expenditure, gross fixed capital formation, change in inventories, and net export of goods and services.

Public Debt Outstanding stands for the independent variables generated by five categories: Government Debt, State Enterprise Debt, Special Financial Institutions Guaranteed Debt, The Financial Institutions Development Fund Debt, and Government Agency Debt, and all of them include external and domestic debts. In Thailand, the government promotes fiscal discipline and ensures transparency and public finance sustainability. Therefore, Fiscal Responsibility Act B.E. 2561 is designated for compliance and the percentage of public debt per Gross Domestic Product is set under the act that it is not allowed to exceed 60%.

Personal Income Tax stands for the control variable; this dataset is recorded as the total direct tax charged on a person's net income in each quarter. The Personal income tax rates in Thailand were progressive with 5-35%, meaning that people will be taxed higher when their net income rises.

In general, Personal Income Tax affect the government revenue, then this indicator is expected to have a positive relationship to Real Gross Domestic Product.

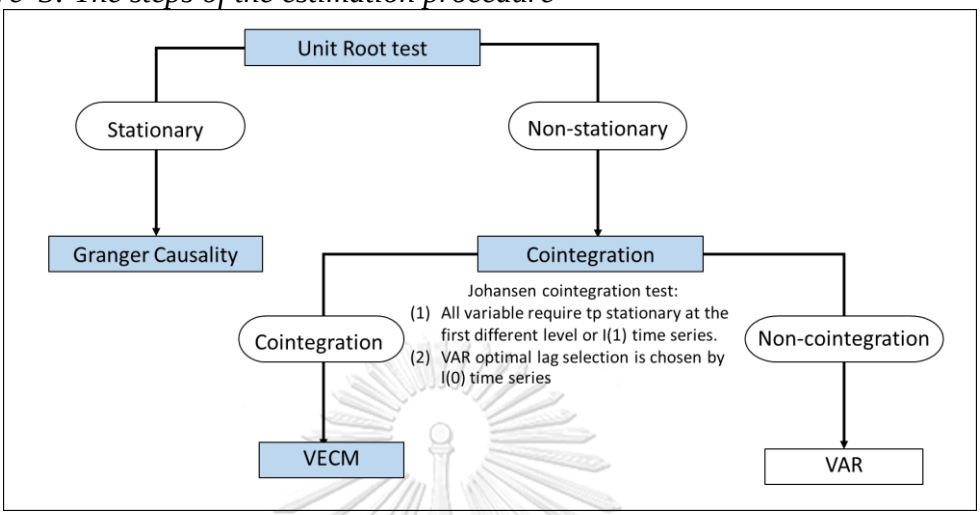
However, the natural logarithm is calculated in all indicators before adding them to the model, that is;

(i) LnRGDP stands for the natural logarithm of Real GDP
(ii) LnPDebt stands for the natural logarithm of Public Debt
(iii) LnPIT stands for the natural logarithm of total Personal Income Tax

3.3. Estimation procedure

This paper will examine the results by 4 main testing as the following map:

Figure 3: The steps of the estimation procedure



Step 1: The data will be tested whether this time-series dataset is stationary or not by the unit root test.

Step 2: When the unit root test condition proves the data, if the findings show that it is non-stationary, it can be solved by testing at the first difference. After that, the data set will be tested cointegration by Johansen cointegration test, providing that all variables of the data set must be stationary at the first different level. Thus, Johansen test will provide the long-term relationship results.

Step 3: Only if the cointegration is found (at least one cointegration), it can run Vector Error Correction Model (VECM) and show the short-term relationship's movement between independent and dependent variables. In contrast, the VECM model cannot run if the Johansen test results reveal no cointegration among the data set.

Step 4: The Granger causality technique will test the data set to find whether the indicators are suitable for forecasting the independent variable in the model or not. However, this step has to test by the data with the stationary condition only.

4. Results and findings

4.1. Unit root test

This approach is tested whether the time-series variable is stationary or non-stationary. This test is necessary before going to the next step and finding the appropriate methodology.

Consequently, this paper will apply Augmented Dickey-Fuller test statistics to check this condition. Then to investigate the presence of the unit root test, the following procedure is based on null and alternative hypotheses:

$H_0 =$ Series is nonstationary or still contains a unit root.

$H_1 =$ Series is stationary.

Table 2: ADF test statistic at the stage level

	ADF Test	1% level	5% level	10% level	Prop*	Note
LnRGDP	-0.213869	-3.563669	-2.918778	-2.597285	0.9298	Not stationary
LnPdebt	-0.168390	-3.546099	-0.291173	-2.593551	0.9362	Not stationary
LnPIT	-1.200421	-3.555023	-2.915522	-2.595565	0.6682	Not stationary

*MacKinnon (1996) one-sided p-values.

