Södertörns Högskola | Department of Economics

Master Thesis 30 credit | Economics | spring 2011

THE RELATIONSHIP BETWEEN DOMESTIC SAVING AND ECONOMIC GROWTH

AND CONVERGENCE HYPOTHESIS: CASE STUDY OF THAILAND

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ABSTRACT

The fact that saving is one of the main factors to economic growth is unquestionable. Accumulated saving can be consider as the sources of capital stock to which play a crucial role in creating investment, production, and employment. And all these activities eventually enhance the economic growth.

Therefore the main objective of this paper, "The relationship between domestic saving and economic growth and convergence hypothesis: case study of Thailand", was to investigate the causality relationship between the domestic saving and economic growth of Thailand. This paper will analyze whether the direction of causality go from domestic saving to economic growth, or vice versa. Granger causality test were conducted by using time series annual data from 1960 to 2010, and the empirical result suggests that the direct of causality go from economic growth to domestic saving only.

Aiming to grow its economy, Thailand had had development plans which used both saving and direct investment to stimulate economy. This paper examine whether the convergence hypothesis does hold in Thailand. This part would check whether or not Thailand is in the process of convergence, catching up, lagging behind, loose catching up, loose lagging behind or divergence over time compared with other developed countries. This test was conducted in pairwise between Thailand-Singapore, Thailand-United States, Thailand-United Kingdom, deployed data from 1970 to 2010, and the Augmented Dickey–Fuller (ADF) Test. The regression results demonstrate that convergence hypothesis does not hold in Thailand.

Finally, the result of Granger Causality report that economic growth rate does matter lead to growth rate of domestic savings in Thailand only. Thus, in order to learn the effect of gross domestic saving per capita growth rate can help narrow the different of GDP between two countries concerned, this paper will examine the correlation of two variables, deployed the OSL methods to investigate the correlation between gross domestic saving growth rate and the different of GDP per capita between Thailand and Singapore. This test also examine whether saving does help support convergence hypothesis for Thailand or not. The test results shows that domestic saving growth rate does not help narrowing the range of different of income of Thailand and

Singapore which mean that domestic saving growth rate does not support the convergence hypothesis in Thailand.

ACKNOWLEDGEMENTS

This paper would not possible without the intelligent and time dedicated of my supervisor Xiange Lin (PhD in Economics, Department of Economics, Sodertorn University) I would like to express my sincere appreciation for your support to my study.

I also need to say thank you to my parents, Mr Supoch and Mrs Panomporn Rasmidatta and my brother, Piyapoch Rasmidatta, for their financial and emotional support. Also thank you to my special friends (Lotto, Tick, Che, View, Neung, Ple, Ball) who help me with a lot for suggestion and emotional support during my study at Sodertorn University.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The economic growth is the common goal of all nations. Everybody lives with more comfortable, better standard of living than ever before and holding a better welfare because of the surge in their economic growth. Government in each country aims to reduce the poverty and increase the level on national income. Therefore, to achieve the main target of economic growth, governments may implement various kinds of policies such as encourage saving, stimulating investment and production in their countries.

Investment contributes to growth in aggregate wealth. But the investment cannot increase without increasing in the amount of saving. Thus, savings perform a major role in providing the national capacity for investment and production, which will affect the potential of economic growth. A serious constraint to sustainable economic growth can cause from the low rate of saving.

In general perception, we accept that increasing aggregate savings contribute to higher investment and lead to the higher GDP growth in the short run. It means that the higher saving rate leads to less consumption, which could also result in larger amount of capital investment and finally a higher rate of economic growth.

On the other hand, in some empirical studies suggest that when economic grow, the economy would contribute to a growth in the personal income and per capita consumption expenditure. According to the theory of marginal propensity to save, saving expand from the increasing of income. As a result, following this concept it can be easily understood that when the economic growth, the amount of saving also increases.

According to the controversial perception about the relationship between saving and economic growth, we cannot refuse that once aggregate saving increases perhaps

from rising in income, it might enhance investment opportunities and generate economic growth for the countries. In the other hand when the economic are growing can lead to the amount of increasing in saving in the countries also.

Thailand which is developing country depends on capital as an important factor for economic growth. The major source of capital comes from internal and external saving. Therefore the combination of saving in Thailand can be categorized the combination as below.

Saving is Thailand

Domestic saving

- Household Saving: (the largest part of saving in Thailand)
- Business saving: (the second largest part of saving in Thailand)
- Public saving
- State enterprises saving

External saving

- External saving

If the country has sufficient high rate of domestic saving, so it would not need the external saving which make a country expose to the uncontrollable risk from the world economic crisis.

An experience from the economic crisis suggests the fact that low saving rates have generated a severe current account deficit in country. For instance, in the case of Thailand prior to the financial crisis in mid-1997, the balance of payment problems were resulted from the high gap of saving and investment in the year 1987-1996. From the figure below, internal saving could not meet the demand of investment, so they borrow money to absorb the scarcity of internal saving. As they depended a lot of external saving, they increase a risk exposure from currency and economics fluctuation. Finally, during the Thai economic crisis in year 1997, government had spent national capital reserve to protect Thai currency. At the time, they continually

lose a lot of capital reserve and eventually failed to maintain the financial stability of the country. (Source: 9th APEC FINANCEMINISTERS´ PROCESS)

Figure 1: Saving and investment in Thailand

Source: 9th APEC FINANCEMINISTERS´ PROCESS

According to the important role of saving, we cannot refuse against the fact that lack of saving accumulation can cause economic crisis as we can learn from the case of Thailand. Therefore, domestic saving as an important source of capital which helps to run economic progress and maintain financial stability should be studied.

Therefore, saving in Thailand casts serious doubts whether higher saving leads to higher investment, which in turn leads to higher economic growth or surprisingly empirical result will provide evident of causality from economic growth to saving. If growth leads higher savings, then it is important to know that the changing growth rates are likely to result in changing in saving which would be a good implication to the policy setting from Thai government. Therefore, this paper will examine the causality between domestic saving rate and economic growth in order to see the direction of causality. Thus, it is vital to use the data between the years 1960 and 2010 to enhance our understanding of the relationship between economic growth and saving by using Granger Causality test.

Moreover, to confirm the result of causality this paper will examine the correlation between domestic saving rate and gap of economic growth whether the findings would show whether domestic saving could enhance economic growth for the country or narrow down the different of GDP per capita for Thailand and developed countries such as Singapore which represent the developed country in Asia. The

Ordinary Least Square (OLS) method was employed in this research to address the causal linkage between saving and the different of GDP per capita of Thailand and Singapore to reveal whether the increasing of domestic saving growth rate help Thailand catching up Singapore or not.

In addition, as the previous statement emphasized on saving, economic growth and the linkage between them, it is better to understand more deeply in the process of growth in Thailand as the economic growth is what everybody concerned.

From the past Thailand used to perform well in economic growth, however, since 1997; Asian financial crisis dropped the growth of GDP per capita and created negative value of the growth rate during the period of 1997-2001. However, the unsmooth of GDP pattern of Thailand casts doubts on the status of growth process in the countries. there are a lot of empirical conventions focusing on the convergence hypothesis which predicted that the poor country would tend to grow faster than the rich country in order to close the income gap between the two countries and would eventually converge and reach the steady state levels where output per capita, capital stock per capita and consumption per capita grow at a common constant rate equaling the exogenously given rate of technological progress. Thus this casts doubt whether Thailand's growth is in the process of catching up or converging when comparing with the developed countries.

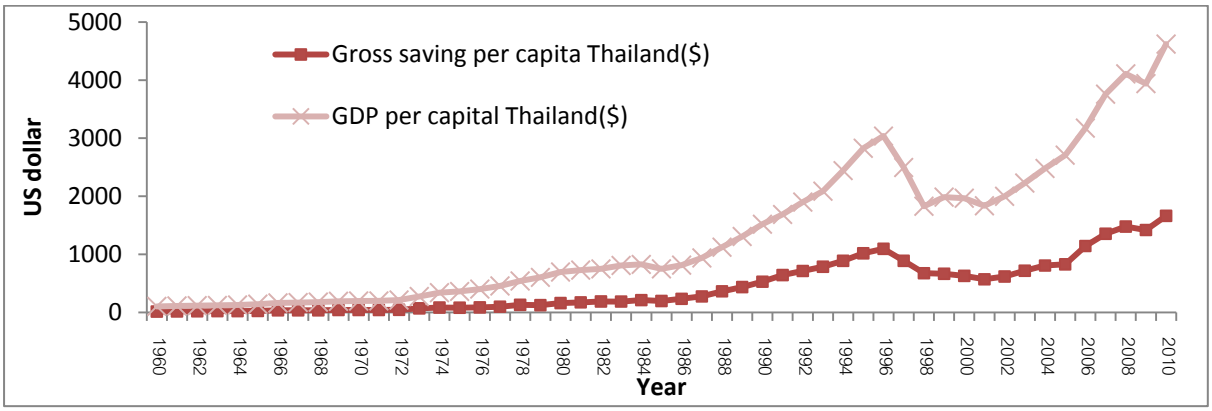
In order to understand more about convergence hypothesis, we should know about the definition of convergence which mainly used in the growth theory based on the relationship between initial income and subsequent growth. The basic idea is that two countries exhibit convergence if one country with the lower initial income grows faster than the other one. This is called β-convergence. If country's per capita income converges to a steady-state value, irrespective of other conditions within a given country, there would be absolute convergence. To be more precise, absolute convergence implies a tendency towards the equalization of per capita incomes (catching-up process). While conditional convergence allows each country to have a difference level of per capita income towards its own converging itself or steady state level.

The research deployed time-series unit root test so as to consider the convergence hypothesis in GDP per capita during the period of 1970-2010 focusing mainly on pairwise of Thailand and Singapore which is the strong economy developed country in Asia, and also includes more sample to confirm the result by testing cover more in pairwise of United States which represented the big economy in continent of America. Finally, study more in the pairwise of Thailand and United Kingdom which presented the developed country in the continent of Europe.

Investigating these pairwise of GDP per capita convergence between Thailand and some developed countries whether they should shed light on their economic relations and on the convergence hypothesis or not. The empirical study has focused on the six possible results which are Divergence, convergence, catching-up, Lagging-behind, Loose Catching-up, and Loose Lagging-behind; whereas catching-up and Lagging-behind are the case where the logarithm of difference in per capita income between two economies is related to a trend stationary process; convergence is linked to a constant mean stationary process. And, divergence, loose catching-up, and loose lagging-behind are associated to a process that contains a unit root.

1.2 Overview of GDP and gross domestics saving per capita of Thailand and Trend of GDP per capita of Thailand Singapore United States, and United Kingdom

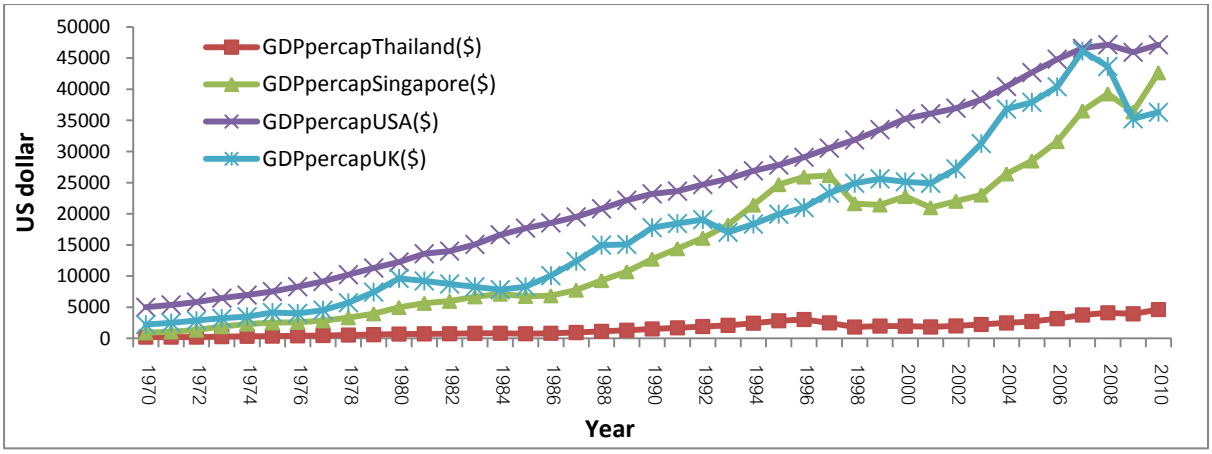
Figure 2: Trend of GDP and gross domestics saving per capita of Thailand



International Monetary fund (IMF)
www.nationmaster.com

The levels of GDP and gross domestics saving per capita of Thailand have increased from 1960 to 2010. However, due to financial crisis in the mid of 1997 the GDP and gross domestics saving per capita have been falling. In 2002, the GDP per capita started to rise and getting back to the same level before crisis in 2006.

Figure 3: Trend of GDP per capita of Thailand Singapore United States, and United Kingdom



International Monetary fund (IMF)
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Singapore, United States and United Kingdom are the major developed capitalist economies. The levels of GDP per capita of Thailand and Singapore, USA, UK in 1970 was not too much different, however, in the recent year, 2010, the level of GDP per capita of Thailand is far behind. In order to prove the convergence theory, thus, this paper will examine the convergence hypothesis between Thailand and Singapore, USA, UK in the following chapter.

1.3 Research objectives

The purpose of this study is to examine the relationship between Domestic savings rate and economic growth rate. This study is going to investigate whether the direction of causality runs from savings to economic growth or vice versa. Moreover, it also investigates the convergence hypothesis of Thailand whether it is in the process of catching up the big developed countries. The objectives would cover what the research is attempting to find out. For example:

- Investigate the causality relationship between Gross domestic savings rate and economic growth rate.
- Examine the convergence hypothesis of Thailand. Focus mainly on investigates in Thailand and Singapore which represented a strong developed economy country in Asian. A research would also cover a pairwise of Thailand and United States of America, which represented the big economy in the continent of America, and Thailand with United Kingdom which represented continent of Europe.
- Examine the correlation of domestic saving rate and the GDP gap whether the changing of gross domestics saving growth rate help catching up or support convergence hypothesis between Thailand and Singapore.

1.4 Methodology

1.4.1 Data collection

The data were collected from various sources such as International Monetary fund (IMF), Bank of Thailand, Office of national economic and social development board. In the case of directional causality of GDP per capita and Gross domestic saving per capita of Thailand were observed yearly basis from 1960 to 2010, as well as the case of Convergence hypothesis of Thailand and Singapore, USA, UK were observed in annually data analysis during the period of 1970-2010.

