Parjiono (2009) ***Economic growth in Indonesia: the driving forces of the level and the growth rate of real per capita income: an econometric time series approach.*** **PhD Thesis, James Cook University.**

Economic Growth in Indonesia:

The driving forces of the level and the growth rate of real per capita income: An econometric time series approach

Thesis submitted by
Parjiono, BSc, MPP
In August 2009

for the degree of Doctor of Philosophy
In the School of Business
James Cook University

Statement of Access

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and;

I do not wish to place any further restriction on access to this work.

______________________________ 18 February 2010

Signature Date

Statement of Sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of other has been acknowledged in the text and a list of references is given.

______________________________, 18 February 2010

Signature Date

Statement on the Contribution of Others

Nature of Assistance	Contribution	Names, title and Affiliations of Co-Contributors
Intellectual support	Editorial assistance	Ms. Kellie John, Learning Adviser, James Cook University Library, Townsville, Australia
Financial support	Stipend, tuition fee, stationary	Government Financial Management Revenue and Administration Project (GFMRAP), Fiscal Policy Office, Ministry of Finance of Indonesia
Data collection	Additional data support	Ahmad Budi Setyawan, Fiscal Policy Office, Ministry of Finance of Indonesia. Pierre van der Eng, Associate Professor, School of Management, Marketing and International Business, Australia National University.

Acknowledgments

I have to express my appreciation to those who have assisted and supported me in many of ways guiding to the completion of this thesis. I am mostly grateful to the almighty God whose mercy and worship direct and steer me throughout to the unknown destination.

I wish to express my thanks to the Government Financial Management and Revenue Administration Project (GFMRAP), Fiscal Policy Office, Ministry of Finance of Indonesia for providing financial for pursuing PhD program at James Cook University, Townsville Australia. My journey would not happen without this support.

I am also grateful to my supervisors, Associate Professor Richard Monypenny and Dr. A.B.M. Rabiul Alam Beg, for their invaluable guidance and suggestions. Associate Professor Richard Monypenny has specifically shown me not only how to write but also how to express my idea. Dr. A.B.M. Rabiul Alam Beg has affectionately edified me with fundamental tool on econometric methodology, from the very preliminary to the analytical applications. All their expertise in theoretical, applied econometric and economic policy is influential in shaping my PhD research.

Special thanks are due to Economics, School of Business, James Cook University (JCU) Townsville, faculty staff members, fellow postgraduate student, and information technology and administrative staffs. They all have provided their assistance in a number of manners. Many helpful comments and suggestion were given by weekly seminar participant in Economics JCU in 2006 and 2009.

In the area of information and data collection, my gratitude goes to JCU Library and the provision of DXDATA access. I also wish to acknowledge Associate Professor Pierre van der Eng at the Australia National University and Mr. Achmad Budi Setyawan at the Ministry of Finance of Indonesia for additional data support.

Finally, I would like to present my thanks to my wife Emi Rosyadah for her total support and understanding throughout the entire period of study and my daughters, delightful Aulia Parsya Karani Parjiono and rising star Prigelle Mrantashi Parjiono. I wish also to submit my gratitude to my parent Mr and Mrs. Ciptowidarto, and parent in law Mr. and Mrs. Nurachman, for moral support.

May the almighty God richly bless you all.

Abstract

An important policy goal for many governments is to increase the growth of real income. Real income is important because, it represents economic wellbeing. This study answers the question: how can Indonesia increase the growth rate of real per capita income in order to increase the welfare of the people. A three step process is used to discover the driving forces of the level and of the growth rate of real per capita income, namely: (i) Investigating if the long run growth characteristic is, exogenous or endogenous; (ii) Investigating and measuring productivity related to growth; and (iii) Discovering the driving forces of the level and of the growth rate of real per capita income.

Econometric methodology, especially time series approach, confirms that the three step process is testable empirically. To investigate the characteristic of economic growth in Indonesia for the period 1960 to 2006, regression equation of time series and cointegration approaches are employed. To investigate and measure the productivity related to growth, technology and income level catching up are examined against two leading economies, namely Japan and USA. Technology catching up is examined using regression equation of time series, while income level catching up is examined utilizing cointegration and the polynomial time trend approach. To discover the driving forces of the level and the growth rate of real per capita income, a bound testing approach to cointegration is employed. The real per capita GDP has been used to reflect real per capita income in most empirical work.

The results of this study suggest:

- First that during the period of 1960 to 2006, Indonesia's economic growth is characterized by the endogenous growth model. This implies that long run per capita income growth can be influenced by appropriate government policy.

- Second, that during the same period, there was a process of adoption of technology or technology catching up by Indonesia from the frontier technology of the developed country Japan and USA. This process has empirically contributed to the acceleration of productivity and to the growth rate achieved by Indonesia of about 6 per cent annually. However, the growth rate of about 6 per cent is insufficient to catch up to Japan and USA in terms of income level in the long run, given that the empirical tests show no evidence of income level catching up.
- Third, that during the period of 1970 to 2006, Indonesia's real per capita GDP can be linked to: capital, labor, exports, external debt to GDP ratio, stock of FDI and population. These results further suggest that in the long run, the increase of capital, employment and export lead to the increase in real per capita GDP, while the increase of external public debt to GDP ratio, stock of FDI and population lead to the decrease in real per capita GDP. In the short run, the increase of the growth of capital, employment and export lead to the increase in the growth of real per capita GDP, while the increase of the growth of external public debt to GDP ratio and population lead to the decrease in real per capita GDP growth.

Some policy implications can be drawn from these results are:

- First, related to the outcome of the exogenous and endogenous investigation, the government should formulate an active development strategy, because the long run growth of real per capita GDP can be influenced by appropriate government policy. The government should also promote investment to boost real per capita GDP growth.
- Second, related to the outcome of investigating and measuring productivity and the growth rate, the government should further develop adoption capacity factors, in order to support the process of adoption of technology for the purpose of accelerating productivity related to growth. This task could include

(i) Reducing tariffs on the import for equipment and production machinery, (ii) Emphasizing human capital development, and (iii) Increasing economic performance. The goal of this task is to achieve high real per capita GDP growth so that Indonesia can catch up, in terms of, real per capita GDP to Japan and USA in the long run.

- Third, related to the outcome of the driving forces of the level and of the growth rate of real per capita GDP, the government should essentially develop policies that directly address an increase in the level and the growth rate of real per capita GDP. These could include generating capital accumulation, creating new jobs to increase employment and increasing export volumes, being more selective to foreign direct investment so that it does not crowd-out domestic investment, reducing the external public debt to GDP ratio and reducing the growth rate of population.

This study maps a new direction in discovering the driving forces of the level and the growth rate of real per capita income by employing three steps process. The process is explored from the properties of economic growth theories, analyzed with the well developed econometric methodology and utilized updated Indonesia's data. This ensures that the outcome presents strong theoretical and empirical background. The findings and suggestions of this study provide input for policy maker for Indonesian development strategy formulation. It offers additional insight into the impact of government policy in the long run economic growth and the factors should be addressed to increase the growth rate of real per capita GDP in order to increase the welfare of the people of Indonesia.