Table 3: ADF test statistic at the first different level

	ADF Test	1% level	5% level	10% level	Prop*	Note
LnRGDP	-5.232704	-3.562669	-2.918778	-2.597285	0.0001	stationary
LnPdebt	-7.387837	-3.548208	-2.912631	-2.594027	0.0000	stationary
LnPIT	-1.200421	-3.555023	-2.915522	-2.595565	0.0440	stationary

*MacKinnon (1996) one-sided p-values.

From table 2, for testing the ADF test for each variable at a 5% significance level, it is obvious that the null hypothesis should be accepted because their p-values are more than the lowest level of the significance level, meaning that all given factors are nonstationary. On the other hand, these problems can be solved by being tested as the first different level for all data sets. As the evidence is shown in table 3, the null hypothesis for all variables should be rejected at a 5% significant level, then all datasets are stationary.

4.2. Co-integration test

This empirical method suggests finding out whether these variables have a long-run relationship or not. However, the optimal lag length should be selected, in this case, the Schwarz information criterion is an indicator for lag order selected and the proper lags at a stage level of data are 5 lags, and when the optimal lag length is added to the model, the test results are following.

Table 4: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Trace			Maximum Eigenvalue		
		Trace Statistic	0.05 Critical Value	Prop**	Max-Eigen Statistic	0.05 Critical Value	Prop**
None*	0.445592	35.63912	29.79707	0.0095	31.85215	21.13162	0.0011
At most 1	0.064788	3.786973	15.49471	0.9200	3.617044	14.2646	0.8974
At most 2	0.003142	0.169929	3.841465	0.6802	0.169929	3.841465	0.6802

*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Huag-Michelis (1999) p-values

The outcome shows that the Unrestricted Cointegration Rank Tests by Trace and Maximum Eigenvalue, are significant as the same rank at confidence levels of 95%. Therefore, there is 1 cointegrating equation at the 0.05 level, which means a long-run relationship for some of them. However, this approach cannot reveal the direction among them. As a result, the rough long-run relationship can be determined by the further step.

Table 5: Long-Run relationship with 1 cointegrating equation

Johansen coefficients (standard error in parentheses)

Variables	Normalized cointegration coefficients	Adjustment Coefficients
LNRGDP	1.000000	-0.155820 (0.06803)
LNPdebt	-1.079652 (0.14892)	0.227941 (0.06103)
LnPIT	0.668087 (0.16778)	-0.281521 (0.14158)

Table 5 shows the Normalized cointegration coefficients from the Johansen cointegration test. The results estimate the negative sign of LnPdebt and the positive sign of LnPIT while LnRGDP is positioned as the dependent variable. To explain the relationship among these variables, the signs of coefficients should be reversed in the long run, which means, LnPdebt has a positive impact while LnPIT has a negative impact on LnRGD. Additionally, the coefficients are statistically significant at 1% level.

The coefficients in this equation represent the elasticities of Real GDP to public borrowing and personal income tax. Therefore, it can be noted that the positive effect of public borrowing is about to offset the negative effect of Individual income tax.

Furthermore, to find the individual speed of adjustment from other explanatory variables, it can be interpreted from the Adjustment Coefficients as the table 5. Since the Adjustment Coefficients in LnRGDP are statistically significant and negatively based on the standard t-test, the error term contributes to explaining the changes in Real GDP. Suppose there is a move away from the equilibrium. In that case, it will be corrected by 15% per quarter to bring back the equilibrium relationship in the long run.

For public borrowing, the balance value of 0.227941 is statistically significant at 0.05 level, which can explain that the adjustment process for the imbalance is relatively faster compared to the changes in real GDP. If there is an imbalance in the past period of 100%, the public debt will adjust to increase by 22.79%.

The last explanatory variable, personal income tax, the negative sign exists, and it is statistically significant at 0.10 level, meaning that it will be amended by 28.15% per quarter to equilibrium to backslide the equilibrium if there is an imbalance occurs.