1.4.2 Hypothesis testing

1. H0: GDP per capita growth does not Granger Cause gross domestic saving growth
   H1: GDP per capita growth does Granger Cause gross domestic saving growth
   And
   H0: Gross domestic saving growth does not Granger Cause GDP per capita growth
   H1: Gross domestic saving growth does Granger Cause GDP per capita growth

2. H0: The convergence hypothesis hold for Thailand
   H1: The convergence hypothesis does not hold for Thailand

3. Ho: Gross domestic saving growth does help convergence hypothesis for Thailand
   H1: Gross domestic saving growth does not help convergence hypothesis for Thailand

1.5 Organization of the study

This paper is organized into six chapters

Chapter one is the introduction and background of the study. In this part would tell the research objective and methodology of the study.

Chapter two presents the theory which involve to this study. This part would contain about growth theory, catching up, and convergence hypothesis

Chapter three reviews the relevant literature of this study which use as a model of empirical studies.

Chapter four is theoretical framework which would indicate the concept of model to use in empirical test. This chapter also contains definition of variable and econometric model.

Chapter five is the empirical result which would include all econometric regression and the test result to answer the objective of this study such as causality test, convergence hypothesis, and ordinary least square method, and also the analysis of the test results.

Chapter six is summary and recommendation. This part would tell the main finding of this study to answer the research objective and the recommendation of the study.

CHAPTER TWO

THEORY

2.1. Theory review on Economic growth theory

2.1.1 Classical economic growth model

This theory consists of concepts from Adam Smith , David Ricardo , and Thomas Robert Malthus . They emphasized about productive investment and capital accumulation as the principal of the growth model. They also focused on the effects of technological progress, the concept of division of labor and the changes in production methods.

Adam Smith stated about supply-side driven growth model. The production functions and output growth function as follows:

Y = f (L, K, T)

Where

Y: output

L: labor

K: capital

T: land

Economic growth in Smith's view

There are relationship's series.

Growth of output/living standards = f(Accumulate capital)

- Accumulate capital. = f(Investment)
- Investment = f(Savings)
- Savings = f(Profits)
- Profits = f(Productivity)
- Productivity = f(division of labor)

Division of labor is the same thing as specialization

- Division of labor = f(extent of the market)
- Extent of market = f(Division of labor)

"It is Causality relationship"

Smith also emphasized about "division of labor which come from two sources, first the saving and capital accumulation, and second the extent of the market. The saving in capitalists system, savings creates investment and hence economic growth. It is useless for division of labor if the market is very small. The economy tries to use cost saving technology and division of labor in the case where the market is large. Division of labor is limited by the size of market, and trade limits the size of market. Free trade can be both domestically and internationally.

2.1.2 Neoclassical growth model

Neoclassical economists believe that a long term rate of economic growth requires rising in the supply of labor and an improvement in labor or capital productivity.

Neoclassical growth models tend to emphasize the simplicity of substitution among factors of production such as labor, capital, land, or other essentials in the production of commodities, which allow the economy to achieve *steady-state growth* which means a constant proportionate rate of growth of all real variables. Neoclassical theory also cited about the long-run equilibrium of a competitive economy by paying attention to the accumulation of capital goods, growth in population, and technological progress. There are two famously known models in Neoclassical theory as below.

2.1.2.1 Harrod - Domar growth model

Harrod - Domar growth model was named after two well-known economists, Sir Roy Harrod of England and Professor Evesey Domar from the US. It is a conventional empirical that helps people to understand the economic growth rate derive from the productivity of capital and the savings level. This model states that aggregate savings are arranged from any funds with the purposes of investment. According to the Harrod - Domar growth model, the growth rate of an economy is depended on two important factors - the savings level and capital-output ratio of the economy.

Economic growth of Harrod – Domar model is under three conditions as follow

- Investment is equal to saving
- Using full of capital stock

- Full employment

Therefore, the rate of growth in GDP will be sustainable if the capital stock and labor have the same rate of growth as income growth rate (warranted rate of growth). However, this theory has some weakness point because the condition above might not be true.

Harrod - Domar model define a close economy, assuming no government, no depreciation, and the investment is equal to saving.

Assume

: Capital-output ratio is (k)
: The level of national saving is (s) which is a proportion of the national income.
: Since close economy the investment (i) is determined by the amount of savings.

Therefore

Savings (S) is a proportion of average propensity to save (APS) times national income (GDP). Define APS = s, Define GDP =Y

$$\mathbf{S = s\,(Y)}$$

Investment (I) in Harrod Domar is defined as the change in capital stock (K)

$$\mathbf{I = \Delta K}$$

The capital stock (K) is a proportion of national income (Y) times the capital-output ratio (k)

$$\mathbf{K = kY}$$

$$\mathbf{K/Y = k}$$

$$\mathbf{\Delta K/\Delta Y = k}$$

$$\mathbf{\Delta K = k\,(\Delta Y)}$$

Since investment equal to saving

$$\mathbf{S = I}$$

From previous formula

$$S = s(Y)$$

$$I = \Delta K$$

$$\Delta K = k(\Delta Y)$$

Therefore

$$s(Y) = k(\Delta Y)$$

$$s/k = \Delta Y/Y$$

From the model above, it is obvious that ΔY/Y is the rate of growth of GDP. (ΔY/Y) can define as the percentage change of GDP, therefore the Harrod - Domar growth model can be explained as: The GDP growth rate (ΔY/Y) is determined by average propensity to save (s), and the national capital-output ratio (k).

In conclusion

- The GDP growth rate has a positive correlation to the average propensity to save (s).
- The more saving or investment in an economy, the greater will be of the rate of national income (GDP)

However, the GDP growth rate has a negative relationship to the national capital-output ratio. The higher of national capital-output ratio, the lower will be the rate of national income (GDP). If we would like to make economy growth, the country should save and invest in a certain portion of its national income.

In summary Harrod-Domar the economic growth rate model is defined by the formula below:

From

$$s/k = \Delta Y/Y$$

$$\Delta Y/Y = g$$

Therefore

$$g = s/k$$

And with depreciation

$$g = s/k - d$$

where

g : Rate of Economic Growth (ΔY/Y)

s : average propensity to save

k: capital-output ratio

d : Capital depreciation

2.1.2.2 The Solow growth model

Solow growth model study about how the capital stock, labor, and technology progress have impact on the production output. Moreover, he predicts that rise in saving rate and the productivity improvement have positively affects per capita income level. He emphasize in increase accumulate capital, higher potential of labor, and advance technology.

Solow supposes that the size of economy does not matter for the economic growth, but the main factors depend on capital, labor and technology.

Start with production function model according to a Cobb-Douglas production.

$$Y_t = F(K_t, L_t)$$

Where

K is capital

L is labor in a (a labor-augmenting technology factor)

$$Y_t = F(K_t, L_t)$$

$$Y_t = L*F(K/L,1)$$

$$Y/L = F(K/L)$$

$$y=F(k)$$

From the assumption, production can be the real income for individual, so (y) is production/income /output per capita, k is capital per capita

Output per capita will equal to consumption per capita plus investment per capita as below.

$$\mathbf{y = i+c \quad .....(1)}$$

(c) is consumption per capita and (i) is investment per capita. Since saving is assumed to be equal to investment, so (i) = (s)

From Solow model, consumption is a proportion of income, s = marginal propensity to save.

$$\mathbf{c = (1-s)y \ .....(2)}$$

Take formula (2) in formula (1)

$$\mathbf{y = i+(1-s)y}$$

We can see saving per capita equal to investment per capita

$$\mathbf{i = sy}$$

For accumulate some capital, the capital stock per capita (k) is a constant rate, and is also has depreciation (d) to replace the erosion of capital stock.

The population is also a constant rate of growing (n)
To see the impact of investment, depreciation, and population growth on capital (change in capital) formula, so we have formula as below.

$$\mathbf{\Delta k = i - (n + d)\, k}$$

Where

Δk is change in capital

D is depreciation

Δk = sy − (n + d))k .....substituting for (i) gives us,

Production function (y) is a function of capital per capita

From

$$\mathbf{y= f(k)}$$

so Δk can be two models

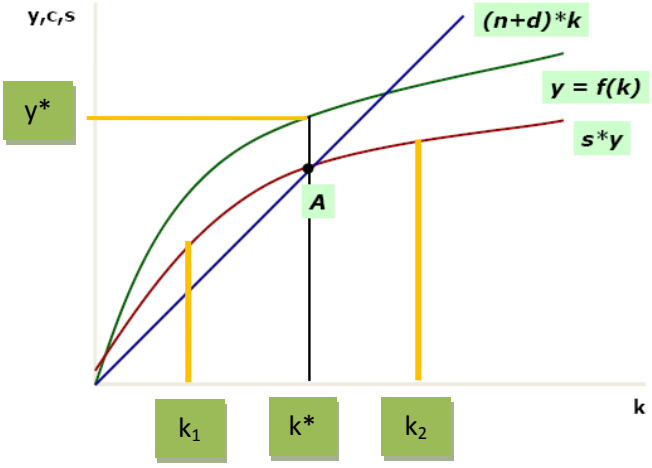
$$\mathbf{\Delta k = sy - (n + d))k} \qquad \text{Or} \qquad \mathbf{\Delta k = s\, f(k) - (n + d))k}$$

In steady state per capita capital will not change (k*) we can explain the level of k will always converge to the steady state level k*. The growth rate of per capita capital is equal to zero at the steady state.

$$\mathbf{s\, y = (n + d))k^*}$$

In steady state s y = (n + d))k at break-even point as we can see from the figure below

Figure 4



Picture from: http://faculty.haas.berkeley.edu/arose/Macro3.pdf
Andrew Rose, Global Macroeconomics 3

The capital stock has depreciation. If the investment or saving cannot compensate to that depreciation, the capital stock will decrease. At steady state (A) is the saving per capita s y is equal to investment per capita (n + d)) k. Capital per capita at break-even point is k*, and this point can determinant the output per capita at y*

If per capita capital less than k* at k_1, the saving per capita (sy) will greater than capital per capita. The saving surplus will change to be capital. Therefore, the capital

per capita will increase and reach steady state at k*. However, If capital per capita greater than k* at k_2, saving per capita will less than capital per capita. The capital will decrease, and the production per capita will also decrease and eventually meet the steady state at k*

However, the Solow's model is quite simplicity because there is only one goods, government is absent, closed economy, and ignorance of employment fluctuation. Moreover, at the steady state every key variables such as capital per capita, production per capita, and consumption per capita, are given as constant in the model.

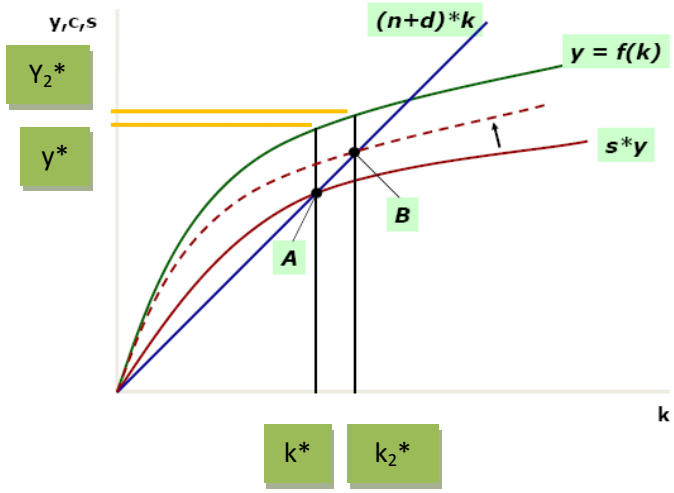
Determinants of long run living standard

Solow considered three variables that affect the long run living standard which are saving rate, population growth, and productivity growth or technology progress.

- **Saving rate rise:**

Solow model predict that the increasing in saving rate have an effect on the income per capita in the positive way. If saving increase, standard of living is also increase. From the figure below

Figure 5



At the steady state A is the equilibrium. When saving rate rise, the line of s*y also shift upward. The equilibrium will change from point A to be at point B, and the

Capital per capita will rise, the steady state move from k* to k_2*, and income/output per capita is also rise from y* to y_2*.

However, there are some skeptical to this effect.

First, this effect is a short run effect. It does not affect the rate of growth in long run.

Second, the changing in per capita income/output which derives from the increasing of saving is quite small.

Third, during transition of the increasing of saving rate has an impact on rate of growth in two characteristics which is in the different level of income, it is hard to know the length of the transitional duration. And we do not know whether this effect will have one-short or long live over of time.

Fourth, the saving rate may be very low and the backward of technology is too much until there is no equilibrium, so the income/output per capital has a tendency to decrease.

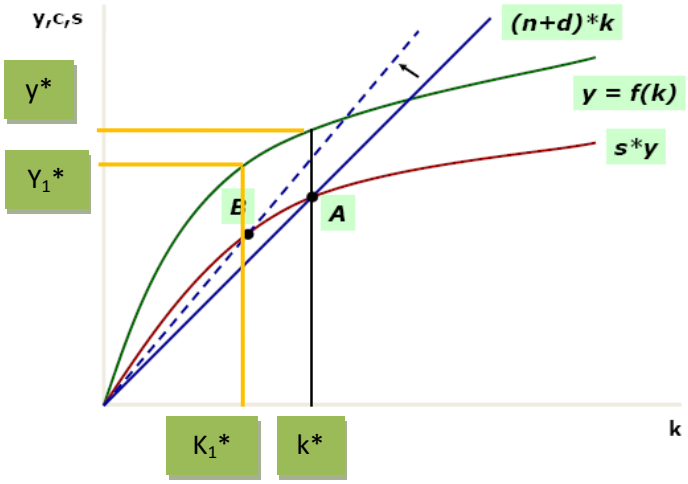
In summary, if the rate of saving increase, the steady state k* will also rises. The income/output per capita is higher; however, the growth rate of output will not grow in the same level as increasing of saving.

*Source: Cambridge journal of economics 1999,23,771-*793

- **Growth of population:**

If the population rise, the capital stock per capita line (n+d)*k will rotates up. The increasing of population (n) will decrease the capital per capita and income/output per capita. The rise in population is as same as the rise in depreciation in capital.