Table of Contents

List of Tables

List of Figures

Chapter I. Introduction

Abstract

Real income represents economic wellbeing. A principal policy goal of many governments is the growth of real income. Policy makers and researchers are interested to know how to increase real per capita income in order to increase the welfare of the people.

This study uses a three step procedure to discover the driving forces of the level, and of the growth rate, of real per capita income. The econometric methodology has confirmed the testability of these three steps procedure.

This study shows that investigating the driving forces of the level and the growth rate of real per capita income, following the three steps procedure, implementing the econometric methodology and using updated Indonesian data, provides a strong theoretical and empirical background for the purpose of economic policy in Indonesia.

This study also fills a few of the existing gaps in the literature of economic growth in Indonesia, which are (i) the impact of government policy on long run growth, (ii) the source and the rapidity of productivity related to growth, (iii) the driving forces of the level and the growth of real per capita income.

1.1. Introduction

An important policy goal for many governments is to increase the growth of real income. Real income is important because it represents economic wellbeing. Policy makers and researchers are interested to know how the growth rate of real per capita income is generated. Indeed, this question is especially relevant for developing countries. This study is specifically interesting for a developing country like Indonesia. The question is then, how can Indonesia attain high real income growth in order to increase the welfare of the people? The purpose of the study is to discover the factors that have been the driving forces of the level, and of the growth rate, of real per capita income in Indonesia. In order to address this issue, this study uses the relationship between the three components, namely: the theory of economic growth, econometric methodology and most recent Indonesian data.

Most economic growth theories suggest that to answer the question of how a developing country can increase real income growth, one should know what the factors that have been the driving forces of the growth of income in that developing country are. However, every theory and every model has a different process and a different framework to identify these factors; thus choosing which of the models is suitable to analyze a specific developing country, in particular Indonesia, is an important issue for this thesis.

The chapter is organized as follows: the next section provides a brief description of the economic growth literature relevant to this thesis. The third section outlines the three step procedure that is used. Section four presents the research questions. Section five outlines the objective of this thesis. Section six outlines the methodology. Section seven outlines the significance of this thesis and Section 8 outlines the organization of this thesis.

1.2. Theory background

This section provides a brief description of the economic growth literature relevant to this thesis. There is extensive and significant economic growth literature that builds up to the modern growth theories such as: Classical, Schumpeterian, and Harrod-Domar. Economists such as Adam Smith, David Ricardo, Karl Max, John Stuart Mill and Robert Malthus have paid attention to the macro issue of growth from their classical perspective.

The early foundations of classical growth theory have brought about the development of modern growth theories. Some examples are: the arguments for the dynamic equilibrium approaches in perfect competition; the effect of population growth on capital per capita; the concept of technological advances which lead to the development of the specialization and evolution of new methods of production; and the concept of the accumulation of physical and human capital (Kan and Omay, 2006). However, some of the significant issues have arisen, for example: an underestimating of the strength of technological progress as an offset to diminishing return (Ricardo, Malthus); an underestimating of the effect of technological progress in industry on the productivity of labor (Marx).

Further development of growth theory is accomplished by Schumpeter (1934, 1939; 1942) who develops a theory where the economy should be soundly and explicitly thought-out in its disaggregated, multi-sector structure. The model is based on the endogenous introduction of new products and/or process and is governed by the process of creative destruction. In the model, Schumpeter treats population growth as exogenous, and the savings rate is either constant or is a residual and not a driver of growth. According to Schumpeter, the growth drivers are irregular punctuated changes in the economic environment, which are brought about by a variety of effects, such as for example, discoveries of new factor supplies. The Schumpeterian framework is suitable to analyze how a country's growth performance will vary with its proximity to the technology frontier. This concept then becomes one of the elementals of the modern endogenous growth theory.

Harrod (1939; 1948) and Domar (1946, 1957) independently developed an economic growth theory which mostly employed the properties of Keynes (1936). The model aims at extending the static equilibrium of Keynes into the long term. The theory is based on a fixed-coefficient technology, constant returns to scale within the production function, in that capital and labor are used in a constant ratio, thus with no substitution between capital and labor. The two aspects of the model of saving and efficiency, which both relate to capital accumulation, are emphasized. For the short run purpose, the model can provide an accurate prediction because it is just simply determines the growth target by the required investment. But there is a problem in the long run, caused by disequilibrium of capital and labor, which is popularly called the knife edge dilemma. If the savings rate is endogenous, and capital using and labor saving technological changes are allowed, the economy has high marginal productivity of capital. In this case the economy has a balanced growth path, but otherwise, the economy has low productivity of capital, and it behaves as the original Harrod-Domar growth model. The Harrod-Domar methodological framework does not capture the importance of technological progress, money and productivity.

Solow (1956) and Swan (1956) address the limitation of the fixed coefficient production function of Harrod-Domar with the neoclassical production function, which has the special characteristic of the shape of the isoquont curve, in that the flexibility of the combination of capital and labor is allowed, but in the sense that it has constant returns to scale. This production function has the property of diminishing returns to capital, in that increases in per worker capital results in less output. Growth is determined exogenously by technological progress. Technology increases productivity through increasing labor productivity. One counter-intuitive aspect in this model is that, because growth depends on the labor force and labor productivity, which is exogenously determined by technology progress, investment does not matter in the long run growth. The capital-output ratio adjusts to offset changes in saving and investment, to keep the long run growth constant.

In terms of productivity, the exogenous growth model suggests that a developing country can grow faster than a developed country, because of diminishing returns to capital. Capital tends to flow towards economies that provide higher returns. Because the developing county is growing faster, there will be income level catching up, where the disparities of income level between the developed country and the developing country narrows and reaches zero in the long run. Thus the income level of the developing country will attain the income level of the developed country in the long run (convergence).

In terms of simplicity, and the capability to explore the driving forces of growth, the exogenous growth model has been one of the modern growth theories used extensively in empirical studies.

However, the limitations of the model, such the incapability to explain the phenomena of divergence, and that some empirical results show that investment does have an effect on growth, ensures a keen research interest is maintained, in part because the research might better explain the relationship between the major driving forces of economic growth. Thus there were some studies in the 1980s and 1990s that addressed the limitations of the exogenous growth model by considering the role of externalities to help explain persistent economic growth. Even though these works were done in the 1980s and 1990s (Romer, 1986; Lucas, 1988; Barro, 1990; Grossman and Helpman, 1991), the fundamental ingredients are mostly a revival of previous work, such as Smith (1776), Schumpeter (1942) Arrow (1962) and Uzawa (1965). Externalities which increase the productivity of labor at the aggregate level of the economy can come from a range of sources. Investment can be made to keep productivity constant or to increase, in order to accelerate growth. Therefore, investment does matter for long run growth and it is endogenous in the model. In that case, governments can influence long run growth through appropriate policy related to investment or policy to increase externalities. Because the driving forces of growth are determined endogenously, this model is called the endogenous growth model.

In terms of productivity, a developing country can grow faster than a developed country, because of productivity catching up through technology adoption. However, to be able to adopt frontier technology from a developed country, a developing country should have sufficient adoption capacity. Adoption capacity can be developed by appropriate government policy (Nelson and Phelps, 1966).