4.3. Vector Error Correction Model (VECM)

This approach is applied to test a dynamical system in which the present state's divergence from its long-run relationship is transmitted into its short-run dynamics. In general, the VECM test can also estimate the Long-run equation as below;

$$\underset{}{\mathrm{ECT}_{t-1}} = LnRGDP - \underset{(0.14892)}{1.079652}\, lnPdebt + \underset{(0.16778)}{0.668087} lnPIT + 13.51581$$

Or it can be expressed as;

$$LnRGDP = \underset{}{-13.51581} + \underset{(0.14892)}{1.079652}\, lnPdebt - \underset{(0.16778)}{0.668087} lnPIT$$

Table 6: The system equation result

		Coefficient	Std.Error	t-Statistic	Prob.	
1	ECT	-0.155820	0.068026	-2.290601	0.0278	**
2	Ln_RGDP (-1)	-0.092199	0.156129	-0.590528	0.5584	
3	Ln_RGDP (-2)	-0.122883	0.176846	-0.694863	0.4915	
4	Ln_RGDP (-3)	-0.219391	0.176051	-1.246177	0.2205	
5	Ln_RGDP (-4)	0.123749	0.175681	0.704396	0.4856	
6	Ln_RGDP (-5)	-0.115280	0.165203	-0.697813	0.4897	
7	Ln_Debt (-1)	-0.015370	0.153046	-1.000160	0.3237	
8	Ln_Debt (-2)	0.200097	0.147626	1.355434	0.1835	
9	Ln_Debt (-3)	0.027892	0.154508	0.180522	0.8577	
10	Ln_Debt (-4)	-0.350680	0.155426	-2.256251	0.0301	**
11	Ln_Debt (-5)	0.020243	0.166922	0.121273	0.9041	
12	Ln_PIT (-1)	-0.008537	0.083449	-0.102300	0.9191	
13	Ln_PIT (-2)	0.045508	0.067393	0.675271	0.5037	
14	Ln_PIT (-3)	0.092553	0.060562	1.528224	0.1350	
15	Ln_PIT (-4)	0.079850	0.059821	1.334821	0.1901	
16	Ln_PIT (-5)	0.059178	0.074956	0.789505	0.4348	
17	C	0.011679	0.006611	1.766631	0.0855	**
R-squared		0.887748	F-statistic		18.2884	
Adjusted R-squared		0.839206	Prob(F-statistic)		0.000000	
S.E. of regression		0.021122	Durbin-Watson stat		2.023156	

Table 7: The Error Correction

Error Correction	D(LnRGDP)	D(LnPDBT)	D(LnPI)
CointEq1	-0.155820	0.227941	-0.281521
	(0.06803)	(0.06103)	(0.14158)
	[-2.29060]	[3.73513]	[-1.98846]

The empirical result from table 7 and table 8 can be described as the following;

- Error Correction Term (Butts et al.) may well have a negative sign and statistical significance at a α level to verify long-run causation. The preceding table shows that ECT is negative and statistically significant at the 0.05 level, implying long-run causation between public debt and personal income tax and real GDP. The Long-run equation from VECM (ECT_{t-1}) also expresses that both explanatory variables are statistically significant at the 0.05 level. The analysis suggests that the speed of adjustment from this model is 15%, which refers to the speed of adjustment toward equilibrium from short-run to long-run equilibrium, and is indicated fine the Error Correction Term (Butts et al.). Therefore, it means when any shock occurs in the short run, it will be corrected by 15% per quarter to bring back the equilibrium relationship in the long run.

The individual adjustment speed can be explained in table 7, the results are similar to the Adjustment cointegration by Johansen coefficients. Suppose any shock happens which leads to the imbalance, the personal income tax is the fastest change with 28.89% per quarter, followed by public debt because its adjustment speed is 22.79% per quarter. While real GDP is the slowest rate of adjustment speed compared to other indicators, the real

GDP is statistically significant and negatively based on the standard t-test. The value of -0.155820 means that the error term contributes to explaining the changes in Real GDP, and it will be amended by 15.58% to fall back to the equilibrium when the imbalance occurs.

- The R-squared and Adjusted R-squared are high, indicating that a statistical indicator in a regression model explains the amount of variation explained by the explanatory and control variable for a dependent variable.

- The F-statistical probability is statistically significant at the 0.05 level, implying that the data is well-fitting.

- The Durbin-Watson statistic value is 2.02, which is in the proper interval, the range of 1.5 to 2.5. Therefore, it can indicate that the data is essentially normal or that autocorrelation does not exist.