Figure 6



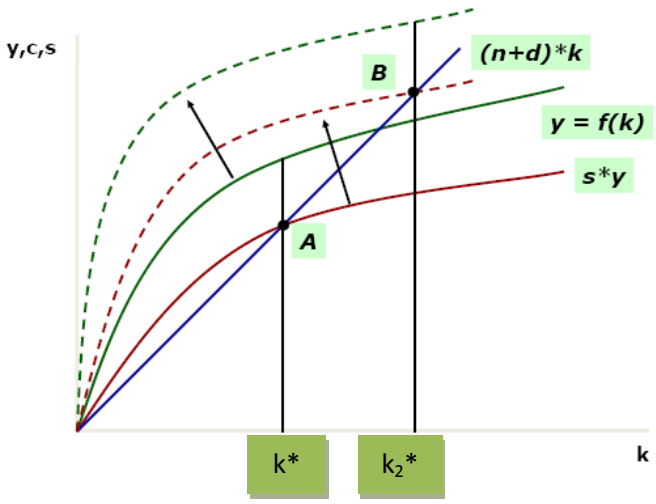
At the steady state, A is the equilibrium. When the population rise, the line of (n+d)*k rotates up. The equilibrium will change from point A to be at point B, and the Capital per capita will decrease, the steady state move from k* to k_1*. And income/output per capita is also decrease from y* to y_1*.

In order to keep stable of output per capita, investment should rise in the same level of population growth rate. It can state that investment should rise in order to compensate with depreciation and more distribute the output per capital to population.

- **Productivity growth or technology progress:**

The productivity growth can derive from the advance of technology or high potential of labor force. This will make the production function (f(k)) shift upward. It will create more output with same the amount of inputs.

Figure 7



The productivity growth can make change in two characteristics. First, production function (f(k)) shift upward. Second, the saving per capita shift upward also because saving per capita is depend on saving (s) and output per capita f(k).

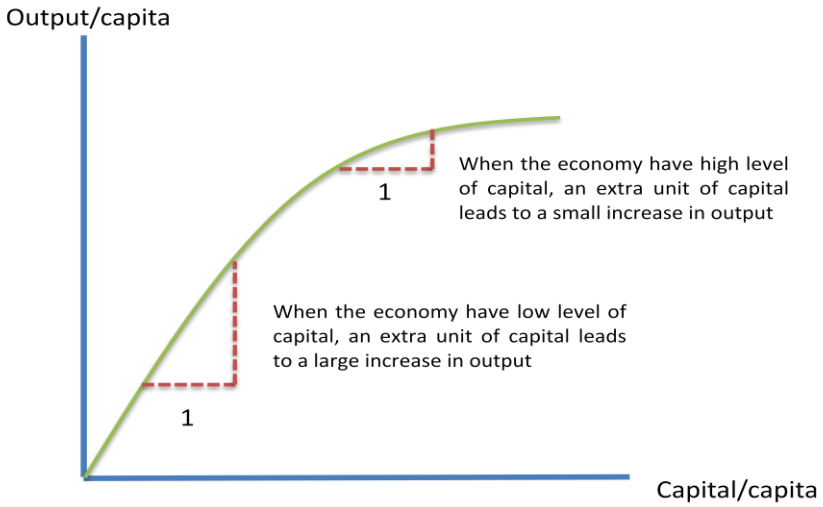
Form above figure, the equilibrium is at point A. When the productivity grows, the production function (f(k)) and the saving per capita (s*y) shift upward. The equilibrium point moves to point B. The steady state k* change to the steady state k_2, and the output per capita have a huge increasing. Therefore, the productivity improvement can rapid the economic growth and accelerate high standard of living.

2.2 Theory review on diminishing return and catching up effect theory

N Gregory Mankiw stated that if government policies stimulate the national saving rate, people will tend to save more and consume less, and this will create more resources available to make capital goods. Therefore, the capital stock will rise, causing growth in productivity and GDP. According to Solow model Diminishing returns, in the stage that economy has high level of capital; the rising of capital stock will only slightly increase their productivity. While, in the stage that economy has low level of capital, the rising of capital stock create a large productivity increasing slightly. As below figure

Figure 8: Illustrating the Production Function

This figure shows how the amount of capital per worker influences the amount of output per worker. Other determinants of output, including human capital, natural resources, and technology, are held constant. The curve becomes flatter as the amount of capital increases because of diminishing returns to capital.



According to diminishing returns, an increase in the saving leads to higher growth only for short period. The higher saving rate generates more accumulated capital which the benefits from additional capital are smaller over time, and the growth slows down because of diminishing return. Therefore, in the long run the higher saving rate can leads to a higher productivity/income level, but not to higher growth of productivity/income.

The diminishing return to capital can also relate catching up effect in the initial conditions on subsequent growth. The country which starts out relatively poor or low level of GDP can easily grow faster than the country which starts out relatively rich or high level of GPD. In poor countries, workers have little access to capital, so their productivity is often low. Increasing the amount of capital at their disposal by only a small amount can produce huge gains in productivity In the other hand, workers in rich countries or countries with lots of capital, and as a result higher levels of productivity, would enjoy a much smaller gain from a similar increase in capital. As the amount of capital is already high, the additional capital investment has a relatively slightly effect on productivity.

The catch-up effect concept

The catch-up effect, also called the theory of convergence, which states that the poorer economies tend to grow faster than the richer economies. Thus, all economies will eventually converge in terms of per capita output/income. The Developing countries have the potential to grow faster and catch-up to the developed countries by copying the factors of production, ideas and knowledge from the developed countries.

There are two fundamental reasons why less developed economies grow faster than rich ones, attribute to the standard growth theories

1) In the neoclassical theory, poorer countries may converge to rich ones because there are diminishing returns to capital. Because of diminishing returns to capital, poor countries – which have lower endowment of capital – accumulate greater physical or human capital and, in addition, capitals tend to flow towards these economies characterized by higher returns (Neo-classical convergence or capital deepening).

2) In the technology gap approach, a high absorption capability makes it easier for a poor country to catch up because the poor countries may adopt technologies and knowledge available in more advanced countries (this is call technological catch-up). These increase the opportunity for poor countries to grow faster than the rich countries through the adoption and implementation of technology.

To be precise, from the general conventions which state that catch-up effect means the poorer country's income will finally catch up to the richer countries. In theory, new technologies and borrowing efficient institutions may allow the economies of emerging countries to grow at a faster rate than industrialized countries' economies or even go beyond them, but the probability of this situation has become arguable as developed countries become increasingly modernized at fast paces. By the law of diminishing returns, if they manage to attain some capital for investment the returns on this investment might be enormous. A developed country is so technologically advanced that the return on investment of every unit of currency spent is radically lower than the return on investment in an undeveloped country because the poor

country is far behind in this diminishing returns path. This extra return allows poor countries to dramatically increase investment capital and raise efficiency until becoming to the law of diminishing returns and they are growing at the same speed as more advanced countries.

However, one of the reasons for this occurrence of divergence is because the poor countries mostly have little in the supply of technology and capita. Since they do not have the access to capital to invest or own the proper resources to improve their processes, they are trapped in this low-efficiency pattern. They can imitate the developed countries, but they will not be able to catch-up because of this limitation.

The Limitations of catch up effect is because the poor country does not assurance that catch-up growth will be achieved. Moses Abramovitz emphasised the need for "Social Capabilities" to benefit from catch-up growth. These include an ability to absorb new technology, attempt capital and participate in global markets. According to Abramovitz, these prerequisites must be in place in its economy before catch-up growth can occur, and explain why there is still have divergence situation in the world today.

To be more understanding, the theory also assumes that technology is freely traded and available to developing countries that are attempting to catch-up. Capital which is expensive and unavailable to these economies can also prevent catch-up growth from occurring, especially given that capital is insufficient in these countries. This often traps countries in a low-efficiency cycle whereby the most efficient technology is too expensive to be acquired. This may show an opportunity for developing countries are lagging behind to catch up developed countries. The differences in productivity techniques is what separates the leading developed countries from the following developed countries, but by a margin narrow enough to give the following countries an opportunity to catch-up. This process of catch-up continues as long as the followed countries have something to learn from the leading countries, and will only stop when the knowledge gap between the leading and following countries becomes very small and finally exhausted. However, this convergence does not

necessarily suggest that leading developed countries are losing their advantage over them.

In addition, the theory of converge applies mostly to those countries already categorized as developed countries because these countries already have and can maintain a stable economy as well as have the environment to utilize the new skills and techniques acquired from other countries. Therefore, the growth rates for developed economies show convergence because these countries have already established themselves and can capitalize on all possible opportunities. Nevertheless, the growth rates between developed countries and developing countries show divergence. While the growth rates for the developed countries are rather similar and close compared to one another, the growth rates for the less developed countries show some in explosive growth while others are in severe decline, emphasizing that the richest country is getting richer while the poorest country continues to become poorer in comparison.

Catching up test concept

Considering two countries: county i and county j, and denotes their log per capita real output as Y_i and Y_j. Catching-up implies the absence of a unit root in their difference $Y_i - Y_j$. Thus non-stationary in $Y_i - Y_j$ must violate the proposition although the occurrence of a non-zero time trend in the deterministic process in itself would not.

Catching-up differs from long-run convergence in that the latter relates to some particular period T equated with long-run equilibrium. The existence of a time trend in the stationary Y_i-Y_j series would imply a narrowing of log per capita output gap. This can say the countries though catching-up had not yet converged. This catching up could be oscillatory, but must imply non-divergence of output differences. On the other hand the absence of a time trend in the stationary series implies that catching-up has been completed. The process comes to convergence process.

Testing for catching-up hypothesis involves the first two stages of testing for convergence, i.e. rejection of a unit root and checking on the significance of the time

trend, but becomes an issue only if the time trend is significant. However, catching-up as a long run property of the model would be inconsistent with a constant, non-time varying, time trend as, asymptotically, a constant time-trend effect would always imply divergence. Therefore, catching-up characterized by stationary output differences and a constant time trend is relevant only for a particular finite T, and only on the basis that the countries have not already converged. Hence, checking for convergence would always be the first stage, which requires stationary output differences, followed by tests for catching-up. Stationary output differences would imply either convergence, catching-up or lag behind for all time periods. (Les Oxley, David Greasley)

2.3 Theory review on convergence hypothesis

Convergence Analysis: Neoclassical Approach

The main focus of growth study has been issue of convergence. The Solow model state the assumption of diminishing marginal returns to capital leads the growth process in an economy, and finally reach to the steady state where output per capita, capital stock per capita and consumption per capita grow at a common constant rate equaling the exogenously given rate of technological progress. This leads to the concept of convergence. The convergence hypothesis can be understood in two different ways as follows.

The first way is convergence in term of level of income. If countries are similar of technology and preferences, then the steady state income levels for them will be the same and with time they will tend to reach that level of income per capita

The second is in terms of the growth rates. According to Solow model, the steady state growth rate is determined by the exogenous rate of technological progress, therefore technology is a public good to be equally shared. All countries will finally attain the same steady state rate of growth.

The convergence hypothesis is one of a part in the neoclassical growth model particularly Solow model (1956). This hypothesis states that the poor country would tend to grow rapidly than the rich country, in order to narrow gap between the two countries. The model also predicts that if the two countries are exactly same except

for their initial income per capita, both of them would tend to end at the long run equilibrium. There are two types of Convergence hypothesis as below.

Type of convergence

1. **Unconditional convergence**
   - **Beta convergence**

If the initial income per capita of poor country is lower than the initial income per head of the rich country, then the poor country must grow faster than the rich country for both of two countries can achieve the common income per capita level (assuming same access to technology, same saving propensity and production, same population growth rate).

- **Absolute convergence**

If the initial income per capita of poor country is lower than the initial income per head of the rich country, then the poor country must grow faster than the rich country, and finally all countries are converging to the common steady state of income level.

2. **Conditional convergence**

On the other hand, these structural parameters differ across countries may not converge to the common level of income per head but to their own steady state level (long run potential of income level). Therefore, economies with lower levels of income per head (expressed relative to their steady state levels of per capita income) tend to grow rapidly. This convergence is called conditional convergence.

Convergence hypothesis test concept

To test the convergence hypothesis using dickey fuller test for the unit root with intercept and time trend.

$$\Delta (Y_{i,t} - Y_{j,t}) = \mu + \alpha (Y_{i,t-1} - Y_{j,t-1}) + \beta t + \sum_{k=1}^{n} \delta_t \Delta (Y_{i,t-k} - Y_{j,t-k}) + \varepsilon t$$

Where Yi,t indicates the logarithm of per capita output for country i,

$Y_{j,t}$ indicates the logarithm of per capita output for country j

The possibilities of convergence are as below.

If the difference between the output series contains a unit root, $\alpha = 0$, output per capita in the two economies would be divergence over time. Income disparity follows a random walk, and income per capita difference is unpredictable

- The absence of a unit root, $\alpha < 0$, the difference between the output series is stationary, can be indicated either catching-up, long-run convergence or lagging behind.
- The absence of a unit root, $\alpha < 0$, and $\beta < 0$ indicate the catching-up. The series $(y_{i,t} - y_{j,t})$ is stationary around a negative deterministic trend, i.e. there is a tendency for the difference in per capita income to narrow over time.
- The absence of a unit root, $\alpha < 0$, and $\beta = 0$ indicate the ***Long-run convergence.*** The series y_i and y_j are cointegrated, i.e. the diminishing in per capita income difference has ended and remain long run equilibrium or stable over time.
- The absence of a unit root, $\alpha < 0$, and $\beta > 0$ indicate the ***Lagging behind.*** There is a tendency for the difference in per capita income to lag behind over time.

CHAPTER THREE

LITERATURE REVIEW

3.1 Causal Relationship between savings and economic growth in countries with different income levels: Ramesh Mohan, 2006

This paper studies on the relationship between domestic saving and economic growth for many countries with different income levels. This paper addresses whether the causality of domestic saving and economic growth is different among low income, low middle income, upper middle income, and high income countries. This study examines 25 countries, including ten high income countries (HIC), and the rest most of it focused on developing countries which are five upper-middle income countries (UMC), five lower-middle income countries (LMC), and Low-income countries (LIC). The model they conduct by test of stationary (the ADF test), test for co-integration by Johansen method, and the granger causality test.

From test of stationary, the ADF test result that LogGDP and LogGDS are non-stationary for 22 out of the 25 countries. After take differenced series (DlogGDP and DlogGDS), the result appear to be stationary for both. However, three countries, namely Egypt, Malaysia, and the United States, one of the variables is non-stationary and the other one is stationary. So they need to be excluded from the analysis because it will lead the causality to misspecification problem.