Based on the discussion in this section on the background of economic growth literature relevant to this thesis, it can be concluded that the development of economic growth theory, from classical to the current modern growth theories, has established two competing growth theories, exogenous and endogenous. These two models have been elemental frameworks for studying economic growth and have commonly been used in recent empirical studies. The phenomenon of uneven development and of persistent inequality can be adequately addressed by either the exogenous or the endogenous growth model (Kong, 2007). Thus the question is; which of the two models is more suitable to analyze economic growth in Indonesia?

1.3. Three steps procedure

This section outlines the three steps used in this thesis. Two fundamental implications can be drawn from the frameworks of the exogenous and the endogenous growth models, in relation to their use for an empirical study of economic growth in Indonesia.

1. Exogenous or endogenous. According to the exogenous growth model, growth is exogenously generated by technological progress. Hence, government policy does not have a permanent impact on long run growth. However, in the endogenous growth model, growth is generated endogenously by factors that can be influenced by appropriate government policy.
2. Returns to capital or technology catching up. According to the exogenous model, a developing country can grow faster than a developed country because of

diminishing returns to capital. Capital tends to flow toward economies that provide higher returns. In growing faster, there will be income level catching up. In the endogenous growth model, a developing country grows faster than a developed country because of technological catch up.

Given these two competing models, it is obvious that in order to analyze the driving forces of the level and the growth rate of real per capita income of a specific developing country, Indonesia, the first step is to determine which of the models is suitable, by investigating if the characteristic of long run growth in Indonesia is exogenous or endogenous. The second step is to examine how the productivity related to growth is generated, by testing the technology and income level catching up theories. The third step is to identify the driving forces of the level, and of the growth rate, of real per capita income, by employing the growth theory found in the first step, and productivity characteristic found in the second step. This thesis uses this procedure to find the driving forces of the level, and of the growth, of real per capita income in Indonesia.

Based on the discussion in this section of the three fundamental steps used in this thesis, it can be concluded that they will produce a thesis with a strong theoretical and empirical background to economic growth in Indonesia.

1.4. Research questions

This section outlines the research questions for this thesis. This thesis attempts to empirically analyze economic growth in Indonesia, to answer the question, how can Indonesia increase the growth of its real per capita income? The research questions for this thesis are:

1. Is long run economic growth in Indonesia exogenous or endogenous?
2. How is the productivity related to growth generated? Is there any process of adoption of technology or technology catching up by Indonesia to the frontier technologies of Japan and USA which has contributed to accelerating productivity

and growth? Is the growth rate achieved by Indonesia sufficient to catch up to the leading countries of Japan and USA in terms of per capita income in the long run?

3. What are the driving forces of the level and of the growth rate of real per capita income in Indonesia?

This thesis observes, as will be discussed in Chapter III, that there has been no study of economic growth in Indonesia which has been conducted using these three fundamental steps. The objective of this thesis is to address these research questions. Therefore, investigating economic growth in Indonesia will fill a few of the gaps in the economic growth literature, including (i) the impact of government policy on long run growth, (ii) the source and the rapidity of productivity related to growth, and (iii) the driving forces of the level and the growth rate of real per capita income. The thesis will also provide a strong theoretical and empirical basis for economic growth policy in Indonesia.

Based on the discussion in this section on the research questions for this thesis, it can be concluded that addressing these three research questions will produce a thesis with a strong theoretical and empirical background to economic growth policy in Indonesia.

1.5. Methodology

This section outlines the methodology. The econometric methodology is employed to address three research questions.

The econometric methodology pays careful attention to the time series properties of the data. The stationarity of the variables is tested using the Dickey Fuller[1] (DF) and Augmented Dickey Fuller (ADF) tests. It applies Akaike information criterion (AIC), Bayesian information criterion (BIC) and Modification Akaike Information Criterion

[1] See Dickey and Fuller (1979).

(MAIC)[2] to uncover the robustness of the ADF test of unit root due to the lag length selection. Every variable is also plotted to see the data generating process. All empirical results are presented and discussed in chapter IV through VI. A number of diagnostic tests are also carried out.

The following three empirical studies are undertaken:

First, to test if the characteristic of long run economic growth in Indonesia is exogenous or endogenous, two approaches are employed:

a. Regression equation of time series approach. This approach is adopted from Karas (2001). It can assess if the impact of government policies on economic growth is permanent or only transitory. In a time series regression, the policy variables can affect output growth all the way through contemporaneously or no contemporaneously. The policy variables that can influence long run growth, used in this study, are population growth, investment rate and openness to international trade. These three variables are jointly tested for their impact through their coefficient estimates. Their significance estimates will indicate if their effect is transitory or permanent. Their signs will be compared with those expected by theory. The study also provides information concerning the role of openness in international trade on economic growth, whether it encourages or discourages growth[3].

b. Cointegration and error correction model (ECM) approach. To test the exogenous or endogenous growth model for Indonesia, Lau's (2008) approach to cointegration and ECM is applied. Lau (2008, p. 650) points out that if the n variables are cointegrated with the r cointegrating vector(s), the long run impact multiplier matrix for structural moving average (MA) representation is of reduced rank of $n-r$. This structural MA exhibits the empirical shock, which can be used to examine the long run effect of the structural shocks on

[2] MAIC is a specific criterion used to determine the optimum lag length in ADF unit root test. This criterion is advocated by Ng and Perron (2001).

[3] It is specifically pointed out by Rodriquez & Rodrik (2000) in their survey that the nature of the relationship between openness and growth is still an unresolved issue.

the level of observed variables. Juselius (2006, p. 277) points out that the empirical shock of structural MA is defined as transitory and permanent. The transitory shock has, by construction, no long run impact on the variables in the system, while the permanent shock must have a significant long run impact on at least one of the variables in the system. This conception is utilized to test if long run growth in Indonesia is exogenous or endogenous. Using a bivariate model, the real per capita income and real per capita investment of Indonesia are examined. If they are cointegrated, the long run effect of temporary changes in real per capita investment share on per capita income for exogenous and endogenous growth models have testable implications. In order to do so, the Johansen (1991, 1995) maximum likelihood estimation (MLE) is implemented to test the cointegration of the variables and estimate the model.

Second, to investigate and measure productivity related to growth, this study utilizes the two catching up hypotheses, that is, technology and income level catching up. Two empirical studies are conducted, one to investigate technology catching up and one to investigate income level catching up.

a. The technology catching up is examined by regression equation of time series which controls for technology gaps and absorptive capacity against technology growth. This test is to observe how the productivity related to growth is generated, whether there is a process of adoption of technology by the country, Indonesia, from the frontier technology of leading countries, namely: Japan and USA, which contributes to the acceleration of productivity. The technology gap is measured by the difference of total factor productivity between the leading country and Indonesia. The adoption capacity is represented by economic performance, human capital development and import growth. The significance of the coefficient estimate of technology gap with the positive sign implies technology catching up occurs. The significance of the coefficient estimate of adoptive capacity factors indicates their role in the process of catching up.

b. The income level catching up is examined by cointegration and ECM, and the polynomial time trend approach. This test is to measure whether the growth of real per capita income, represented by the growth of real per capita GDP achieved by Indonesia, is sufficient to catch up to the leading income countries, namely: Japan and USA, in the long run. In the cointegration and ECM, the per capita GDP of the leading country and the per capita GDP of Indonesia should be cointegrated. The estimate of ECM should then be able to show that the constant and trend are jointly equal to zero, in order to attain the condition of catching up. The polynomial time trend approach requires that the difference of the real per capita income level between the leading country and Indonesia is moving towards zero, in order to attain the catching up process.