Furthermore, when considering about total relevant variables in terms of the short-run relationship with Real GDP as a target should be:

$$\Delta LnRGDP = \underset{(0.006611)*}{0.011679} + \underset{(0.156129)}{-0.092199}\Delta LnRGDP_{t-1} \underset{(0.176846)}{-0.122883}\Delta LnRGDP_{t-2} \underset{(0.176051)}{-0.219391}\Delta LnRGDP_{t-3} \underset{(0.175681)}{+0.123749}\Delta LnRGDP_{t-4}$$

$$\underset{(0.165203)}{-0.115280}\Delta LnRGDP_{t-5} \underset{(0.153046)}{-0.015370}\Delta Lnpdebt_{t-1} \underset{(0.147626)}{+0.200097}\Delta Lnpdebt_{t-2} \underset{(0.154508)}{+0.027892}\Delta Lnpdebt_{t-3}$$

$$\underset{(0.155426)**}{-0.350680}\Delta Lnpdebt_{t-4} \underset{(0.166922)}{+0.020243}\Delta Lnpdebt_{t-5} \underset{(0.083449)}{-0.008537}\Delta LnL_{t-1} \underset{(0.067393)}{+0.045508}\Delta LnL_{t-2}$$

$$\underset{(0.060562)}{+0.092553}\Delta LnL_{t-3} \underset{(0.059821)}{+0.079850}\Delta LnL_{t-4} \underset{(0.074956)}{+0.059178}\Delta LnL_{t-5} \underset{(0.068026)*}{-0.15582}ECT_{t-1}$$

4. The Granger Causality test

This statistical hypothesis test is used to see whether one-time series can be used for forecasting another or not, based on an F-test with the condition of a stationary time series. However, the optimal lag length should be selected, in this case, the Schwarz information criterion is an indicator for lag order selected and the proper lags for the first difference of data are 4 lags, and when the optimal lag length is added to the model, the test results are presented below.

Table 8: Results of the Granger causality test

Null hypothesis:	Obs	F-Statistic	Prob.	Causality
LnPDebt does not Granger Cause LnRGDP	55	2.58424	0.0493	Unidirectional lnPDebt→ lnRGDP
LnRGDP does not Granger Cause LnPDebt		0.77316	0.5483	
LnPIT does not Granger Cause LnRGDP	55	3.01455	0.0273	Bidirectional lnPIT ↔ lnRGDP
LnRGDP does not Granger Cause LnPIT		4.48804	0.0038	
LnPIT does not Granger Cause LnDebt	55	3.05363	0.0259	Unidirectional lnPIT → lnPDebt
LnDebt does not Granger Cause LnPIT		1.30646	0.2817	

As the previous result shows, all variables have a causality at least 1 direction to other factors at a 5% level of significance, meaning that it is proper to run these indicators through the model and there are suitable to forecast other factors.

The relationship between Public debt and Real GDP is unidirectional because only the LnPDebt granger causes LnRGDP, which means it is reasonable to predict Real Gross Domestic Product by public borrowing with a 5% significant level.

Similar to Personal income tax and public debt, only the LnPIT granger causes LnPdebt, which means that there is the causality that runs from Personal Income Tax to Public debt at a 5% level of significance.

On the other hand, real GDP has a bidirectional causality relationship with Personal Income Tax because both indicators do granger cause to each other. Therefore, it is unclear what the cause is because two of them cause each other when a bidirectional causality exists in the model at a 5% level of significance.

In summary, the results from the Johansen cointegration approach reveal that there is 1 cointegrating equation at the 0.05 level which means a long-run relationship exists amid these data sets. Based on the normalized cointegration coefficient and the upper chamber of the VECM are expressed in terms of the long-run association in the variable as the following equation:

$$LnRGDP = -13.51581 + 1.079652\ lnPdebt - 0.668087 lnPIT$$

Where Real GDP represents as the dependent variable, -13.51581 is the constant term, 1.079652 stand for the coefficient of national debt and -0.668087 refers to the coefficient of personal income tax. Meaning that Public Debt has a positive relationship with Real Gross Domestic Product, in contrast, Personal Income Tax has a negative association with economic growth in the case of Thailand.

Furthermore, monotonically adjustment towards equilibrium happens because the coefficient of ECT is -0.155820, and it is statistically significant at 95% of the confidence level. Therefore, it shows that the speed of adjustment is 15.58%, which measures how fast amid the short-run dynamics adjust back to the long-run equilibrium.

When focusing on individual adjustment speed, when any shock happens which leads to the imbalance, the personal income tax is the fastest change with 28.89% per quarter, followed by public debt because its adjustment speed is 22.79% per quarter. While real GDP is the slowest rate of adjustment speed compared to other indicators, the real GDP is statistically significant and negatively The value of -0.155820 means that the error term contributes to explaining the changes in Real GDP, and it will be amended by 15.58% to fall back to the equilibrium when the imbalance occurs.

The R-squared and Adjusted R-squared are high, The F-statistical probability is statistically significant at the 95% confident level and The Durbin-Watson statistic value is between 1.5 – 2.5, indicating that a statistical indicator in a regression model represents the amount of variation explained by the predictor variable for a response variable, implying that the data is well-fitting and that autocorrelation does not exist.