Using the Johansen test to test for co-integration, the logGDP and the logGDS of 18 countries that were co-integrated, VEC model was use to estimated. However, in the four economies for which LogGDP and LogGDS were not co-integrated were estimated the Granger causality by using VAR model.

The result of the relationship between domestic saving and economic growth for with different income levels is indicate that for high income countries (HIC) the direction of causality run from economic growth rate to growth rate of saving. Except Singapore which is vice versa. It is because Singapore has the forced saving system.
In upper-middle income countries (UMC), the result indicates that there is bi-direction causality. The direction of causality runs from growth rate of saving to

economic growth rate in the same time it runs from economic growth rate to growth rate of saving. This can imply that these countries are in the transit time to reach the steady state as high income countries (HIC)

The empirical study for lower-middle income countries (LMC) also has the result similar to high income countries (HIC) which is the direction of causality run from economic growth rate to growth rate of saving. However, there is no causality between growth rate of saving and economic growth rate in Ecuador.

The empirical result in Low-income countries (LIC) suggest that some countries are bi- direction causality, in some countries the direction of causality run from growth rate of saving to economic growth rate, and some countries is run from economic growth rate to growth rate of saving. And India is no causality between two variables.

In conclusion, this paper based the result favor the causality relationship in term of causality run from economic growth rate to growth rate of saving. Moreover, they believe that the income class does play an important role for the causality direction.

3.2 Saving Dynamics in the Asian countries: Ahmad Zubaidi Baharumshah, Marwan A. Thanoon, Salim Rashid, 2002

This paper studies on the factor that influenced the saving behavior in Singapore, South Korea, Malaysia, Thailand, and Philippines with income, interest rate, dependency ration and foreign capital inflow. The study will examines, **first** the foreign savings obstruct domestic saving both in long run and short run. **Second**, use Granger causality test between saving and economic growth. **Third**, study the effect of interest rate on saving. **Fourth**, study the causality between foreign and domestic savings in long run, using vector error correction model (VECM), and Engle and Granger.

The empirical result of cointegration in five countries shows that there are stable relationship between savings and its determinants, saving, GNP, Dependency ratio, Interest rate, currency account.

The empirical result short run dynamics which conducted by an error correction model show that Singapore, South Korea, Malaysia, Thailand share a common determinants of saving and have a positive impact of economic growth on saving.

There are causality direction run from foreign saving to domestic saving, however, the causality of this two variable are weak all countries except Singapore. As for capital inflows and domestic savings in short are negatively in all countries except Thailand. But the result has totally different result in long run.

The study also suggests that there is no relationship between saving and economic growth which is different from the general perception that saving can cause economic growth.

The empirical study about interest rate can demonstrate that there is a positive direction in Singapore, South Korea, and Malaysia except Thailand which is negative relation.

3.3 Capital flows and saving in Latin America and Asia: A reinterpretation Reinhart, Carmen and Talvi, Ernesto University of Maryland, College Park, Department of Economics, 1998

This empirical study addresses the relationship between national saving and foreign saving in East Asia and Latin America including 24 countries.

Their study has approaches as follow: **First**, examine whether there are possible regional differences in household preferences, the constraints of liquidity, the smoothing of consumption, the saving rates' determinants, and the policy which response to capital inflows; **Second,** narrow down in comparison between East Asia and Latin American; **Third**, analyze the relationship between domestic and foreign saving in the context of the individual country level.
The empirical study suggest that the difference in saving behavior during the period of capital inflow flow to countries in 1990s for Asia and Latin America is not show to have short run relationship.

None of the evidence show that Asia and Latin America considerably different; that the occurrence of liquidity constraints is obviously different across regions; that the economic policy response to the capital inflow during year 1990s was constantly different in Asia more than in Latin America; or that the capital inflows and domestic saving have positively correlated direction in Asia and negatively correlated direction in Latin America. Moreover, domestic saving and foreign saving are opposite relationship, and both region, Asia and Latin America, have similarity correlation. In addition, the cyclical elements of domestic saving and foreign saving demonstrate a significant degree of co-movement across regions.

3.4 Convergence in GDP per capita and real wages: Some results for Australia and the UK; Les Oxley, David Greasley, 1997

They consider to what extent convergence exists for Australia and the UK using both data for GDP per capita and real wages. They gave the assumption which is close trade, immigration and educational links between these two countries, and test whether any evidence of convergence exists or not. This paper used time-series unit root-based tests to consider the convergence in GDP per capita and real wages between Australia and the United Kingdom, during the period 1870-1992. Investigating pairwise GDP per capita convergence between Australia and the United Kingdom should shed light on Britain-Australia economic relations and on the convergence hypothesis more generally.

This section reports tests for long-run convergence, and catching-up. On the basis of the results in Table 1, for the 1870-1992 periods, Eq. (1), neither version of the convergence hypothesis receives support, since a unit root cannot be rejected in the cross-country differences in GDP per capita. But the Eq. (2), Table 1 reinforces these results, showing that for the period 1892-1992 the unit-root hypothesis is rejected. The results show that Australia and the UK appear to have attained long-run convergence. These results lend support to exogenous, Solow growth model strategy.

Table 1
Unit root tests. Differences in GDP per capita (without discontinuities)

Countries	Sample	ADF [a]	LM (SC)	Q6
UK-Australia	1870–1992	−3.250	0.792	4.029
UK-Australia	1892–1992	−5.531 *	0.309	7.969

* Significant at the 5% level, based on MacKinnon [12].
[a] ADF denotes ADF(4).

As for the results of differences in real wages between Australia and the UK for the longer period, 1855-1988, shows that the unit hypothesis is rejected. However, the significant time-trend effect now favors the weaker notion of catching-up, rather than convergence.

However, consider whether British and Australian wages are cointegrated shows that British and Australian real wages are individually integrated, of order 1, I(1). The results report of implementing the Johansen [10], cointegration approach, shows that they are co-integrated, strengthening the notion that real wages will eventually converge, once the process of catching-up has been completed.

In conclusion, The empirical test of this paper's statistical findings lies in the support found for the convergence hypothesis deployed a time-series perspective. The rejection of a unit root for UK-Australian GDP per capita and UK-Australian real-wages series result, support for the convergence hypothesis, when applied to GDP per capita and catching-up in the case of real wages.

3.5 Income convergence: the Dickey-Fuller test under the simultaneous presence of stochastic and deterministic trends; Manuel G´omez and Daniel Ventosa-Santaul`aria, 2007

The article is organized by: lists the relevant Data Generating Processes (DGP) included in τ -convergence literature. And analyzes the asymptotic efficiency of the DF test in estimating both the sign and estimated of the parameter associated with the determinist trend.

	Interpretation	Representation
1	Divergence	$y_t = y_{t-1} + u_{yt}$
2	Convergence	$y_t = \mu_y + u_{yt}$
3	Catching-up or Lagging-behind*	$y_t = \mu_y + \beta_y \cdot t + u_{yt}$
4	Loose Catching-up or Loose Lagging-behind**	$y_t = Y_0 + \mu_y \cdot t + \sum_{i=1}^{t} u_{yi}$

* Catching-up: where $\beta_y < 0$ and Lagging-behind: where $\beta_y > 0$.
** Loose Catching-up: where $\mu_y < 0$ and Loose Lagging-behind: where $\mu_y > 0$.
The process u_{yt} satisfies the conditions stated by Phillip's(1986) lemma, p.369 with variance σ_y^2, long-run variance λ^2, and autocovariances ρ_{yi} for $i = 1, 2, \ldots$

Eq(1) is associated with divergence, i.e. the case where the logarithmic difference in per capita income between two economies follows a random walk; Eq(2) is interpreted as convergence: the series under analysis is mean stationary; Eq(3) is related to the systematic narrowing (widening) of the per capita income gap if the sign of the deterministic trend estimator is negative or positive, which is catching-up or lagging-behind respectively. Eq(4), this process represents a weaker notion of catching-up or lagging-behind. Indeed, loose catching-up or loose lagging-behind suggests that the poorer economy is erratically, though inexorably catching up or lagging behind if the sign of the deterministic trend estimator is negative or positive respectively.

The standard methodology to test for convergence using time-series is the DF framework. In this case, the relevant auxiliary regression includes a constant and a deterministic trend, as in the equation follow.

$$\Delta y_t \quad = \quad \alpha + \delta y_{t-1} + \beta T + U_t$$

The various possible outcomes that result from this test are shown in table below.

δ	β	Process
$= 0$	$= 0$	Divergence
< 0	$= 0$	Convergence
< 0	< 0	Catching-up
< 0	> 0	Lagging-behind
$= 0$	< 0	Loose Catching-up
$= 0$	> 0	Loose Lagging-behind

If the regression contains unit root, we would tend to conclude that two economies are diverging when in fact they are, though somewhat sluggishly, catching up or lagging behind. This is a serious mistake given that loose catching-up (loose lagging-

behind) is in fact asymptotically equal to catching-up (lagging-behind). While it's economic significance is entirely different from divergence.

The Monte Carlo experiment suggests that the large number of evidence of divergence in this literature may be due to the fact that this test fails to differentiate between divergence and loose catching-up or loose lagging-behind.

The lack of empirical support for the convergence hypothesis may be cause from two reasons:

1) The failure of previous studies to give due importance to the case where the difference in per capita income contains both a determinist and a stochastic trend— the situation defined in this study as loose catching-up or loose lagging-behind

2) The poor performance of the DF test when analyzing series with this characteristic. These circumstances may have led practitioners to erroneously conclude that two economies are diverging when they are, in fact, catching up or lagging behind, though somewhat wearily.

We are aware that current empirical studies make extensive use of more sophisticated tests procedures that allow for the possible existence of structural breaks. Their results, indicating rejection of the convergence hypothesis, should also be taken with caution because the shortcomings of the DF may likewise be applicable to these tests.

CHAPTER FOUR

ECONOMETRIC FRAMEWORK

4.1 Definition of variable

GGS_t : Gross domestic saving per capita growth rate

Definition of gross domestic saving*: Gross domestic savings are calculated as Gross domestic product (GDP) minus consumption by government and the private sector (total consumption). Per capita figures expressed per 1 population. A high gross domestic saving rate usually indicates a country's high potential to invest. (Source; World bank)*

$GGDP_t$: Gross domestic product (GDP) per capita growth rate

Definition of Gross domestic product; the value of all final goods and services produced in a country in one year (see also gross national product). GDP can be measured by adding up all of an economy's incomes- wages, interest, profits, and rents- or expenditures- consumption, investment, government purchases, and net exports (exports minus imports). Both results should be the same because one person's expenditure is always another person's income, so the sum of all incomes must equal the sum of all expenditures. Per capita figures expressed per 1 population (Source; World bank)

GAP_t : The different of logarithm of GDP per capita between two countries

Definition of GAP: differences between countries' logarithm of GDP per capita over time. Consider the notion of catching-up. In particular, two countries i and j are catching-up (but not yet converged), if yi – yj does not contain a unit root. Nonstationarity in yi – yj must violate this definition, although the occurrence of a nonzero time trend in the deterministic process would not. (Source; A Nordic convergence club, LES OXLEY and DAVID GREASLEY)

$$GAP_t = GDP_{D,t} - GDP_{T,t}$$

Where

$GDP_{D,t}$	:	the logarithm of developed countries' GDP per capita
$GDP_{S,t}$	:	the logarithm of Singapore's GDP per capita
$GDP_{USA,t}$	:	the logarithm of Unite States' GDP per capita
$GDP_{UK,t}$	:	the logarithm of Unite Kingdom's GDP per capita
$GDP_{T,t}$	:	the logarithm of Thailand's GDP per capita

4.2 Model specification

Test for stationary of GDP per capita growth rate and Gross domestic saving per capita growth rate
(Unit root test: The Augmented Dickey–Fuller (ADF) Test)

The first step of the testing procedure is to determine whether the data contain unit roots indicating the data is non-stationary or not. The test was being use is the augmented Dickey–Fuller (ADF) test which has developed from Dickey and Fuller. This test is use for checking whether variable X_t (GDP growth rate, Gross Saving growth rate) have unit root or not. If parameter α is equal to Zero, it mean variable X_t contain unit root which mean the data is non stationary.

$$H_0: \alpha = 0$$
$$H_1: \alpha < 0$$

Regressions in the ADF test:

X_t is a random walk: $\Delta X_t = \alpha X_{t-1} + \sum_{k=1}^{n} \delta_k \Delta X_{t-k} + \varepsilon_t$

X_t is a random walk with drift: $\Delta X_t = \mu + \alpha X_{t-1} + \sum_{k=1}^{n} \delta_k \Delta X_{t-k} + \varepsilon_t$

X_t is a random walk with drift around a stochastic trend:

$$\Delta Xt = \mu + \beta t + \alpha Xt\text{-}1 + \sum_{k=1}^{n} \delta k \Delta Xt\text{-}k + \varepsilon t$$

Where

X_t	is GDP growth rate, Gross Saving growth rate.
	$\Delta X_t = (X_t - X_{t-1})$
$\mu, \beta, \alpha, \delta$	is parameter

ε_t is a pure white noise error term

Use the Akaike Information Criterion and Schwarz Information criterion to define the lag length n for $\sum_{k=1}^{n} X_{t-k}$, By doing so, the maximum lag length of ten (10) was chosen to run regression. And the lag length with the lowest AIC and SIC values would be select.

MODEL 1

Test for causality (Granger Causality)

To consider the objective question in previous state: Is it GDP growth rate that "causes" the gross saving growth rate (GGDP → GGS) or is it the gross saving growth rate that causes GDP growth rate (GGS →GGDP). Where the direction of causality that arrow points to. The Granger causality test assumes that the information relevant to the prediction of the respective variables, GGDP and GGS, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions

$GGS_t = b_0 + b_1 GGDP_t + e_t$

And

$GGDP_t = B_0 + B_1 GGS_t + E_t$

Where

GGS t : gross domestic saving per capita growth rate

GGDP t : GDP per capita growth rate

et, Et : Error term

bo, b1, Bo, B1 : Parameter

The F- statistics calculated from below formula is a test for causality effects.

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)}$$

MODEL 2

Test for convergence hypothesis
(Unit root test: The Augmented Dickey–Fuller (ADF) Test)

To test convergence hypothesis, we follow the Augmented Dickey Fuller test base of the different in log GDP per capita between Singapore, USA, UK and Thailand to determine the convergence process in Thailand.

The equation is as follow.