Third, to discover the driving forces of the level and of the growth rate of real per capita income, the empirical investigation is conducted based on the framework of the economic growth model that resulted from the first and second empirical studies. A bound testing approach to cointegration advocated by Pesaran et. al. (2001) is employed. The bound testing to cointegration is a method for testing the existence of the level relationship between a dependent variable and a set of regressors based on the use of cointegration techniques. The advantages of employing this method are: (i) it is simple and applicable to investigate the existence of a short run and a long run relationship between the variables; (ii) it is applicable irrespective whether the regressors of the model are purely I(0), purely I(1), or mutually cointegrated; (iii) it is relatively efficient in a small or a finite sample size, as is the case in this study.

In order to employ the methodology, this study is helped with three econometrics software packages, namely: RATS version 7, CATS in RATS version 2, and Shazam version 10. Some reference manuals and user guide are used to guide the operational of RATS and CATS in RATS which include Enders (1996, 2003), Doan, (2007), and

Dennis et. al. (2005). User's reference manual version 10 due to Whistler et. al. (2004) is referred to guide in operating Shazam.

Based on the discussion in this section on methodology, it can be concluded that the methodology used will produce results that have a strong empirical underpinning.

1.6. Significance of this thesis

This section outlines the significance of this thesis. This thesis maps a new direction for exploring Indonesia's economic growth by employing the properties of economic growth theories, by employing developed econometric methodology and by employing most recent, comprehensive and representative data. This thesis is the first to investigate the driving forces of the level, and of the growth rate, of real per capita income in Indonesia following three fundamental steps:

First, this thesis provides empirical evidence as to whether the impact of the Indonesian government policy on long run growth is just transitory or permanent. The outcome also guides the next step in determining which of the models is appropriate to be utilized to investigate the driving forces of the level, and of the growth rate, of real per capita income in Indonesia.

Second, this thesis provides empirical evidence as to whether the acceleration of productivity related to growth is contributed to by adoption of technology. This suggests one of the development strategies for Indonesia to use in order to accelerate its productivity and growth. This thesis also measures whether the growth of output attained by Indonesia is sufficient to catch up to the leading countries, e.g. Japan and USA, in terms of per capita income in the long run. This outcome suggests the importance for Indonesia to build a strong adoption and implementation capacity to adopt frontier technology in order to support the process of catching up to developed economies.

Third, the thesis provides empirical evidence concerning the driving forces of the level and the growth rate of real per capita income, using the growth model identified in the first step, and considering 14 variables to influence real per capita income. To do so, the bound testing approach to cointegration has been applied and modified into a two steps procedure. The outcome suggests the variables that have been the driving forces of the level and the growth rate of real per capita income.

Based on the discussion in this section on the significance of this thesis, it can be concluded that for policy makers and for government, the outcome of this thesis may serve as guidance for development planning, budgeting and policy formulation. The long run growth characteristic empirically found suggests a development strategy, related to the impact of the government policy on the long run growth. The thesis provides suggestions on how Indonesia can accelerate its productivity growth. The increasing of the acceleration of productivity related to growth is a must for Indonesia if the country is to achieve the position of a developed country in terms of per capita income in the long run. The thesis further provides clear empirical evidence concerning the driving forces of the level and of the growth rate of real per capita income. These are the variables that should be addressed by government policy in order to increase the growth rate of real per capita income.

1.7. Thesis organization

The thesis is organized in seven chapters. Chapter 1 is the introduction; chapter 2 is the literature review of economic growth; chapter 3 is the Indonesian economy; chapter 4 is the economic growth in Indonesia: exogenous and endogenous; chapter 5 is the Indonesian economy: does it catch up to the world's leading economies?; chapter 6 is the driving forces of the level, and the growth rate, of real per capita income in Indonesia. Chapter 7 is conclusion and policy implication.

Chapter 2 explores economic growth theories to help address the problem of how to increase real per capita income growth in Indonesia. The perspectives of growth theories are viewed, from classical to current modern theories. It is shown how the exogenous and endogenous growth theories have evolved from earlier theories. These two models have been commonly used to analyze economic growth. This chapter also shows the competing features of these two models, and asks which of the models is most suitable to analyze a specific developing country like Indonesia. By observing their properties, this chapter then proposes three steps process to determine which model to be used, to investigate and measure the productivity related to growth, and to identify the driving forces of the level and of the growth rate of real per capita income. This chapter also confirms that econometric methodology is available to do the empirical analyses.

Chapter 3 explores the literature on growth in Indonesia. This chapter has two parts: the first provides some background of the performance of economic growth since 1960 and discusses policies related to physical and human capital, openness to trade, investment, and macroeconomic. The second reviews the literature on economic growth in Indonesia, in connection with the three steps process. It confirms that there has been no study conducted to address economic growth in Indonesia using the three steps used in this thesis.

Chapter 4 deals with the two competing theories of economic growth, namely exogenous or endogenous. This chapter has two main purposes: (i) To investigate if the impact of government policy on long run growth is permanent or just transitory. If the impact is just transitory, government policy does not influence long run growth. (ii) To determine what analytical framework and model has to be used in order to discover the driving forces of the level, and of the growth rate, of real per capita income in Indonesia.

Chapter 5 empirically investigates technology and income level catching up theories. This chapter has two main purposes: (i) To investigate how productivity related to growth in Indonesia has been generated. The technology catching up hypothesis is tested against two main economic partner countries of frontier technology, Japan and USA. The result provides empirical evidence of whether there is a process of adoption of technology by Indonesia from these leading partner countries which contributes to the acceleration of productivity and growth. The result is also to provide evidence of whether the country has been able to develop sufficient adoption capacity in the process of adoption of technology. (ii) To measure whether the growth rate achieved by Indonesia is sufficient to catch up to the world leading economies in terms of per capita income. Incomes level catching up tests are conducted for Indonesia against Japan and USA. This outcome of this chapter has policy implications for the Indonesian development strategy associated with the acceleration of productivity and growth as a developing and laggard country.

Chapter 6 addresses the driving forces of the level, and the growth of real per capita income in Indonesia, focuses the empirical analysis for the purpose of discovering the factors that influence the level, and the growth rate, of real per capita income. Twelve policy variables and two external factors are used in the estimation. The outcome of this chapter has policy implications for increasing the growth rate of real per capita income in the short run and the long run, in order to increase the welfare of the people.

Chapter 7 provides the main findings of the study and their policy implications. This chapter also outlines some contributions of the research to knowledge; some limitations; and some suggestions for future research.

Chapter II. Literature review of economic growth

Abstract

Understanding economic growth theories helps explore the driving forces of economic growth of a country and explain how a country can attain high growth.