In addition, all variables have a causality at least 1 direction to other factors at a 5% level of significance, meaning that all indicators are suitable to forecast another factor in the model. The unidirectional causality relationship is found between running Personal Income Tax through Public debt and from Public debt through Real Gross Domestic Product. Whereas, Real Gross Domestic Product and Personal Income Tax have unidirectional causality to each other.

5. Conclusion

Due to the objectives, this study are to discover the degree of a causal relationship between Thailand's national debt, personal income tax, and growth in the economic term and empirically analyze the direction of the public borrowing influence on economic growth in Thailand. The empirical analysis shows that the relationship among these indicators is found in the long run from 2005 to 2019, in the case of Thailand. The study applies the Vector Error Correction Model (VECM) with three economic indicators, namely, Real Gross Domestic Product (RGDP), Public debt outstanding (PDEBT), and Personal Income Tax (PIT). The 4 main investigation results are the following:

5.1. Public debt positively influences Thailand's economic growth in the short term and long term at the 95% confidence level, under the condition that the ratio of debt-to-GDP is not legally permitted over 60%.

5.2. Personal Income Tax negatively influences on the long-run growth in Thailand at the 95% confidence level. However, it has an insignificant positive at the same confidence level in the short run.

5.3. the speed of adjustment from this model is 15%, which means when any shock occurs in the short run, it will be corrected 15% per quarter to bring back the equilibrium relationship in the long run.

5.4. The causality relationship happens amid independent variables and Thailand's economic growth at a 5% significance level.

In addition, this finding is generated from the main idea of the national debt, but in the fact, there are various indicators that are not considering in the model.

The results from this study can suggest that the public debt has a favorable impact on Thailand’s growth when the government can incur the national debt but maintain it to do not over the appropriate proportion of debt and GDP. Furthermore, they should reveal and confirm transparency of objectives and the process of projects which is spent by this borrowing, and maintain their fiscal discipline.

6. Recommendations

6.1. In addition, this finding is generated from the main idea of the national debt, but in fact, various factors are not included in the model. Therefore, further study should consider other factors and run them through the new model.

6.2. The financial sources, external and internal debt, have different costs, which might affect different impacts. Thus, further research can examine it, compare the appropriate options, and recommend the applicable policy.

6.3. Due to the limitation of data, the period might not cover the critical period. For instance, the Asian financial crisis occurred and began in Thailand from 1997 to 1999, only one of public debt categorized, the central government debt, increased around 441.81% or from less than 177 to over 959 billion baht, since the financial crisis occurred or during June 1997 and September 1999. Then, it is a significant change that should be considered. Hence, further study can correct this concern, and the result might be better accurate.

6.4. The positive association between national debt and Thailand's growth is under the Fiscal Responsibility Act B.E. 2561, in which the percentage of public debt per GDP is set under the act of unpermitted to exceed 60%, however, the proportion has been changed to reach 70% due to recovering the economy from the outback of pandemic in 2019. Then, this condition might appear in the different impact in the future study in this area which should be a significant case study.

7. Appendix

Table 9: Unit root test at stage level (Real GDP)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.232704	0.0001
Test critical values:	1% level	-3.562669	
	5% level	-2.918778	
	10% level	-2.597285	

Table 10: Unit root test at stage level (Public Debt)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.387837	0.0000
Test critical values:	1% level	-3.548208	
	5% level	-2.912631	
	10% level	-2.594027	

Table 11: Unit root test at stage level (Personal Income Tax)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.971271	0.0440
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

Table 12: Var lag selection at stage level

Lag	LogL	LR	FPE	AIC	SC	HQ
0	103.7480	NA	3.57e-06	-4.029919	-3.915198	-3.986233
1	269.8323	305.5952	6.67e-09	10.31329	-9.854408	-10.13855
2	288.4719	32.06011	4.56e-09	-10.69888	-9.895828	-10.39307
3	306.3044	28.53195	1.26e-0.9	11.05218	-9.904962	-10.61531
4	339.2860	48.81272	6.44e-10*	-12.01144	-10.52006	-11.44351
5	365.9801	36.30400*	7.99e-10	-12.71920	-10.88366*	-12.02022*
6	370.8747	6.069307	9.54e-10	-12.55499	-10.37528	-11.72494
7	377.2651	7.157273	9.54e-10	-12.45060	-9.926734	-11.48950
8	391.4819	14.21681	8.57e-10	-12.65928	-9.791242	-11.56711
9	410.6787	16.89320	6.57e-10	-13.06715*	-9.854951	-11.84393
10	419.3341	6.578036	8.08e-10	-13.05336	-9.496999	-11.69908