$\Delta GAP_t = \mu + \alpha GAP_{t-1} + \beta t + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \varepsilon_t$

Where

$GAP_t = GDP_{D,t} - GDP_{T,t}$

Where

$\boldsymbol{GDP_{D,t}}$	:	the logarithm of developed countries' GDP per capita
$\boldsymbol{GDP_{S,t}}$	:	the logarithm of Singapore's GDP per capita
$\boldsymbol{GDP_{USA,t}}$	:	the logarithm of Unite States' GDP per capita
$\boldsymbol{GDP_{UK,t}}$	:	the logarithm of Unite Kingdom's GDP per capita
$\boldsymbol{GDP_{T,t}}$	:	the logarithm of Thailand's GDP per capita

Use the Akaike Information Criterion and Schwarz Information criterion to define the lag length n for $\sum_{k=1}^{n} X_{t-k}$, By doing so, the maximum lag length of ten (10) was chosen to run regression. And the lag length with the lowest AIC and SIC values would be select.

Form Convergence hypothesis hold for both countries, where the GAP or different between the logarithm of GDP for developed countries and Thailand must not have unit root. If the difference between the output series contains a unit root, $\alpha = 0$, non-stationary, the output per capita in the two economies could be either diverge, Loose Catching-up or Loose Lagging-behind. On the other hand, the absence of a unit root, $\alpha < 0$, indicates either catching-up, convergence, or Lagging-behind. To interpret the result, let's consider the result presented below.

α	β	Process
=0	=0	Divergence
<0	=0	Convergence
<0	<0	Catching-up
<0	>0	Lagging-behind
=0	<0	Loose Catching-up
=0	>0	Loose Lagging-behind

Manuel G´omez and Daniel Ventosa-Santaul`ari

MODEL 3

Test OLS: Ordinary least square

In order to examine the correlation of domestic saving rate and the gap of GDP per capita whether the changing of domestic saving rate is help perform as a main variable to catching up or narrowing the gap between Thailand and Singapore or not, we use OLS method to help explain the correlation.

$$\Delta GAP_t = \mu + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \gamma GGS_t + \varepsilon_t$$

Where

$$GAP_t = GDP_{S,t} - GDP_{T,t}$$

GDP$_{S,t}$: the logarithm of Singapore's GDP per capita

GDP$_{T,t}$: the logarithm of Thailand's GDP per capita

GGS$_t$: the gross domestic saving per capita growth rate

If the t-stat of GGS (gross saving per capita growth rate) generate the significant result, it can imply that growth rate of gross domestics saving does play a role to create GDP per capital growth rate to catching up or support convergence of the different of GDP per capita between Thailand and Singapore.

CHAPTER FIVE

EMPIRICAL RESULTS: ANALYSIS

5.1 MODEL 1

: Test for causality

The hypothesis which stated in the introduction part of this study would test the direction of causality between economic growth and savings for case study of Thailand. The Augmented Dickey–Fuller (ADF) test used to indicate whether both GDP per capita growth rate (GGDP) and gross domestic saving per capita growth rate (GGS) have unit roots in the level data. If the unit roots present, the data show nonstationay. Thus, the variables need to be differenced in order for the series to be stationary. Without differencing the data, a causality test would lead to misspecification. Granger causality was tested to determine the relationship between growth rate of saving and economic growth.

Econometric Procedures

Test for stationary (Unit root test: The Augmented Dickey–Fuller (ADF) Test)

Regressions in the ADF test: test X_t with a random walk with drift around a stochastic trend:

$$\Delta X_t = \mu + \beta_t + \alpha X_{t-1} + \sum_{k=1}^{n} \delta_k \Delta X_{t-k} + \varepsilon_t$$

Null hypothesis H_0 : there is unit root $\alpha = 0$

H_1 : there is no unit root $\alpha < 0$

X_t is GDP per capita growth rate, Gross domestic saving per capita growth rate.

$$\Delta X_t = (X_t - X_{t-1})$$

μ, β, α, δ is parameter

εt is a pure white noise error term

5.1.1 Test for stationary of GDP per capita growth rate

To test the Augmented Dickey–Fuller (ADF) Test at order of integration equal to 0 or I(0), the lag lengths need to be determined. Using AIC and SIC methods for specifying the lag length. The results of lag length are present below.

Table 5.1.1: the result of AIC and SIC value for GDP per capita growth rate

Lag length	AIC value	SIC value
0	-1.923059***	-1.807234***
1	-1.905293	-1.749360
2	-1.884242	-1.687417
3	-1.824514	-1.585996
4	-1.776832	-1.495796
5	-1.726224	-1.401826
6	-1.680456	-1.311832
7	-1.627900	-1.214169
8	-1.679868	-1.220129
9	-1.672755	-1.166091
10	-1.659150	-1.104629

**** indicate lowest AIC and SIC value*

According to the rule of thumb for choosing the appropriate lag length, the lag with the smallest AIC and SIC value should be chosen. From the table above, the lag with the smallest AIC and SIC value is lag 1 which contain the -1.923059 of AIC value and -1.807234 of SIC value. Hence using lag lengths at 0 in the Augmented-Dickey Fuller (ADF) test. The result of the ADF test is presented below

Select lag length at 0

The result of the Augmented Dickey–Fuller (ADF) Test: a random walk with drift around a stochastic trend

$$\Delta GGPD_t = \mu + \beta_t + \alpha GGPD_{t-1} + \varepsilon_t$$

$GGPD_t$ is GDP per capita growth rate

Null hypothesis	H_0 : there is unit root	$\alpha = 0$
	H_1 : there is no unit root	$\alpha < 0$

Dependent Variable = D(GGPD)

Regressors	Co-efficient	Std Error	t-stat
Constant	0.051487	0.028997	1.775601
$GGDP_{t-1}$	-0.568535	0.134682	-4.221305***
β_t	-0.000275	0.000913	-0.300627

*** *denotes statistically significant at 5% level of significance*

**Data from 1961-2010.*

The critical value provided at 5% level of significant is -3.504330. And the computed tua value is -4.221305. The ADF test states if the computed tua value is more negative than the critical value or the absolute of computed tua value is more positive than the absolute of the critical value. From this test, the computed tua value is more negative than the 5% critical value, so we reject the null hypothesis of unit root. This is meant that the data of GDP per capita Growth rate this stationary.

5.1.2 Test for stationary gross domestic saving per capita growth rate

Table 5.1.2: The result of AIC and SIC value for gross domestic saving per capita growth rate

Lag length	AIC value	SIC value
0	-1.134735***	-1.018909***
1	-1.070191	-0.914258
3	-1.004497	-0.807673
4	-0.971297	-0.690260
5	-1.043485	-0.719087

6	-1.051190	-0.682567
7	-1.011878	-0.598147
8	-1.089733	-0.629994
9	-1.102557	-0.685893
10	-1.130686	-0.585165

**** indicate lowest AIC and SIC value*

According to the rule of thumb for choosing the appropriate lag length, the lag with the smallest AIC and SIC value should be chosen. From the table above, the lag with the smallest AIC and SIC value is lag 0 which contain the AIC value of -1.134735 and SIC value of -1.018909. Hence using lag lengths at 0 in the Augmented-Dickey Fuller (ADF) test. The result of the ADF test was demonstrated as follow.

Select lag length at 0

The result of the Augmented Dickey–Fuller (ADF) Test: a random walk with drift around a stochastic trend

$$\Delta GGS_t = \mu + \beta t + \alpha GGS_{t-1} + \varepsilon_t$$

GGS_t is gross domestic saving per capita growth rate

Null hypothesis	H_0 : there is unit root	$\alpha = 0$
	H_1 : there is no unit root	$\alpha < 0$

Dependent Variable = D (GGS)

Regressors	Co-efficient	Std Error	t-stat
Constant	0.102065	0.043146	2.365572
GGS_{t-1}	-0.821579	0.146006	-5.627016***
βt	-0.001013	0.001364	-0.742644

**** denotes statistically significant at 5% level of significance*

**Data from 1961-2010*

The critical value provided at 5% level of significant is -3.504330. The computed tua value is -5.627016 which is more negative than the 5% critical value. Therefore, reject the null hypothesis of unit root. This is meant that the data of gross saving growth rate is stationary.

5.1.3 Granger Causality Test

According to the purpose of this thesis in the introduction part is to examine the relationship between gross domestic savings rate and economic growth rate. This study will investigate whether the direction of causality is from savings lead to economic growth or vice versa during period of 1960-2010, using *Granger Causality test*.

From two regressions

$$GGS_t = b_0 + b_1 GGDP_t + e_t$$

And

$$GGDP_t = B_0 + B_1 GGS_t + E_t$$

Where

GGS_t	:	gross domestic saving per capita growth rate
$GGDP_t$	:	GDP per capita growth rate
e_t, E_t	:	Error term
b_0, b_1, B_0, B_1	:	Parameter

The causality result between growth rate of GDP per capita and growth rate of gross domestic saving per capita can be shown as below.

Table 5.1.3 the result for Granger Causality test

Direction of causality	*P*	F value	Prob.	Decision
GGDP does not Granger Cause GGS	1	4.18290	0.0466***	Reject
GGS does not Granger Cause GGDP	1	0.01494	0.9033	Do not reject

****Indicates significant at the 5 percent level; p is the lag length, which was selected by AIC, for the causality model.*

These results suggest that the direction of causality is from GDP per capita growth rate to Gross domestic saving per capita growth rate since the estimated F is significant at the 5 % level of significant; Reject the null hypothesis that GGDP does not Granger Cause GGS. On the other hand, there is no “reverse causation” from Gross domestic saving per capita growth rate to GDP per capita growth rate, because the F value is statistically insignificant.

To answer the objective of determining whether the direction of causality in Thai economy is from savings lead to economic growth or vice versa. The empirical result above suggests that the direction is only come from economic growth rate does play an important role to Granger causes growth rate of savings. This can be concluded that Thailand tends to have higher level of income (GDP) first in order to generate higher rate of domestic saving.

Discussion of the Results: Granger Causality

The absence of any relationship from domestic saving to economic growth appears to be at odd with the popular perception that higher saving causes economic growth and raised an important issue regarding the appropriateness of using domestic saving as a target variable for economic progress. Nevertheless, this piece of evidence is consistent with that found in the study of Ramesh Mohan, *CAUSAL RELATIONSHIP BETWEEN SAVINGS AND ECONOMIC GROWTH IN COUNTRIES WITH DIFFERENT INCOME LEVELS*, which also report the empirical study that the direction of Granger Causality in Thailand, lower-middle income country, are from economic growth rate to growth rate of savings.

From the result that domestic saving does not granger cause to economic growth in Thailand was supported by the information which was stated in the introduction part about the problem from high gap of internal saving and investment. Before economic crisis time, during year 1987-1996, Thailand did not have enough national saving to serve for demand of investment. Even though national savings as a percentage of GDP in the 1987 rose from 27.5 % to 34.3 % in1996, it was still insufficient to be a source of finance domestic investment, which higher from 27.9 % in 1987 to 41.8 % in 1996. There was a large gap of saving and investment of 7.5 percent of GDP in

1996. (Source*: 9th APEC FINANCEMINISTERS´ PROCESS*) Therefore, there were a lot external saving come to absorb the insufficiency of internal saving. From the combining of internal and external saving could help to create investments which lead to economic growth in Thailand.

Moreover GDP growth in Thailand did not occur mainly from saving only, but it grew by other reasons such as foreign direct investment (FDI). Before crisis time, Thailand has a huge increasing amount of foreign direct investment, start from year 1987 to 1998 as in the figure below. Foreign direct investments could bring technology progress and technological innovation into the country which might be a factor to create economic growth for Thailand. In summary from many factors which create investment in Thailand can be the reasons to make economic growth even internal saving is little. Thus, this is the reason why the empirical result suggests that domestic saving does not granger cause to economic growth in Thailand.

Figure 9: Foreign direct investments in Thailand

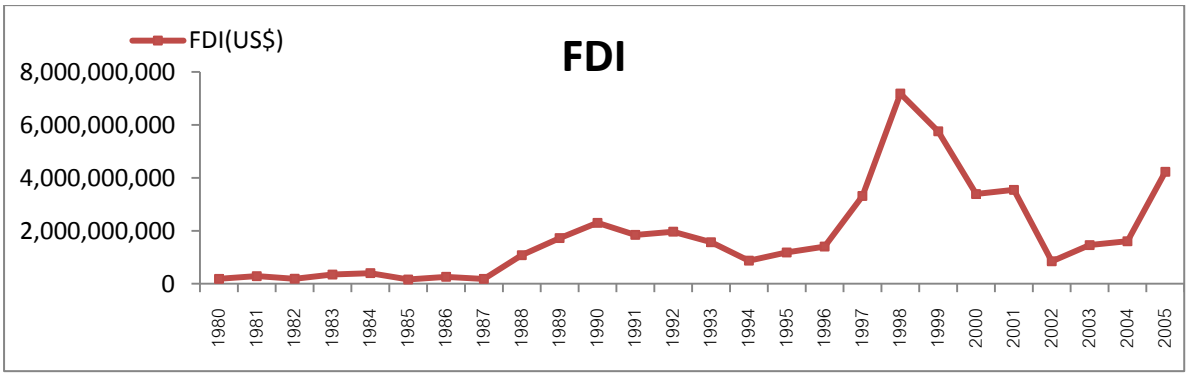


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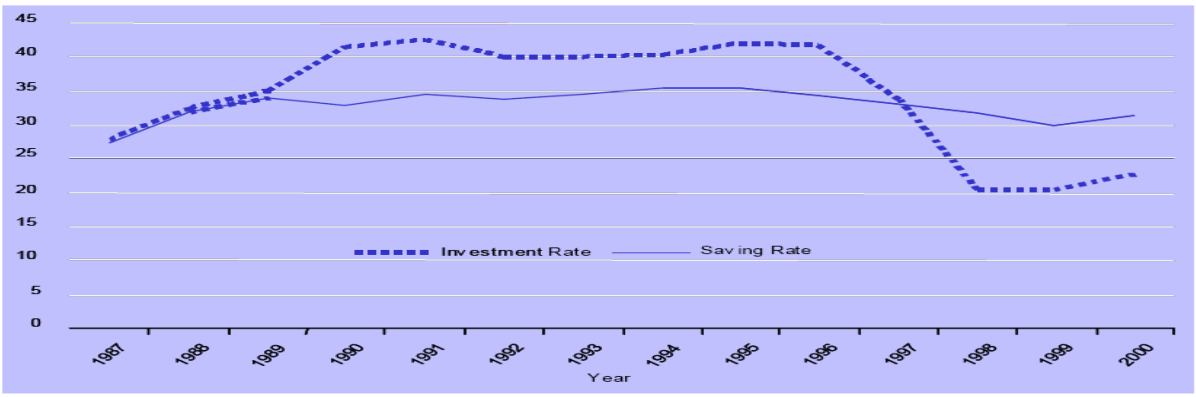
Figure 10: Investment and saving rate



(Source: 9th APEC FINANCEMINISTERS´ PROCESS)

In addition, to explain the link running from GDP to saving in Thailand, I relied on the work of John Maynard Keynes, Absolute Income Hypothesis as following statement. Back to after the financial crisis in mid 1997, the GDP per capital tended to decreased, and saving rate in Thailand also declined largely from around 34-35 % of GDP to around 30-31 % of GDP due to falling income and stagnant economy. (Source: 9th APEC FINANCEMINISTERS´ PROCESS). This situation can be explain by the marginal propensity to save theory which states that saving is a function of income, and in the positive direction. Therefore, after crisis in Thailand income has decreased, people would tend to decrease in their consumption and their saving. From the situation after financial crisis in Thailand can help explain why GDP per capita cause Granger Causality to saving per capita.