The development of economic growth theories from classical to modern has established a strong framework within modern growth theories, namely exogenous and endogenous growth models. The exogenous growth model postulates that the growth of output is exogenously determined by technology progress. Hence, government policy does not have a permanent impact on long run growth. Endogenous growth implies that growth is endogenously determined. Thus, government policy could have permanent impact on long run growth.

In terms of productivity growth, a developing country tends to grow faster than a developed country because of diminishing returns to capital in exogenous growth or technological catching up in endogenous growth.

The outcome of this review of economic growth theories suggests that in order to conduct a study of economic growth for a specific developing country, specifically to identify the driving forces of economic growth, there are at least three steps process that have to be implemented: (i) investigate the long run economic growth is exogenous or endogenous, (ii) investigate the source and the rapidity of the productivity growth, and (iii) identify the driving forces of the level and the growth rate of real per capita income.

2.2. Introduction

Understanding economic growth theories helps explore the driving forces of economic growth of a country and helps explain how a country can attain high growth. More specifically, the importance is to identify the drivers of growth and to incorporate these into the development of a country strategy in order to increase the welfare of the people. This information is very relevant, especially for a developing country.

There have been some extensive surveys of recent developments in the economic growth literature, among others these include: Aghion and Howitt (1998), Fagerberg and Verspagen (2002), Thirwall (2002), Rogers (2003), Barro and Sala-i-Martin (2004), Aghion and Durlauf (2005), Kan and Omay (2006), Castellacci (2007), Kong (2007), and Aghion and Howitt (2009),

The main objective of this review is to comprehend the properties of economic growth theories, including their development and empirical applications in order to analyze economic growth in a specific developing country. In order to reach this objective the review goes through three steps. The first is to provide a perspective review of economic growth theories from classical to modern theories. The second is to explore the models and frameworks of modern growth theories. The third is to provide empirical review relate to the fundamental steps suggested by modern growth theories in order to analyze economic growth in a specific developing country.

The development of economic growth theories from classical to current has established strong competing frameworks within modern growth theories, namely the exogenous and the endogenous growth models. The exogenous growth model postulates that the growth of output is exogenously determined by technological progress. Hence, any government policy would not have a permanent effect on long run growth. The endogenous growth model postulates that growth is endogenously determined. Thus, government policy could have a permanent impact on long run growth.

The chapter is organized as follows; the next section presents an overview of the economic growth theories from the classical to the modern growth theories; Section three discusses in detail the models and frameworks of the modern exogenous and endogenous growth theories; Section four reviews the empirical studies related to the three step process used in this study to discover the driving forces of the level, and of the growth rate, of real per capita income namely: (i) Investigating if the long run growth characteristic is exogenous or endogenous; (ii) Investigating and measuring productivity related to growth; and (iii) Discovering the driving forces of the level, and of the growth rate, of real per capita income. Section five presents chapter conclusion.

2.2. Economic growth theories in perspective

Economic growth has been a core concern of economics since economics started as a discipline, at least since the famous book by Adam Smith published in 1776 (*An inquiry into the Nature and Causes of the Wealth of Nations*). This section surveys economic growth from the classical to modern growth theories. The aim of this section is to identify the different points of view of the growth theories from Adam Smith (classical) to the new growth theory.

2.2.1. Classical view

Most great classical economists are concerned with the macro issues of growth, and the distribution of income between wages and profits. Kan and Omay (2006) point out that several topics of classical growth theory have been brought to the modern growth theories, with their arguments of fundamental dynamic equilibrium approaches in perfect competition environment, the effect of population growth on capital per capita, technological advances which lead to the development of specialization and evolution of new methods of production, and physical and human capital accumulation. The classical views include those of Adam Smith, Thomas Malthus, David Ricardo, John Stuart Mill, and Karl Marx.

Smith suggests two distinct sources of economic growth, one directly associated with the increase in specialization, and the other related to the level of specialization. Furthermore, Smith's optimistic model of growth consists of discrete jumps and a gradually increasing underlying rate of technological process. The impulsive discrete rises in per capita output are the result of increases in specialization caused by improved transportation or institutional changes. Continuous innovation, research and learning by doing are functions of the degree of specialization which will encourage the increase of per capita output. Increasing specialization will drive technology growth, and it will in turn drive further specialization. Clearly, development and growth are emphasized by increasing the size of market, accompanied by increasing returns and externalities due to the rising division of labor (Greiner et. al., 2005). In fact, the notions of increasing return and externalities become the basic concept of the endogenous model in modern growth theory, which will be discussed later.

The prevailing classical views after Smith provide more caution about the process of economic development and growth. It starts from Thomas Malthus, who claimed that there would be imbalance between food supply and population because population grows much faster than that of food availability, which results in living standards oscillating around a subsistence level.

The importance of investment in machinery is emphasized by David Ricardo in order to increase per capita income. However, Ricardo identifies the diminishing return process is due to the scarcity of natural resources, especially in agriculture. Economies would end up in a stationary state with no capital accumulation and therefore no growth. Ricardo argues that technological change could temporarily raise labor productivity and the profit rate, but offset the eventual occasion of capital accumulation as a result of increasing rents that lead the profit rate to drop to zero (Thirwall, 2002, p. 8-9).

Pursuing Ricardo, Karl Marx sees the importance of investment in machinery and capital accumulation to generate per capita income. It is different with John Stuart Mill, who underlines the importance of education and science as the engine of growth. Marx is concerned about the falling of profit due to competition between capitalists, overproduction and social disturbance. When capital accumulation takes place, it encourages production which then leads to the increase of wages, and in turn drives the profits down. The effort to reduce wages would create social problems, and substituting labor with technological progress would worsen existing social problems. Of these two however, Marx's achievement is critical, in that he does not only provide rigorous formulation to date of the growth model, but also does so in a multi-sectoral context and provides the ingredient for the concept of steady state growth equilibrium.

In view of the process, all of the classical economists believe that private agents in the market economy accomplish economic activity, and they should be supported by social and public infrastructure (Greiner et. al., 2005). As such, beside the positive immensity of market forces, it is always accompanied by inequality. In the long run, this inequality converges to the stationary state condition as the solution for growth equilibrium.

The classical concept of the division of labor and increasing returns (Smith) remained inactive in its era, till revitalized by Ramsay (1928), Young (1928), and Schumpeter (1942). Ramsay (1928) refreshes the increasing return concurrently with the household optimization behavior. This notion does not receive sufficient recognition in its time, but since the1960s, Ramsay's utility function has been employed widely in economic theory. Young (1928) revitalizes the increasing return which is associated with the output of all industries. Young's concept of increasing return is a phenomenon, which covers the interaction between activities in the process of general industry expansion in macroeconomic (Thirwall, 2002). Even though it is lost in an occasion of time, another generation of Myrdal (1957) and Kaldor (1957) revive it in their development of non-equilibrium models.

In general, the formulation of classical growth theory is still gloomy, especially for the market and capitalist world. Thirwall (2002) points out that some prognostications such as underestimating the strength of technological progress as an offset to diminishing return (Ricardo, Malthus), and underestimating the effect of technological progress in industry on the productivity of labor (Marx) indicate this quarrel. However, it is also obvious that the classical growth model performs an integrated part of the growth and development model that later on become fundamental departures of modern growth theories. Their base formations are brought about to the development of new growth theories.