Table 13: Var lag selection at first difference level

Lag	LogL	LR	FPE	AIC	SC	HQ
0	199.1758	NA	6.69e-08	-8.007175	-7.891349	-7.963231
1	206.8784	113.3314	7.79e-09	-10.15830	-9.695000	-9.982526
2	291.1009	51.80997	3.29e-09	-11.02453	-10.21375	-10.71692
3	324.8184	53.67282	1.21e-09	-12.03341	-10.87515	-11.59396
4	346.4977	31.85517	7.39e-10	-15.55092	-11.04519*	-11.97965*
5	351.8581	7.220178	8.88e-10	-12.40237	-10.54916	-11.69927
6	361.6486	11.98842	9.08e-10	-12.43464	-12.23395	-11.59970
7	365.6611	4.42150	1.20e-09	-12.23106	-9.682897	-11.26429
8	379.1568	13.22034	1.12e-09	-12.41456	-9.518921	-11.31596
9	404.6687	21.86733*	6.64e-10*	-13.08852*	-9.845398	-11.85808
10	410.0483	3.952347	9.49e-10	-12.94075	-9.350149	-11.57848

Table 14: Johansen cointegration test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.445592	35.63912	29.79707	0.0095
At most 1	0.064788	3.786973	15.49471	0.9200
At most 2	0.003142	0.169929	3.841465	0.6802

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.445592	31.85215	21.13162	0.0011
At most 1	0.064788	3.617044	14.26460	0.8974
At most 2	0.003142	0.169929	3.841465	0.6802

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LN_RGDP_	LN_DEBT_	LN_PI_
23.66639	-25.55146	15.81120
39.38553	-8.064118	-15.14521
17.59580	0.210117	-5.698529

Unrestricted Adjustment Coefficients (alpha):

D(LN_RGDP_)	-0.006584	-0.001501	-0.000826
D(LN_DEBT_)	0.009631	0.000903	-0.000609
D(LN_PI_)	-0.011895	0.007823	-0.000799

Table 14: Johansen cointegration test (Cont.)

1 Cointegrating Equation(s): Log likelihood 395.2219

Normalized cointegrating coefficients (standard error in parentheses)

LN_RGDP_	LN_DEBT_	LN_PI_
1.000000	-1.079652	0.668087
	(0.14892)	(0.16778)

Adjustment coefficients (standard error in parentheses)

D(LN_RGDP_)	-0.155820
	(0.06803)
D(LN_DEBT_)	0.227941
	(0.06103)
D(LN_PI_)	-0.281521
	(0.14158)

2 Cointegrating Equation(s): Log likelihood 397.0304

Normalized cointegrating coefficients (standard error in parentheses)

LN_RGDP_	LN_DEBT_	LN_PI_
1.000000	0.000000	-0.630876
		(0.09585)
0.000000	1.000000	-1.203131
		(0.09839)

Adjustment coefficients (standard error in parentheses)

D(LN_RGDP_)	-0.214919	0.180332
	(0.13159)	(0.07673)
D(LN_DEBT_)	0.263512	-0.253380
	(0.11829)	(0.06898)
D(LN_PI_)	0.026602	0.240857
	(0.26845)	(0.15654)

Table 15: Vector Error Correction Estimates

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_RGDP_(-1)	1.000000
LN_DEBT_(-1)	-1.079652
	(0.14892)
	[-7.24994]
LN_PI_(-1)	0.668087
	(0.16778)
	[3.98196]
C	-13.51581

Table 15: Vector Error Correction Estimates (Cont.)