For all these situation stated above, we can say that in the case study of Thailand the rate of GDP tend to lead to the rate of domestic saving rather than the changing of domestic saving cause the changing in GDP.

5.2 MODEL 2

: Test for convergence hypothesis (Unit root test: The Augmented Dickey–Fuller (ADF) Test)

The catching up and convergence hypothesis in previous chapter states that the lagging country, with low productivity levels and initial income, will tend to grow more fast by copying the technology of the leader country, without having to bear the associated costs of research and development. Given the important of income or GDP per capita of two countries, developed and developing countries in Asia, this paper is to examine whether or not Thailand is catching up with developed countries such as Singapore, USA, and UK by using convergence hypothesis.

A strategic testing:

Testing for convergence involves a two-stage process. The first stage is check for the existence of a unit root in the difference between income (GDP) per capita in the two countries. The non-rejection of a unit root implies non-stationary, and

rejection of a unit root implies stationary. Second the non-rejection of the time-series property implies of the convergence hypothesis. In summary, the convergence criteria requirement is the rejection of the unit root hypothesis and the significant time-trend effects are absent.

Econometric Procedures

5.2.1 The result of convergence hypothesis: Pairwise Thailand and Singapore

$$\Delta GAP_t = \mu + \alpha GAP_{t-1} + \beta t + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \varepsilon_t$$

Where

$$GAP_t = GDP_{D,t} - GDP_{T,t}$$

Where

$GDP_{D,t}$	:	the logarithm of developed countries' GDP per capita
$GDP_{S,t}$	:	the logarithm of Singapore's GDP per capita
$GDP_{USA,t}$	:	the logarithm of Unite States' GDP per capita
$GDP_{UK,t}$	:	the logarithm of Unite Kingdom GDP per capita
$GDP_{T,t}$	:	the logarithm of Thailand's GDP per capita

To test the Augmented Dickey–Fuller (ADF) Test at order of integration equal to or I(0), the lag lengths need to be determined. Using AIC and SIC methods for specifying the lag length. The results of lag length are present below.

Table 5.2.1.1: The result of AIC and SIC value for GAP

Lag length	AIC value	SIC value
0	-3.369044***	-3.234365***
1	-3.536996	-3.353779
2	-3.621254	-3.434428
3	-3.509574	-3.271680
4	-3.711429	-3.421099
5	-3.712380	-3.368781

6	-3.765439	-3.368697
7	-3.847358	-3.399278
8	-4.012077	-3.517426
9	-4.143028	-3.603890
10	-4.174886	-3.595444

**** indicate selected lag length which was selected by AIC and SIC value from Eview program*

According to the rule of thumb for choosing the appropriate lag length, the lag with the smallest AIC and SIC value should be chosen. From the result above, the lag with the smallest of AIC value is lag 10 which contain the AIC value of -4.174886, however, the smallest of SIC value is lag 9 which contain the SIC value of -3.603890. Hence we use the best lag lengths selected from the Eview program which is the lag length at 0 in the Augmented-Dickey Fuller (ADF) test. The result of the ADF test was demonstrated as follow.

Select lag length at 0 at order of integration equal to 0 or I(0)

Table 5.2.1.2: The result of the Augmented Dickey–Fuller (ADF) Test with I(0): a random walk with drift around a stochastic trend

$$\Delta GAP_t = \mu + \alpha GAP_{t-1} + \beta t + \varepsilon_t$$

Null hypothesis H_0 : there is unit root $\alpha = 0$

H_1 : there is no unit root $\alpha < 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat
Constant	0.533739	0.145312	3.673053
GAP_{t-1}	-0.265383	0.080396	-3.300929**
βt	0.001614	0.001347	1.198799

*** denotes statistically significant at 10% level of significance*

**Data from 1970-2010, exclude 1997-2001 in order to avoid shock from Asian economic crisis.*

**During 1997-2001, GDP per capita of Thailand face with the decreasing far behind from year 1996 and fluctuating from Asian economic crisis, so we exclude five years off.*

Select lag length at 0 at order of integration equal to 1 or I(1)

Table 5.2.1.2: The result of the Augmented Dickey–Fuller (ADF) Test with I(1): a random walk with drift around a stochastic trend

Null hypothesis	H_0 : there is unit root	$\alpha = 0$
	H_1 : there is no unit root	$\alpha < 0$

Dependent Variable = D(GAP, 2)

Regressors	Co-efficient	Std Error	t-stat
Constant	0.019805	0.017643	1.122542
$D(GAP_{t-1})$	-0.581108	0.157432	-3.691175***
βt	-0.000792	0.000771	-1.027392

**** denotes statistically significant at 5 % level of significance*

From order of integration equal to 0 or I(0), the critical value provided at 5% level of significant is -3.548490. If the computed tua value is more negative than the critical value or absolute of computed tua value is more positive than absolute of the critical value, we reject the null hypothesis of unit root. From the result above, the absolute of computed tua value which is 3.300929 less than the absolute term of 5% critical value (3.548490), so we accept the null hypothesis at 5% level of significant. Therefore, Thailand and Singapore is divergence process over time, since it is contain unit root.

According to the order of integration equal to 1 or I(1), the critical value provided at 5% level of significant is -3.557759. The computed tua value is -3.691175, so we reject the null hypothesis at 5% levels of significant. This is meant that the different of logarithm GDP per capita between Singapore and Thailand is stationary at 5% level of significant in the integration equal to 1 or I(1)

The existing of the unit root are support the divergence process. This can be indicated the concepts of divergence, loose catching-up and loose lagging-behind process.

According to the Manuel G´omez and Daniel Ventosa-Santaul`ari study, if the co-efficient of deterministic time trend is equal to zero, it can indicate there is a Divergence process. If the co-efficient of deterministic time trend less than zero, it can indicate that is a Loose Catching-up process. And, if the co-efficient of deterministic time trend more than zero, it can indicate that is a loose lagging-behind process.

Due to the Augmented Dickey–Fuller (ADF) Test use the method to interpret hypothesis by using tua-value table. There is no method to interpret significant of value of deterministic time trend, so we could apply tua value table to help interpret the significant of value of deterministic time trend as well. From the value of deterministic time trend's co-efficient is 0.001614, and the t-stat is equal to 1.198799, the critical value provided at 5% level of significant is -3.548490. This indicates that the deterministic time trend is statistically insignificant, and accept the null hypothesis that deterministic time trend's coefficient equal to zero. This implies that Thailand is in the process of divergence to Singapore in term of growth in GDP per capita.

The result reveals that Thailand is in the process of divergence to Singapore in term of growth in GDP per capita, divergence process occurred over the 1970-2010 periods, with exclude 5 years associated with the Asian crisis presented in Asia. Because, in the Asian crisis period indicate inconsistency of GDP per capita over time. Thus, the Asian financial crisis period should be excluded from the empirical data. Moreover, the process of divergence of the growth in GDP per capita between both countries could be supported by the figure of GDP per capita below. This figure demonstrate that trend of GDP per capital of Thailand are so far behind GDP per capita of Singapore which is hard to become to the process of convergence or catching up.

Figure11: Gap of logarithm of GDP per capita between Thailand and Singapore

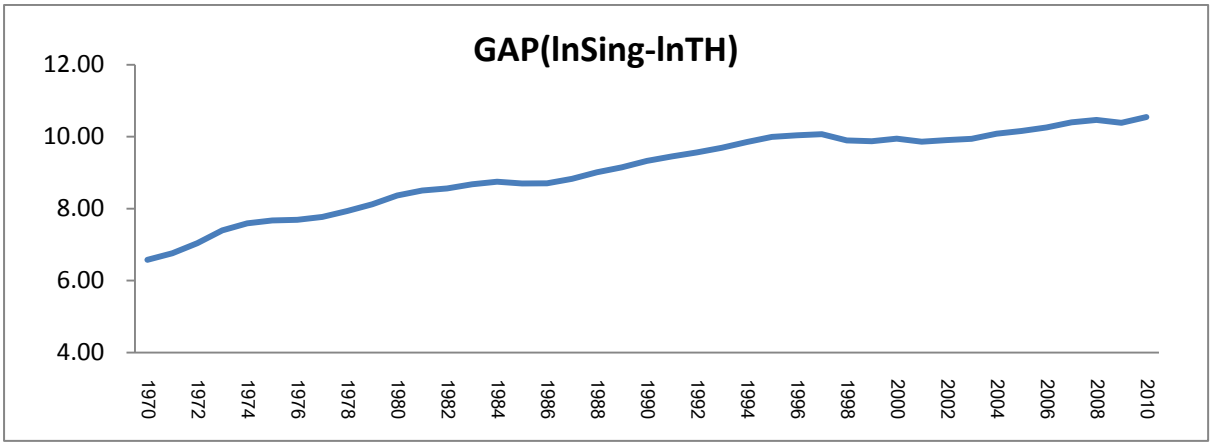
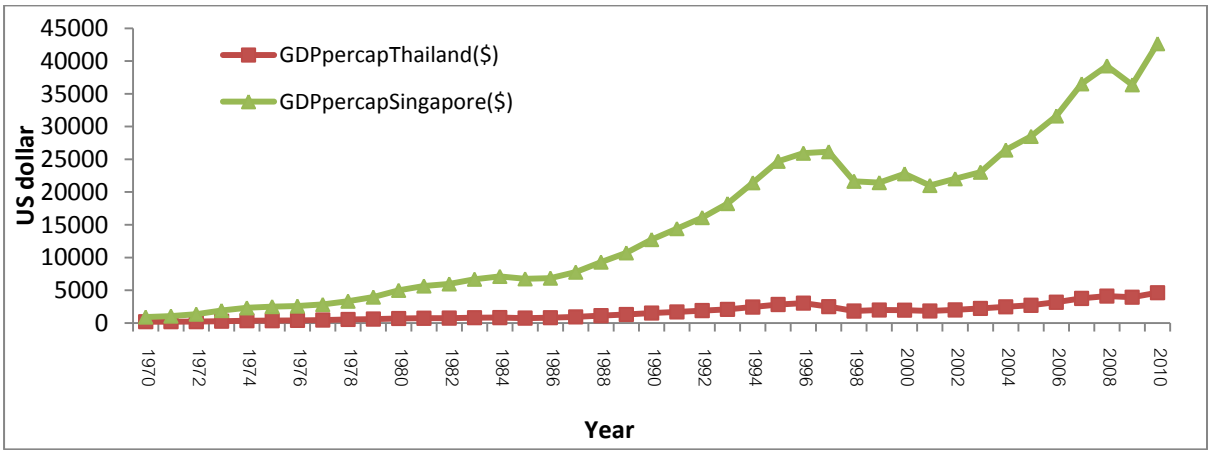


Figure12: Trend of GDP per capita of Thailand and Singapore



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The result demonstrate that Thailand is in the process of divergence to Singapore over period of time, so in order to examine more convergence hypothesis evidence, we need to investigate more about pairwise GDP per capita convergence between Thailand and other countries whether they are can shed light on Thailand economics relations and the convergence hypothesis is exist or not. Therefore, I select United States of America to be a representative of the continent of America and select United Kingdom to be a representative of the continent of Europe.