2.2.2. Schumpeterian

Schumpeter (1934, 1939; 1942) develops a theory that an economy should be soundly and explicitly thought-out in its disaggregated, multi-sectoral structure. The methodologies employed, as the main secular engine of growth, are supply driven. The difference, however, is revitalization of technology, efficiency, and conducting the division of labor. The Schumpeterian growth model is a particular type of economic growth model that is based on the endogenous introduction of new products and/or process and is governed by the process of creative destruction (Dinopoulos and Sener, 2007). In his growth model, Schumpeter treats population growth as exogenous, and savings rate as somewhat constant or as a residual and not a growth driver. According to Schumpeter, the growth drivers are irregular punctuated changes in the economic environment, which are brought about by a variety of effects, that is, discoveries of new factor supplies, and entrepreneurial innovation as the central one. It is different with Ricardo (classical), in that there is no diminishing return to innovation. It is also different with the exogenous model, determined exogenously, which will be discussed in a later subsection.

There are two main inputs to innovation: the private expenditures made by the prospective innovators, and the stock of innovations that have been made by past innovators. The model of growth broadly encompasses an innovation that leap over the technology available before innovation, resulting in new technology parameters in the innovating sector. It also encompasses the case of an innovation that catches up to a global frontier. This process is then called creative destruction which has been formalized further by Sagerstrom, et. al. (1990), Grossman and Helpman (1991) and Aghion and Howit (1992). Hence, innovation is the central element in Schumpeter growth theory. As such, Schumpeter stresses the requirements for successful innovation to include open markets, access to credit and sufficiently stable macro economic conditions. Schumpeter argues that the uncertainties accompanying inflation and other financial disturbances could be a lasting obstacle to innovation and productivity growth. Aghion and Howitt (2009, p. 100) therefore point out that the assumption of perfect financial market development is one limitation of the model. Since every country has different stages in financial market development, it seems to work much better in some countries than in others.

As the basis of growth is mainly due to innovation and technology, it does not therefore, work spontaneously for developing and under developing countries, which are always associated with weak entrepreneurial impulse, limited competence of the state, and have no precise knowledge about the actual economic structure and technical expertise to generate innovation (Bhatt, 1966). In this case, Aghion and Howitt (2006) point out that the Schumpeterian framework is suitable to analyze how a country's growth performance will vary with its proximity to the technology frontier. Accordingly, a country has to be able to formulate its policies in order to sustain a converging process as the country approaches the frontier. This view is then explored by Gerschenkron (1962) in the concept of technology catching up and national capacity, and is further formalized by Nelson and Phelps (1966). The concept becomes apparent that a follower country tends to catch up to frontier technology so as to accelerate their productivity and growth. This concept provides support to the Schumpeterian approach, even though there is no specific research and development, and innovation generated by Nelson and Phelps, but their thinking of growth is being constructed by productivity-improving adaptations which depend upon the stock of human capital (Aghion and Howitt, 2006).

Schumpeter has provided a versatile concept of growth. This later on becomes fundamental for the new growth theory (specifically endogenous theory) which heavily emphasizes the externalities of knowledge. Aghion and Howitt (2005) show the forces of the Schumpeterian growth paradigm through the formulating model of endogenous growth based on quality improving innovation.

2.2.3. Harrod-Domar

Harrod (1939; 1948) and Domar (1946, 1957) independently develop an economic growth theory which mostly employs the ingredient of Keynes (1936). The model aims at extending a static equilibrium of Keynes into the long term. The theory is based on a fixed-coefficient technology, a constant return to scale within the production function, in that the capital and labor are used in constant ratio, thus no substitution in between. Two critical aspects of saving and efficiency which both relate to capital accumulation are emphasized.

For the short term purpose, the model can provide an accurate prediction of growth, and has been extensively used by less developed and developing countries in their growth formulation and strategy. The simplicity is to determine the growth target in short term, by the 'required' investment. If the ability of saving to finance this 'required' investment is shortage, the country thus needs another source to finance this gap, which usually comes from foreign aid or another result of government debt. Easterly (1997) argues that it is in fact not a long term relationship between investment and growth, but short term growth target in relation to aid and investment. It is possibly the reason why Harrod-Domar was acceptable at the time and is still 'haunting' recent development planning for less developed and developing countries, supposedly because of promises by the short term growth and brought about by donor countries and multilateral finance institutions.

For the long term purpose, the knife-edge dilemma, caused by in-equilibrium between the growth rate of capital and labor, leads to the difficulty in estimating long term growth. Further, the influence of technology progress, money and productivity gains considered essential for long run growth and development can not be captured in its methodological framework (Nedomlelova, 2007). However, if saving rate is endogenized and capital using and labor saving technological changes are allowed, the economy has high marginal productivity of capital. In this case, Zuleta (2007) finds the economy would present a balanced growth path in the long run. But, if it is low marginal productivity of capital; the economy tends to behave as the original Harrod-Domar growth equilibrium.

Thirwall (2002) conceives that establishing the Harrod-Domar equilibrium has led to the great debate (from the 1950s to the 1980s) in growth economics, between the exogenous growth school with the major leaders Robert Solow, Paul Samuelsson and Franco Modigliani, against the Keynesian school with the central characters Nicholas Kaldor, Joan Robinson, Richard Kahn and Luigi Pasinetti. While the Keynesian school focuses on the saving ratio, the exogenous School emphasizes the capital-output ratio to bring the economy to equilibrium. The astonishing outcome is that growth is not influenced by investment in the long run, because labor force and productivity are determined exogenously. The increase in the capital-output ratio would offset saving or investment, leave the long run growth un-changed. This is what the foundation of the exogenous growth model with diminishing return to capital (Thirwall, 2002), done by relaxing the factor proportion of capital and labor, and all stringencies assumed away (Sato, 1964).

Conversely, Kaldor (1961) insists that persistent growth of per capita income is one of the major phenomenon that can be observed in a number of countries over a long period. In view of this, Greiner et. al. (2005) point out that Kaldor is the first to state the persistent growth of per capita income as stylized fact, and the resurgence of new growth theory (Uzawa, 1965; Romer, 1986; Lucas, 1988; Barro, 1990) has approximately captured the same view of Kaldor's persistent growth factors identification. In this scrutiny, the properties of classical growth which are emphasized by building on enter-temporal behavior and the dynamic optimization of economic agents have been rediscovered.

In general, despite criticisms, the Harrod-Domar growth model was quite accepted in its time. The model provides the starting point for the next growth protagonists to make the equilibrium mechanism available. The two views on instituting the knife-edge in-equilibrium dilemma have brought about the development of modern growth theories, exogenous and endogenous, which will be discussed in next.

2.2.4. Modern growth theories: exogenous and endogenous models

In the current literature of modern economic growth theory, there are two established models that have different and competing views on how growth is generated, namely exogenous and endogenous. These two models are in fact a development of the previous models.

The exogenous growth model is pioneered by the seminal paper of Solow (1956) and Swan (1956), initially to address the limitation of the fixed-coefficient production function of Harrod-Domar with the neoclassical production function. The specific characteristic of neoclassical production function is the isoquants shape curve, in that the flexibility of a combination between capital and labor is allowed, in the sense that it is a constant return of scale. This production function has the properties of diminishing return where additional augmentation in per worker capital results in less output. Growth is determined exogenously by technological progress. Technology increases productivity through labor augmenting.