Error Correction:	D(LN RGDP)	D(LN DEBT)	D(LN PI)
CointEq1	-0.155820	0.227941	-0.281521
	(0.06803)	(0.06103)	(0.14158)
	[-2.29060]	[3.73513]	[-1.98846]
D(LN RGDP (-1))	-0.092199	0.032175	1.083190
	(0.15613)	(0.14006)	(0.32494)
	[-0.59053]	[0.22971]	[3.33349]
D(LN RGDP (-2))	-0.122883	-0.303779	0.037922
	(0.17685)	(0.15865)	(0.36806)
	[-0.69486]	[-1.91478]	[0.10303]
D(LN RGDP (-3))	-0.219391	-0.262449	0.201126
	(0.17605)	(0.15794)	(0.36640)
	[-1.24618]	[-1.66174]	[0.54892]
D(LN_RGDP_(-4))	0.123749	-0.156202	0.033537
	(0.17568)	(0.15760)	(0.36563)
	[0.70440]	[-0.99110]	[0.09172]
D(LN RGDP (-5))	-0.115280	-0.212249	0.081630
	(0.16520)	(0.14820)	(0.34383)
	[-0.69781]	[-1.43214]	[0.23742]
D(LN_DEBT_(-1))	-0.153070	0.128078	-0.314813
	(0.15305)	(0.13730)	(0.31852)
	[-1.00016]	[0.93285]	[-0.98835]
D(LN DEBT (-2))	0.200097	0.028218	-0.333416
	(0.14763)	(0.13244)	(0.30724)
	[1.35543]	[0.21307]	[-1.08518]
D(LN DEBT (-3))	0.027892	0.169598	0.083806
	(0.15451)	(0.13861)	(0.32157)
	[0.18052]	[1.22357]	[0.26062]
D(LN_DEBT_(-4))	-0.350680	0.118856	-0.046777
	(0.15543)	(0.13943)	(0.32348)
	[-2.25625]	[0.85242]	[-0.14461]
D(LN DEBT (-5))	0.020243	0.311073	-0.148227
	(0.16692)	(0.14975)	(0.34740)
	[0.12127]	[2.07733]	[-0.42667]
D(LN_PI_(-1))	-0.008537	-0.164309	-0.199049
	(0.08345)	(0.07486)	(0.17368)
	[-0.10230]	[-2.19480]	[-1.14608]
D(LN PI (-2))	0.045508	-0.049559	-0.051344
	(0.06739)	(0.06046)	(0.14026)
	[0.67527]	[-0.81973]	[-0.36606]
D(LN PI (-3))	0.092553	-0.074369	-0.167829
	(0.06056)	(0.05433)	(0.12604)
	[1.52822]	[-1.36881]	[-1.33150]
D(LN PI (-4))	0.079850	-0.005101	0.679218
	(0.05982)	(0.05367)	(0.12450)
	[1.33482]	[-0.09505]	[5.45551]
D(LN PI (-5))	0.059178	0.011889	0.091596
	(0.07496)	(0.06724)	(0.15600)
	[0.78951]	[0.17681]	[0.58715]
C	0.011679	0.014199	0.006828
	(0.00661)	(0.00593)	(0.01376)
	[1.76663]	[2.39412]	[0.49625]
R-squared	0.887748	0.501809	0.979678
Adj. R-squared	0.839206	0.286374	0.970890
Sum sq. resids	0.016507	0.013285	0.071502
S.E. equation	0.021122	0.018949	0.043960
F-statistic	18.28840	2.329290	111.4787
Log likelihood	141.8865	147.7499	102.3066
Akaike AIC	-4.625426	-4.842589	-3.159503
Schwarz SC	-3.999264	-4.216427	-2.533341
Mean dependent	0.008828	0.013518	0.009888
S.D. dependent	0.052675	0.022431	0.257653

Determinant resid covariance (dof adj.)	2.74E-10
Determinant resid covariance	8.82E-11
Log likelihood	395.2219
Akaike information criterion	-12.63785
Schwarz criterion	-10.64886
Number of coefficients	54

Table 16: Vector Error Correction Estimates (Real GDP is positioned as the dependent Variable)

Sample (adjusted): 7 60

Included observations: 54 after adjustments

D(LN_RGDP_) = C(1)*(LN_RGDP_(-1) - 1.07965199785*LN_DEBT_(-1) + 0.668086645028*LN_PI_(-1) - 13.5158089859) + C(2)*D(LN_RGDP_(-1)) + C(3)*D(LN_RGDP_(-2)) + C(4)*D(LN_RGDP_(-3)) + C(5) *D(LN_RGDP_(-4)) + C(6)*D(LN_RGDP_(-5)) + C(7)*D(LN_DEBT_(-1)) + C(8)*D(LN_DEBT_(-2)) + C(9)*D(LN_DEBT_(-3)) + C(10) *D(LN_DEBT_(-4)) + C(11)*D(LN_DEBT_(-5)) + C(12)*D(LN_PI_(-1)) + C(13)*D(LN_PI_(-2)) + C(14)*D(LN_PI_(-3)) + C(15)*D(LN_PI_(-4)) + C(16)*D(LN_PI_(-5)) + C(17)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.155820	0.068026	-2.290601	0.0278
C(2)	-0.092199	0.156129	-0.590528	0.5584
C(3)	-0.122883	0.176846	-0.694863	0.4915
C(4)	-0.219391	0.176051	-1.246177	0.2205
C(5)	0.123749	0.175681	0.704396	0.4856
C(6)	-0.115280	0.165203	-0.697813	0.4897
C(7)	-0.153070	0.153046	-1.000160	0.3237
C(8)	0.200097	0.147626	1.355434	0.1835
C(9)	0.027892	0.154508	0.180522	0.8577
C(10)	-0.350680	0.155426	-2.256251	0.0301
C(11)	0.020243	0.166922	0.121273	0.9041
C(12)	-0.008537	0.083449	-0.102300	0.9191
C(13)	0.045508	0.067393	0.675271	0.5037
C(14)	0.092553	0.060562	1.528224	0.1350
C(15)	0.079850	0.059821	1.334821	0.1901
C(16)	0.059178	0.074956	0.789505	0.4348
C(17)	0.011679	0.006611	1.766631	0.0855