5.2.2 The result of convergence hypothesis: Pairwise Thailand and United State

Select lag length at 10 at order of integration equal to 0 or I(0) *(Lag length was chosen from Eview program)*

Table 5.2.2: The result of the Augmented Dickey–Fuller (ADF) Test of GAP Thailand and United States: a random walk with drift around a stochastic trend

$$\Delta GAP_t = \mu + \alpha GAP_{t-1} + \beta t + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \varepsilon_t$$

Null hypothesis H_0 : there is unit root $\alpha = 0$

H_1 : there is no unit root $\alpha < 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat
Constant	9.022375	3.389097	2.662177
GAP_{t-1}	-2.682974	1.017080	-2.637918
$D(GAP_{t-1})$	2.439002	0.712118	3.424998
$D(GAP_{t-2})$	1.906356	1.006507	1.894032
$D(GAP_{t-3})$	1.850793	0.775324	2.387122
$D(GAP_{t-4})$	1.927718	0.685115	2.813713
$D(GAP_{t-5})$	1.366063	0.855426	1.596938
$D(GAP_{t-6})$	1.558610	0.503276	3.096927
$D(GAP_{t-7})$	1.243567	0.721782	1.722913
$D(GAP_{t-8})$	1.119585	0.534174	2.095920
$D(GAP_{t-9})$	0.912442	0.366189	2.491726
$D(GAP_{t-10})$	0.549953	0.457054	1.203257
βt	-0.060968	0.020840	-2.925591

*** denotes statistically significant at 10% level of significance*

**Data from 1970-2010, exclude 1997-2001 in order to avoid shock from Asian economic crisis.*

**During 1997-2001, GDP per capita of Thailand face with the decreasing far behind from year 1996 and fluctuating from Asian economic crisis, so we exclude five years off.*

From order of integration equal to 0 or I(0), the critical value provided at 5% level of significant is -3.733200. If the computed tua value is more negative than the critical value or absolute of computed tua value is more positive than absolute of the critical value, reject the null hypothesis of unit root. From the result above, the absolute of computed tua value which is -2.637918. This absolute term (2.637918) less than the absolute term of 5% critical value (3.733200), so we accept the null hypothesis at 5% level of significant. Therefore, Thailand and United States is, since is contain unit root and divergence process over time

5.2.3 The result of convergence hypothesis: Pairwise Thailand and United Kingdom

Select lag length at 0 at order of integration equal to 0 or I(0) *(Lag length was chosen from Eview program)*

Table 5.2.3: The result of the Augmented Dickey–Fuller (ADF) Test of GAP Thailand and United Kingdom: a random walk with drift around a stochastic trend

$$\Delta GAP_t = \mu + \alpha GAP_{t-1} + \beta t + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \varepsilon_t$$

Null hypothesis	H_0 : there is unit root	$\alpha = 0$
	H_1 : there is no unit root	$\alpha < 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat
Constant	0.388199	0.269835	1.438652
GAP_{t-1}	-0.157081	0.111283	-1.411545
$D(GAP_{t-1})$	0.406112	0.201301	2.017434
βt	-0.001788	0.001556	-1.149257

*** denotes statistically significant at 10% level of significance*

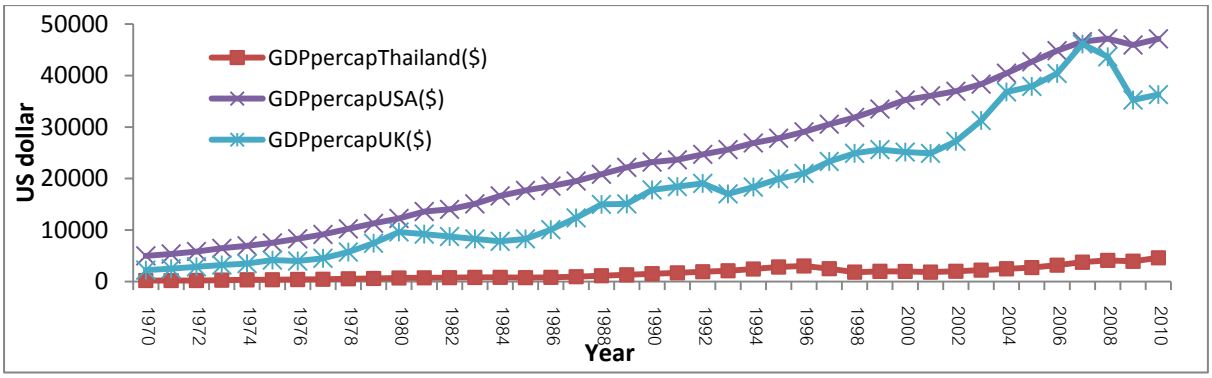
**Data from 1970-2010, exclude 1997-2001 in order to avoid shock from Asian economic crisis.*

**During 1997-2001, GDP per capita of Thailand face with the decreasing far behind from year 1996 and fluctuating from Asian economic crisis, so it exclude five years off.*

From order of integration equal to 0 or I(0), the critical value provided at 5% level of significant is -3.557759. If the computed tua value is more negative than the critical

value or absolute of computed tua value is more positive than absolute of the critical value, we reject the null hypothesis of unit root. From the result above, the absolute of computed tua value which is -1.411545. This absolute term (1.411545) less than the absolute term of 5% critical value (3.557759), so we accept the null hypothesis at 5% level of significant. Therefore, Thailand and United Kingdom is divergence process over time, since it is contain unit root. The figure below also demonstrate that trend of GDP per capital of Thailand are so far behind GDP per capita of USA and UK which indicate the process of convergence is hard to perform.

Figure 13: Trend of GDP per capita of Thailand and Unit states and Unite Kingdom



Discussion of the Results: Convergence hypothesis

From all the empirical results of pairwise between Thailand and Singapore, Thailand and United States, Thailand and United Kingdom, none of the computed tua-value demonstrate more negative than the critical value at 5% level of significant, so we accept the null hypothesis of unit root. We can say Thailand and Singapore, Thailand and United States, and Thailand and United Kingdom are in the process of divergence over time, since they contain of unit root which could not prove for convergence hypothesis. Therefore, such results seem to suggest that convergence hypothesis would not to hold for the Thailand - Singapore, Thailand - United States, and Thailand - United Kingdom

According to the theory of catching up effect, Moses Abramovitz emphasized the reason why developing countries such as Thailand is in the process of divergence is maybe because of the limitation from ability to absorb new technology, attract capital

and participate in global markets. Also the Developing countries face with the limited supply of technology and capital. They can mimic the developed countries, but they will not be able to catch-up because of these limitation. Thus, these reasons seem to explain why the convergence hypothesis would not to hold for the Thailand.

5.3 MODEL 3

: Test for OLS (ordinary least squares)

From the conventional perception about the relationship between saving and economic growth, we cannot refuse against that once aggregate saving might be enhance investment opportunities and generate economic growth in the countries, however, the result of Granger Causality report that economic growth rate does matter lead to growth rate of domestic savings in Thailand. But domestic savings doesn't play any role to cause economic growth. Therefore, to prove the correlation of gross domestic saving per capita growth rate and the GDP per capita growth rate, we examine whether gross domestic saving per capita growth rate can help narrow the different of GDP between two countries concerned.

Deployed OLS method to help explain the correlation, the regression model would be the different of logarithm of GDP per capita are treated as the dependent variable for the models, and it is expected to be determined by the following explanatory variables which is different of lag of GDP per capita and very vital explanatory variable which is gross domestic saving per capita growth rate. This regression would mainly focus on proving whether the changing of gross domestic saving per capita growth rate help catching up or closing gap of GDP per capita between Thailand and Singapore.

The regression models which are used to observe are as below

$$\Delta GAP_t = \mu + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \gamma GGS_t + \varepsilon_t$$

Where

$$GAP_t = GDP_{S,t} - GDP_{T,t}$$

Where

$GDP_{S,t}$	:	the logarithm of Singapore's GDP per capita
$GDP_{T,t}$	:	the logarithm of Thailand's GDP per capita
GGS_t	:	the gross domestic saving growth rate
t	:	deterministic time trend

The Hypothesis of the Study

GGS (the gross domestic saving growth rate):

The higher gross domestic saving rate should help country growth in economy which leads to help closing GAP of GDP per capita between both countries concerned. Thus, it is expected that GGS has a negative impact on the different of GDP per capita.

Econometric Procedures

Due to the different of GAP of GDP between two countries, exclude five years during financial crisis off. Thus before using OLS methods we need to check about stationary of gross domestic saving growth rate variable which exclude five years off again.

5.3.1 Test for stationary of GGS_t with exclude 5 years (1997-2001)

Table 5.3.1 Unit root test of GGS: The Augmented Dickey–Fuller (ADF) Test) at I(0)

Lag	Without Trend & intercept	5% critical value	Prob.	With intercept	5% critical value	Prob.	With Trend & intercept	5% critical value	Prob.
0	-3.220	-1.951	0.0021*	-6.296	-2.951	0.000*	-6.193	-3.548	0.0001*
1	-1.931	-1.951	0.0522	-4.726	-2.957	0.0006*	-4.613	-3.558	0.0044*
2	-1.548	-1.952	0.1124	-5.105	-2.963	0.0003*	-4.958	-3.568	0.0020*
3	-1.068	-1.953	0.2510	-2.786	-2.972	0.0732	-2.808	-3.580	0.2060

The Dickey Fuller test states that if the computed tua value is more negative or the absolute of computed tua value is more positive than the critical value, we reject the null hypothesis of unit root. From the test of stationary unit root test the Growth of

gross domestic saving at order of integration equal to or I(0) is stationary in the level of Without Trend & intercept at lag 0, With intercept at lag 0 1 2, and With Trend & intercept at lag 0 1 2 . We can conclude that gross saving growth rate is stationary at order of integration equal to or I(0).

5.3.2 Test for ordinary least squares (OLS)

Table 5.3.2.1: Ordinary least squares at lag length 0.

$$\Delta GAP_t = \mu + \gamma GGS_t + \varepsilon_t$$

Dependent Variable = D (GGS)

Null hypothesis $H_0 : \mu, \gamma = 0$

$H_1 : \mu, \gamma \neq 0$

Regressors	Co-efficient	Std Error	t-stat	p-value
Constant	0.017882	0.014599	1.224878	0.2296
GGS_t	-0.044127	0.087071	-0.506790	0.6158

**** denotes statistically significant at 5% level of significance*

*** denotes statistically significant at 10% level of significance*

**Data from 1970-2010, exclude 1997-2005 in order to avoid shock from Asian economic crisis.*

R square = 0.007962, Adjusted R square = -0.023039

The R-square value is 0.007962 which means that 00.79 percent of the different of Gap GDP per capita between Singapore and Thailand was explained by gross saving growth rate.

From μ : P-value = 0.2296. Therefore this test is statistically insignificant, we accept that μ is equal to zero.

From γ: P-value = 0.6158. Therefore this test is statistically insignificant, we accept that γ is equal to zero. The coefficient of GGS_t is -0.044127 and negative as expected.

In conclusion there is no relationship between the different of Gap of GDP per capita and gross domestic saving growth rate, that is, the coefficient $\gamma = 0$

Table 5.3.2.2: Ordinary least squares at lag length 1.

$$\Delta GAP_t = \mu + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \gamma GGS + \varepsilon_t$$

Null hypothesis $H_0 : \mu, \delta, \gamma = 0$

$H_1 : \mu, \delta, \gamma \neq 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat	P value
Constant	0.008285	0.011719	0.706959	0.4852
$D(GAP_{t-1})$	0.509266	0.138732	3.670866	0.0010
GGS_t	-0.037720	0.068903	-0.547436	0.5883

**** denotes statistically significant at 5% level of significance*

*** denotes statistically significant at 10% level of significance*

**Data from 1970-2010, exclude 1997-2005 in order to avoid shock from Asian economic crisis.*

R square = 0.317466, Adjusted R square = 0.270395

To interpret the regression above, the R-square value is 0.317466 which means that 31.75 percent of the different of Gap GDP per capita between Singapore and Thailand was explained by $D(GAP_{t-1})$, and gross saving growth rate.

From μ : P-value = 0.4852 Therefore this test is statistically insignificant, we accept that μ is equal to zero.

From δ_1: P-value = 0.0010. Therefore this test is statistically significant at 10% level of significance, we reject that δ_1 is equal to zero.

$D(GAP_{t-1})$ has an impact on ΔGAP_t. If $D(GAP_{t-1})$ changes by a unit, so ΔGAP_t changes on average 0.509266 units in the same direction.

From γ: P-value = 0.5883. Therefore this test is statistically insignificant, we accept that γ is equal to zero. The coefficient of GGS_t is -0.037720 and negative as expected.

There is no relationship between the different of Gap GDP per capita and gross domestic saving per capita growth rate, since they are insignificant. We accept the hypothesis that the coefficient $\gamma = 0$

Table 5.3.2.3: Ordinary least squares at lag length 2.

$$\Delta GAP_t = \mu + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \gamma GGS + \varepsilon_t$$

Null hypothesis $H_0 : \mu, \delta, \gamma = 0$

$H_1 : \mu, \delta, \gamma \neq 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat	P value
Constant	0.001133	0.011164	0.101450	0.9200
$D(GAP_{t-1})$	0.417679	0.174129	2.398670	0.0239
$D(GAP_{t-2})$	-0.026958	0.155054	-0.173863	0.8633
GGS	-0.009007	0.064446	-0.139768	0.8899

**** denotes statistically significant at 5% level of significance*

*** denotes statistically significant at 10% level of significance*

**Data from 1970-2010, exclude 1997-2005 in order to avoid shock from Asian economic crisis.*

R square = 0.231260, Adjusted R square = 0.142560

From the regression above, the R-square value of about 0.231260means that 23.13 percent of the different of Gap GDP per capita between Singapore and Thailand is explained by $D(GAP_{t-1})$, $D(GAP_{t-2})$ and gross saving growth rate.

From μ : P-value = 0.9200 Therefore this test is statistically insignificant, we accept that μ is equal to zero.

From δ_1: P-value = 0.0239. Therefore this test is statistically significant at 5% level of significant, we reject that δ_1 is equal to zero.

$D(GAP_{t-1})$ has an impact on ΔGAP_t. If $D(GAP_{t-1})$ changes by a unit, so ΔGAP_t changes on average 0.417679 units in the same direction.

From δ_2: P-value = 0.8633. Therefore this test is statistically insignificant; we accept that δ_2 is equal to zero.

From γ: P-value = 0.8899. Therefore this test is statistically insignificant, we accept that γ is equal to zero. The coefficient of GGS_t is -0.009007 and negative as expected.

There is no relationship between the different of gap GDP per capita and $D(GAP_{t-2})$, and gross domestic saving per capita growth rate, since they are insignificant. We accept the hypothesis that the coefficient $\delta_2 , \gamma = 0$

Table 5.3.2.4: Ordinary least squares at lag length 3

$$\Delta GAP_t = \mu + \sum_{K=1}^{n} \delta_k \Delta GAP_{t-k} + \gamma GGS + \varepsilon_t$$

Null hypothesis $H_0 : \mu, \delta, \gamma = 0$

$H_1 : \mu, \delta, \gamma \neq 0$

Dependent Variable = D(GAP)

Regressors	Co-efficient	Std Error	t-stat	P value
Constant	0.011149	0.013146	0.848109	0.4051
$D(GAP_{t-1})$	0.379835	0.201920	1.881117	0.0727
$D(GAP_{t-2})$	-0.052877	0.197211	-0.268125	0.7910
$D(GAP_{t-3})$	-0.096043	0.158161	-0.607250	0.5496
GGS	-0.068910	0.079184	-0.870254	0.3932

**** denotes statistically significant at 5% level of significance*

*** denotes statistically significant at 10% level of significance*

R square = 0.180774, Adjusted R square = 0.038300

From the regression above, the R-square value of about 0.180774 means that 18.0774 percent of the different of gap GDP per capita between Singapore and Thailand is explained by $D(GAP_{t-1})$, $D(GAP_{t-2})$, $D(GAP_{t-3})$ and gross saving growth rate.

From μ : P-value = 0.4051 Therefore this test is statistically insignificant, we accept that μ is equal to zero.

From δ_1: P-value = 0.0727. Therefore this test is statistically insignificant, we accept that δ_1 is equal to zero.

From δ_2: P-value = 0.7910. Therefore this test is statistically insignificant, we accept that δ_2 is equal to zero.

From δ_3: P-value = 0.5496. Therefore this test is statistically insignificant; we accept that δ_3 is equal to zero.