One counter-intuitive conclusion in this model is that, because growth depends on labor force and labor productivity which is exogenously determined by technological progress, investment does not matter for long run growth. The capital-output ratio copes with offset and changes in saving and investment, and keeps the long run growth untouched. This is the exogenous mechanism that the endogenous (new) growth theory rise to overwhelm (Thirwall, 2002).

The endogenous growth model considers the role of externalities to explain persistent economic growth. Even though this model graciously rose in the 1980s and 1990s

(Romer, 1986; Lucas, 1988; Barro, 1990; Grossman and Helpman, 1991), in fact the fundamental ingredients are mostly a revival of the previous perspective of Smith (1776), Schumpeter (1942), Arrow (1962) and Uzawa (1965). The externalities can come from any factor that increases the productivity of labor on the aggregate level of the economy. Hence, the investment can be paid to keep the productivity constant or increasing, in order to accelerate growth. Therefore, investment matters for the long run growth and it is endogenous in the model.

Based on the discussion in this section on economic growth theories, it can be concluded that, in general, it is apparent that most of the properties of the endogenous model are in fact a revival from the classical authors Smith and Ricardo, and from the Schumpeterian foundation while Harrod-Domar's knife edge has been relaxed in Solow (1956) to become the exogenous growth model. These two competing growth theories (exogenous and endogenous) have been commonly used in recent empirical studies. In order to identify the fundamental properties of the growth theories and identify which of the models is most suitable to analyze the growth of a specific developing country's economy, the next section outlines the model and framework of the two modern growth theories: the exogenous and endogenous growth models.

2.3. The model and framework of modern growth theories

This section outlines the model and framework of the two modern growth theories of the exogenous and endogenous model. This describes the process and the framework of both models and draws their implications for growth. The purpose is to have these for later empirical and practical analyses. The framework closely follows the formulation by Lim (1999), Barro and Sala-I-Martin (2004), Greiner et. al. (2005) and Aghion and Howitt (2009).

2.3.1. The exogenous growth theory

Exogenous or neoclassical is one of modern growth theories pioneered by Solow (1956) and Swan (1956). The model is an improvement of the Harrod-Domar model, which relaxes the assumption of fixed proportion in the production function and enables a derivation of an equilibrium growth path at a constant rate. Three assumptions have been fundamental of the model (Thirwall, 2002): (i) the labor force (*l*) and labor saving technical progress (*t*) grow at a constant exogenous rate, (ii) all saving is invested, such that $S = I = sY$, and (iii) output is a function of capital and labor, where the production function exhibits constant returns to scale, and diminishing return to individual factors of production. This subsection specifically discusses the exogenous growth model based on Solow's (1956) paper.

According to Sollow (1956), two homogenous factors, capital (*K*) and labor (*L*) are inputs to produce output (*Y*).

$$Y = f(K, L) \qquad K > 0, L > 0 \tag{2.3.1.1}$$

The characteristic of this function is assumed to exhibit constant returns to scale, positive marginal productivity, and diminishing marginal rate substitution, that is $f'(\bullet) > 0, \quad f''(\bullet) < 0$. The labor force is understood to grow at a natural rate $n = \Delta L / L$, with exogenous population growth and no technological change as Harrod's natural change. Hence, the function of labor supply at time *t* is provided in the following equation:

$$L(t) = Loe^{nt} \tag{2.3.1.2}$$

where *L* and *Lo* denote total employment and the initial level of employment or labor supply, respectively. Capital (*K*) is performed and evolved based on the gross investment (*I*) and depreciation *δK*, that is, any change in the level of capital stock ($dK / dt = \Delta K$) is signified by gross investment less depreciation. Since the behavior of the household is that a part of each instant's output is consumed and the rest is saved and invested (because $S = I$), using the constant *s* as the fraction of income saved, the change in the capital stock over time is given by:

$$\Delta K = I - \delta K = sf(K, L) - \delta K \qquad (2.3.1.3)$$

This equation explains the process of capital accumulation through time, in the case that all available labor has been fully employed. Once the time path of capital stock and that of labor force are performed, then the corresponding time path of real output can be computed from the production function.

Introducing k to label the ratio of capital to labor (K / L), implies that $K = kL = kLoe^{nt}$. Dividing both sides of the equation (2.3.1.3) by L and taking a differentiation of k with respect to time, yields:

$$\Delta k = \Delta K / L - (\Delta L / L)k\ . \qquad (2.3.1.4)$$

Labeling $\Delta L / L$ with *n,* and inserting equation (2.3.1.3) into (2.3.1.4) obtains:

$$\Delta k = sf(k) - k(\delta + n) \qquad (2.3.1.5)$$

In equation (2.3.1.5), the $sf(k)$ represents a total product curve as varying amounts of k employed with one unit of labor. It also articulates output per unit of labor as a function of capital per labor. Hence, the rate of change of per unit capital stock of effective labor is the difference between two. The first, $sf(k)$, is actual investment per unit effective of labor. The second, $k(\delta + n)$, is reduction of capital (per labor) as a result of depreciation and population growth. The steady state is the break even investment, which is the amount of investment that must be made to keep k at the existing level.

The steady state of growth is achieved through a condition where each variable of the model is growing at a constant rate over time. That is, if output constantly grows, then both investment and the capital stock have the same growth rate. It implies that the ratio of the capital to output is constant since saving (to become investment) is a fixed proportion of output (s), which indicates capital stock growth. In the long run, while all variables are expanding at the same rate, the growth rate will be determined by the growth of labor supply, including its productivity. Any change in the saving rate and the level of investment will only have a transitory effect on the steady state growth rate. In general, Solow concludes that the steady state is not bad place for the theory of growth to start, but it may be a dangerous place for it to end (Solow, 2000, p. 7).

Barro and Sala-I-Martin (2004) point out, referring to equation (2.3.1.5) as a fundamental equation of the Solow model; it can provide a basic departure for the convergence hypothesis. The k is determined in each case by the same $sf(k)/k$ and $\delta + n$, if the economy has the same underlying parameters. As a result, the growth rate $\Delta k / k$ is explicitly higher for the economy with lower initial value (poor country). One implication is that countries with lower capital-labor ratio at the initial time will have higher per capita growth rate, $\Delta k / k$. Consequently, developing countries tend to converge to those with higher capital labor ratios (developed countries).[4]

Solow (1957) empirically tested the model using US data over the period 1909-1949. The empirical model is based on the fact that technological progress has been an important factor in determining growth, but it is one that is difficult to put into plain words. It starts with the basic model of Solow's growth in the form of production function. To allow for technological change, variable t is added, such that shifts in production function are defined as neutral, meaning that they can increase or decrease the output from a given input while leaving marginal rates of substitution as is. In that case, the production function takes the form as follows:

[4]Barro and Sala-I-Martin (2004) and McQuinn and Whelan (2007) discuss further the convergence hypothesis into absolute and conditional convergence, and Wolff & Gittleman (1993) provide an empirical example of those cases.