R-squared	0.887748	Mean dependent var	0.008828
Adjusted R-squared	0.839206	S.D. dependent var	0.052675
S.E. of regression	0.021122	Akaike info criterion	-4.625426
Sum squared resid	0.016507	Schwarz criterion	-3.999264
Log likelihood	141.8865	Hannan-Quinn criter.	-4.383940
F-statistic	18.28840	Durbin-Watson stat	2.023156
Prob(F-statistic)	0.000000		

Table 17: Granger Causality

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
DPDEBT does not Granger Cause DRGDP	55	2.58424	0.0493
DRGDP does not Granger Cause DPDEBT		0.77316	0.5483
DPI does not Granger Cause DRGDP	55	3.01455	0.0273
DRGDP does not Granger Cause DPI		4.48804	0.0038
DPI does not Granger Cause DPDEBT	55	3.05363	0.0259
DPDEBT does not Granger Cause DPI		1.30646	0.2817

REFERENCES

Abubakar, A. B., & Mamman, S. O. (2020). Permanent and transitory effect of public debt on economic growth. *Journal of Economic Studies*.

Al-Zeaud, H. A. (2014). Public debt and economic growth: An empirical assessment. *European Scientific Journal*, *10*(4).

Amin, A., Chen, Y., & Huang, S. (2018). Personal income tax and economic growth: a comparative study between China and Pakistan. *Asian Journal of Economic Modelling*, *6*(1), 65-73.

Bal, D. P., & Rath, B. N. (2014). Public debt and economic growth in India: A reassessment. *Economic Analysis and Policy*, *44*(3), 292-300.

Bökemeier, B., & Greiner, A. (2013). On the relation between public debt and economic growth: An empirical investigation.

Butts, H. C., Mitchell, I., & Berkoh, A. (2012). Economic growth dynamics and short-term external debt in Thailand. *The Journal of Developing Areas*, 91-111.

Etale, L. M., & Bingilar, P. F. (2016). The relationship between petroleum profit tax, personal income tax and economic growth in Nigeria. *Research Journal of Finance and Accounting, 7 (12)*, 82-86.

Greiner, A. (2013). Sustainable public debt and economic growth under wage rigidity. *Metroeconomica*, *64*(2), 272-292.

Kalaš, B., Milenković, I., Pjanić, M., Andrašić, J., & Milenković, N. (2017). The impact of tax forms on economic growth: Evidence from Serbia. *Industrija*, *45*(2), 113-125.

Keynes, J. M. (1982). *Activities 1931-1939: World crises and policies in Britain and America* (Vol. 21). Macmillan.

Lartey, E. Y., Musah, A., Okyere, B., & Yusif, N. (2018). Public debt and economic growth: Evidence from Africa. *International Journal of Economics and Financial Issues*, *8*(6), 35.

Lee, S.-P., & Ng, Y.-L. (2015). Public debt and economic growth in Malaysia. *Asian Economic and Financial Review*, *5*(1), 119-126.

Ntshakala, P. L. (2015). Effects of public debt on economic growth in Swaziland. *International Journal of Business and Commerce*, *5*(1), 1-24.

Sanusi, K. A., Hassan, A., & Meyer, D. (2019). Non-linear Effects of Public Debt on Economic Growth in Southern Africa Development Community (SADC) Countries. *International Journal of Economics & Management*, *13*(1).

Shahor, T. (2018). The impact of public debt on economic growth in the Israeli economy. *Israel Affairs*, *24*(2), 254-264.

Tsoulfidis, L. (2007). Classical economists and public debt. *International Review of Economics*, *54*(1), 1-12.

Widmalm, F. (2001). Tax structure and growth: are some taxes better than others? *Public choice*, *107*(3), 199-219.

VITA

NAME Kanpimon Chaisaard

DATE OF BIRTH 27 August 1994

PLACE OF BIRTH Phitsanulok