From γ: P-value = 0.3932. Therefore this test is statistically insignificant, we accept that γ is equal to zero. The coefficient of GGS_t is -0.068910 and negative as expected.

There is no relationship between the different of gap GDP per capita and some of $D(GAP_{t-1})$,$D(GAP_{t-2})$, $D(GAP_{t-3})$ and gross domestic saving per capita growth rate, since they are all statistically insignificant. We accept the hypothesis that the coefficient $\delta_1, \delta_2, \delta_3, \gamma = 0$

Discussion of the Results: **Ordinary least squares**

According to the all of the test results above which suggest that gross saving growth rate does not have any impact on $\Delta\ GAP_t$ or does not help to catch up or narrow gap between Thailand and Singapore.

Also this result was supported by the empirical test, granger causality, in model 1 which indicated that the growth rate of GDP per capital is help lead to growth rate of gross domestics saving. However, growth rate of gross domestics saving does not play any role to create growth of GDP per capital. In conclusion the independent variable, gross domestic saving growth rate, does not perform as a main factor to help Thailand growth catching up Singapore economy. We can say gross domestic saving rate does not help support convergence hypothesis as if would not help enhance economic growth of Thailand.

CHAPTER SIX

SUMMARY AND RECOMMENDATION

6.1 Summary

Saving is one of the main factors to economic growth, once saving help create investment, production, employment, and finally enhance economic growth. Countries which have high rate of national saving are not mainly depend on foreign direct investment or external saving which create chance of risk from unstable currency.

Therefore the primary propose of this paper, "The relationship between domestic saving and economic growth and convergence hypothesis: case study of Thailand", has focused on the investigation the causality relationship between the domestic saving and economic growth of Thailand. Using time series annual data from 1960 to 2010, Granger causality test were conducted. The main objective was to determine whether the direction of causality go from domestic saving to economic growth, or vice versa. Also examine whether convergence hypothesis does hold in Thailand by selecting pairwise between Thailand-Singapore, Thailand-United States, Thailand-United Kingdom, deployed data from 1970 to 2010, and the Augmented Dickey–Fuller (ADF) Test. Finally, this paper also proved whether saving does help support convergence hypothesis for Thailand or not. This test deployed the OSL methods to investigate correlation between gross domestic saving growth rate and the different of GDP per capita between Thailand and Singapore whether domestic saving growth rate help narrow the range of different of income from two countries (Thailand-Singapore)

The main finding of this study suggested below

- In summary, based on the empirical result of Granger causality test the study favor the hypothesis which suggests that the causality is from economic growth rate to growth rate of domestic saving in Thailand only. However, the gross domestic saving growth does not Granger Cause GDP per capita growth. The result of the empirical test clearly point toward a positive impact of economic growth to saving or it can say that income of the country does play an important role to lead the saving in the country for case study of Thailand.

- The empirical results of pairwise between Thailand and Singapore, Thailand and United States, Thailand and United Kingdom, all the result contain unit root. This can conclude that three pairwise are in the process of divergence over time, and could not prove for convergence hypothesis. Therefore, the main conclusion of these studies is that convergence hypothesis would not to hold for the Thailand - Singapore, Thailand - United States, and Thailand - United Kingdom. The long run convergence has not been achieved and Thailand is not even in the process of catching up to three developed countries.

- Due to objective to prove the correlation of gross domestic saving per capita growth rate and the GDP per capita growth rate, the investigation suggest that gross domestic saving per capita growth rate does not help to narrow the different of GDP between two countries concerned. Or we can say that the domestic saving rate would not hold or support convergence hypothesis in Thailand. This result was supported by the granger causality which indicated that domestic saving does not play any role to enhance economic growth in Thailand.

6.2 Recommendation

- More research should be dedicated to the empirical studies of convergence hypothesis. There are not many researches in convergence hypothesis especially based on Thailand.
- The data using in the annually data. If we conduct the study by using the quarterly data, the empirical result would be more exactly.
- The other main factors such as FDI or external saving which state in causality empirical part might be perform as the main variables of economic growth. Of course this is beyond the scope of this paper, but this is open another agenda for future research.

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APPENDIX

MODEL 1

Test for stationary (Unit root test: The Augmented Dickey–Fuller (ADF) Test)

GDP per capita growth rate of Thailand

Null Hypothesis: GGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.221305	0.0084
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GGDP)
Method: Least Squares
Date: 05/03/11 Time: 17:48
Sample (adjusted): 1962 2010
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GGDP(-1)	-0.568535	0.134682	-4.221305	0.0001
C	0.051487	0.028997	1.775601	0.0824
@TREND(1961)	-0.000275	0.000913	-0.300627	0.7651

R-squared	0.279615	Mean dependent var	0.002041
Adjusted R-squared	0.248293	S.D. dependent var	0.103581
S.E. of regression	0.089806	Akaike info criterion	-1.923059
Sum squared resid	0.370996	Schwarz criterion	-1.807234
Log likelihood	50.11496	Hannan-Quinn criter.	-1.879115
F-statistic	8.927352	Durbin-Watson stat	1.772975
Prob(F-statistic)	0.000530		

Gross domestic saving per capita growth rate of Thailand

Null Hypothesis: GGS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.627016	0.0001

Test critical values:	1% level	-4.156734
	5% level	-3.504330
	10% level	-3.181826

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GGS)
Method: Least Squares
Date: 05/03/11 Time: 17:50
Sample (adjusted): 1962 2010
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GGS(-1)	-0.821579	0.146006	-5.627016	0.0000
C	0.102065	0.043146	2.365572	0.0223
@TREND(1961)	-0.001013	0.001364	-0.742644	0.4615

R-squared	0.407985	Mean dependent var	0.000612
Adjusted R-squared	0.382245	S.D. dependent var	0.169465
S.E. of regression	0.133195	Akaike info criterion	-1.134735
Sum squared resid	0.816082	Schwarz criterion	-1.018909
Log likelihood	30.80100	Hannan-Quinn criter.	-1.090791
F-statistic	15.85036	Durbin-Watson stat	1.985143
Prob(F-statistic)	0.000006		

The result of causality (Granger Causality)

Pairwise Granger Causality Tests
Date: 05/03/11 Time: 18:04
Sample: 1961 2010
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
GGDP does not Granger Cause GGS	49	4.18290	0.0466
GGS does not Granger Cause GGDP		0.01494	0.9033

MODEL 2

The result of convergence hypothesis (Unit root test: The Augmented Dickey–Fuller (ADF) Test)

Thailand and Singapore

Select lag length at 0 at order of integration equal to 0 or I(0)

Null Hypothesis: GAP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.300929	0.0832
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GAP)
Method: Least Squares
Date: 05/04/11 Time: 20:06
Sample (adjusted): 1971 2010
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GAP(-1)	-0.265383	0.080396	-3.300929	0.0024
C	0.533739	0.145312	3.673053	0.0009
@TREND(1970)	0.001614	0.001347	1.198799	0.2397

R-squared	0.443483	Mean dependent var	0.012353
Adjusted R-squared	0.407579	S.D. dependent var	0.055925
S.E. of regression	0.043045	Akaike info criterion	-3.369044
Sum squared resid	0.057439	Schwarz criterion	-3.234365
Log likelihood	60.27374	Hannan-Quinn criter.	-3.323114
F-statistic	12.35182	Durbin-Watson stat	1.109802
Prob(F-statistic)	0.000113		

Select lag length at 0 at order of integration equal to 1 or I(1)

Null Hypothesis: D(GAP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.691175	0.0376
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GAP,2)
Method: Least Squares
Date: 05/04/11 Time: 20:08
Sample (adjusted): 1972 2010

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GAP(-1))	-0.581108	0.157432	-3.691175	0.0009
C	0.019805	0.017643	1.122542	0.2708
@TREND(1970)	-0.000792	0.000771	-1.027392	0.3127

R-squared	0.334095	Mean dependent var	-0.003437
Adjusted R-squared	0.288170	S.D. dependent var	0.051281
S.E. of regression	0.043266	Akaike info criterion	-3.353851
Sum squared resid	0.054286	Schwarz criterion	-3.216438
Log likelihood	56.66161	Hannan-Quinn criter.	-3.308302
F-statistic	7.274876	Durbin-Watson stat	1.894602
Prob(F-statistic)	0.002751		

Thailand and United State

Null Hypothesis: GAPUSA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.637918	0.2705
Test critical values:	1% level	-4.667883	
	5% level	-3.733200	
	10% level	-3.310349	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GAPUSA)
Method: Least Squares
Date: 05/06/11 Time: 05:04
Sample (adjusted): 1981 1996
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GAPUSA(-1)	-2.682974	1.017080	-2.637918	0.0778
D(GAPUSA(-1))	2.439002	0.712118	3.424998	0.0417
D(GAPUSA(-2))	1.906356	1.006507	1.894032	0.1545
D(GAPUSA(-3))	1.850793	0.775324	2.387122	0.0970
D(GAPUSA(-4))	1.927718	0.685115	2.813713	0.0671
D(GAPUSA(-5))	1.366063	0.855426	1.596938	0.2086
D(GAPUSA(-6))	1.558610	0.503276	3.096927	0.0534
D(GAPUSA(-7))	1.243567	0.721782	1.722913	0.1834
D(GAPUSA(-8))	1.119585	0.534174	2.095920	0.1271
D(GAPUSA(-9))	0.912442	0.366189	2.491726	0.0883
D(GAPUSA(-10))	0.549953	0.457054	1.203257	0.3152
C	9.022375	3.389097	2.662177	0.0762
@TREND(1970)	-0.060968	0.020840	-2.925591	0.0612

R-squared	0.938643	Mean dependent var	-0.038125
Adjusted R-squared	0.693216	S.D. dependent var	0.079012

S.E. of regression	0.043763	Akaike info criterion	-3.469019
Sum squared resid	0.005746	Schwarz criterion	-2.841291
Log likelihood	40.75216	Hannan-Quinn criter.	-3.436875
F-statistic	3.824532	Durbin-Watson stat	2.125555
Prob(F-statistic)	0.148209		

Thailand and United Kingdom

Null Hypothesis: GAPUK has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.411545	0.8381
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GAPUK)
Method: Least Squares
Date: 05/06/11 Time: 05:15
Sample (adjusted): 1972 2010
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GAPUK(-1)	-0.157081	0.111283	-1.411545	0.1691
D(GAPUK(-1))	0.406112	0.201301	2.017434	0.0533
C	0.388199	0.269835	1.438652	0.1613
@TREND(1970)	-0.001788	0.001556	-1.149257	0.2602

R-squared	0.219831	Mean dependent var	-0.037187
Adjusted R-squared	0.136242	S.D. dependent var	0.102587
S.E. of regression	0.095343	Akaike info criterion	-1.746205
Sum squared resid	0.254528	Schwarz criterion	-1.562988
Log likelihood	31.93927	Hannan-Quinn criter.	-1.685473
F-statistic	2.629888	Durbin-Watson stat	2.115665
Prob(F-statistic)	0.069681		

MODEL 3

Test OLS: Ordinary least square

Test the lag length at lag 0. The formula would be as below.

Dependent Variable: D(GAP)
Method: Least Squares
Date: 05/06/11 Time: 06:21

Sample (adjusted): 1971 2010
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.017882	0.014599	1.224878	0.2296
GGS	-0.044127	0.087071	-0.506790	0.6158

R-squared	0.007962	Mean dependent var	0.012353
Adjusted R-squared	-0.023039	S.D. dependent var	0.055925
S.E. of regression	0.056566	Akaike info criterion	-2.849803
Sum squared resid	0.102390	Schwarz criterion	-2.760017
Log likelihood	50.44665	Hannan-Quinn criter.	-2.819183
F-statistic	0.256836	Durbin-Watson stat	0.805618
Prob(F-statistic)	0.615777		

Test the lag length at lag 1. The formula would be as below.

Dependent Variable: D(GAP)
Method: Least Squares
Date: 05/06/11 Time: 06:27
Sample (adjusted): 1972 2010
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008285	0.011719	0.706959	0.4852
D(GAP(-1))	0.509266	0.138732	3.670866	0.0010
GGS	-0.037720	0.068903	-0.547436	0.5883

R-squared	0.317466	Mean dependent var	0.010625
Adjusted R-squared	0.270395	S.D. dependent var	0.051302
S.E. of regression	0.043820	Akaike info criterion	-3.328381
Sum squared resid	0.055686	Schwarz criterion	-3.190968
Log likelihood	56.25409	Hannan-Quinn criter.	-3.282832
F-statistic	6.744362	Durbin-Watson stat	1.964578
Prob(F-statistic)	0.003934		

Test the lag length at lag 2. The formula would be as below.

Dependent Variable: D(GAP)
Method: Least Squares
Date: 05/06/11 Time: 06:53
Sample (adjusted): 1973 2010
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001133	0.011164	0.101450	0.9200
D(GAP(-1))	0.417679	0.174129	2.398670	0.0239

D(GAP(-2))	-0.026958	0.155054	-0.173863	0.8633
GGS	-0.009007	0.064446	-0.139768	0.8899

R-squared	0.231260	Mean dependent var	0.004667
Adjusted R-squared	0.142560	S.D. dependent var	0.043449
S.E. of regression	0.040233	Akaike info criterion	-3.464695
Sum squared resid	0.042086	Schwarz criterion	-3.277869
Log likelihood	55.97043	Hannan-Quinn criter.	-3.404928
F-statistic	2.607199	Durbin-Watson stat	2.044622
Prob(F-statistic)	0.073034		

Test the lag length at lag 3. The formula would be as below.

Dependent Variable: D(GAP)
Method: Least Squares
Date: 05/06/11 Time: 06:58
Sample (adjusted): 1974 2010
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011149	0.013146	0.848109	0.4051
D(GAP(-1))	0.379835	0.201920	1.881117	0.0727
D(GAP(-2))	-0.052877	0.197211	-0.268125	0.7910
D(GAP(-3))	-0.096043	0.158161	-0.607250	0.5496
GGS	-0.068910	0.079184	-0.870254	0.3932

R-squared	0.180774	Mean dependent var	0.002500
Adjusted R-squared	0.038300	S.D. dependent var	0.041600
S.E. of regression	0.040796	Akaike info criterion	-3.400056
Sum squared resid	0.038278	Schwarz criterion	-3.162162
Log likelihood	52.60078	Hannan-Quinn criter.	-3.327329
F-statistic	1.268821	Durbin-Watson stat	2.008371
Prob(F-statistic)	0.310841		