$$Y = T(t) f(K, L) \tag{2.3.1.6}$$

where $T(t)$ measures the cumulated effect of shifts over time in the production function, defined as neutral[5] technological change. Differentiating equation (2.3.1.6) with respect to time, and divide all by Y obtains the output growth:

$$\frac{\Delta Y}{Y} = \frac{\Delta T}{T} + w_K \frac{\Delta K}{K} + w_L \frac{\Delta L}{L} \tag{2.3.1.7}$$

where $w_K = \frac{\partial Y}{\partial K}\frac{K}{Y}$ and $w_L = \frac{\partial Y}{\partial L}\frac{L}{Y}$ are the relative shares of capital and labor, respectively. Equation (2.3.1.7) has the assumptions of a competitive factor market, constant returns to scale and the two factors K and L are paid their marginal products. Moreover, if all factor inputs are classified either as K or L, then $w_K + w_L = 1$. Assuming the conclusion of production function (f) is homogenous of degree one and where $y = Y/L,\ k = K/L$, equation (2.2.1.7) has an expression in the growth of output per unit of labor:

$$\frac{\Delta y}{y} = \frac{\Delta T}{T} + w_K \frac{\Delta k}{k} \tag{2.3.1.8}$$

In the growth accounting framework, if the growth path of T can not be explained by the change in capital and labor, it is then commonly called the Solow residual. The main finding of this empirical test is that gross output per labor hour has doubled for the period 1909-1949, with 87.5 per cent of the increase attributable to technical change and the remaining 12.5 per cent to the increased use of capital. The fact that the proportion of the residual is high and unexplained by the model has generated considerable research and discussion concerning the formulation of policy on economic growth.

[5] Neutrality refers to the condition that output can be increased or decreased from given inputs without having any effect on marginal rate of substitution.

Mankiw, et. al. (1992) have exhaustively tested the Solow model and extended the aggregate production function, with human capital stood-in by educational attainment so as to augment the Solow model. They found that the Solow model performs well in explaining cross country differences in income levels and is even more successful when human capital is taken into account, and concluded that the model is consistent with international evidence, if it acknowledges the importance of human as well as physical capital. Gundlach (2007) argues that it can be the reason for essential change in the Solow model textbook presentation. It follows that a large body of empirical research has been generated by Mankiw, et. al. (1992) discussing the robustness of the study results. However, some studies have criticisms. Islam (1995), Klenow and Rodriques-Clare (1997), Hall and Jones (1999), Gundlach (2007) are among studies that contrast Mankiw et. al. (1992).

In a recent study, Barosi-Filho, et. al. (2005) conducted an empirical test using the dynamic panel data–time series approach to examine individual country. The evidence supports the original Solow growth model. This robustness of the original Solow model is also supported by Klump, et. al. (2007) in their study on the constant elasticity of substitution production function and exogenous Solow growth theory.

It is obvious therefore, that the empirical literature on exogenous growth as to whether or not to augment the model to better explain the factual growth phenomenon is still an ongoing debate. However, despite the discussion surrounding the augmentation, the specific characteristic of the model is simple and relatively compliant for empirical purposes. The canonical model also provides a methodology in growth accounting for measuring the rate of technological progress, the so-called Solow residual model or total factor productivity (TFP) growth. TFP is defined as difference between output growth and the share growth rates of capital and labor inputs. Because its nature is residual, it is in fact a measure of ignorance. Many factors can cause a shift in the production function, such as technical innovation or organizational and institutional change.

The strengths of the exogenous growth model lie in its simplicity and ability to quantify various influences on growth. However, it has some weaknesses that leave the model inadequate for the analysis of growth behavior.

1. The model fails to explain the per capita income dispersion across countries. In addition, the unconditional convergence that all countries will ultimately attain the same income does not hold.
2. The empirical studies found that over 50 per cent of growth is attributable to technological progress. However, the exogenous model does not address the problem of an endogenity of factors influencing technological progress and the volatility of growth rates in the world economy. Even though attempts have been made to embody technological change in variables such as physical investment and labor inputs, it still remains to be determined exogenously.
3. The model indicates that the steady state growth rate is not affected by changes in the level of investment, which means that increases in investment will have only transitory effects on the level of income. This implies that government policy does not have permanent impact on growth, the impact is just transitory. However, there has been empirical evidence indicating that investment has positive and significant effects on growth rate.

The major problems of the exogenous growth model, as discussed, have generated an intense interest in developing a new growth model, the endogenous growth model which might better explain the relationship among the major determinants of growth.

2.3.2. The endogenous (new) growth theory

Using infinite-horizon inter-temporal optimization techniques, and introducing imperfect competition, the endogenous (new) growth model endeavors to capture the effects generated by technological progress and factors of production. A group of models that emerged in the course of the 1980s explain long run economic growth endogenously, by relaxing the assumption of diminishing return to capital and by rendering technological progress endogenous to the model. Output and productivity growth do not rely on exogenous technical progress. The endogenous growth model of endogenous technology focuses on the equilibrium behavior of individuals and/or firms, which is an extension and revival of the ideas of early writers (model), such as the classical economists, Schumpeter (1942) and Arrow (1962). This subsection specifically discusses the endogenous growth model with some formulations.

As discussed in the previous section, the Schumpeterian growth model, economic incentives for new technology development and the linkages between investment and technology diffusion describe the endogenous nature of the growth process. At the micro level, firms searching for new products and production methods to increase profits lead to diffusion of knowledge to other firms. As the swiftness of knowledge dispersion has slowed, it will be followed by a slower rate of economic growth. This condition then encourages new innovation. That is, the Schumpeterian dynamic process of economic development. Meanwhile, Arrow (1962) models the economy that gains from the spill-over effects of increased knowledge. Arrow considers knowledge, through 'learning by doing', to be a function of total capital stock so that the more the economy invests, the higher is its productivity. So, firms gain knowledge from their own and other firms past investment experience.

The endogenous growth model has the standard assumption of an aggregate production function $F(\bullet)$ that depends on physical capital K, labor L, and technology T. Different to the exogenous model of diminishing return technology, it relaxes this assumption and can exhibit either constant or increasing returns. The simplest example of the endogenous growth model with linear production function in a one sector economy is proposed by Rebelo (1991) and takes the following form:

$$Y = f(K, L) = TK \qquad T > 0 \tag{2.3.2.1}$$

The difference of this function with the exogenous model is that the assumption of the marginal product of capital is not diminishing as K goes to infinity. The endogenous model applies a broader definition of capital (K) to include inputs such as human capital, physical capital, knowledge and public infrastructure in order to eliminate the diminishing return to capital feature in the long run. The absence of diminishing returns to the factor that can be accumulated is the key to the endogenous growth model (Barro and Sala-I-Martin, 2004). Aghion and Howitt (2009, p. 13) emphasize that the way to sustain growth rate is to save a large fraction of GDP, some of which will find its way into financing higher rates of technological progress and will result in faster growth.

The endogenous models based on specified preferences, technology and equilibrium concepts are developed to analyze the responses of growth to different external factors[6] and there are various models that examine the impact of different external factors on growth. Romer (1986, 1990, 1994) suggests externalities to research and development. Lucas (1988) focuses on human capital formation externalities (education). Barro (1990) study the government activities externalities, and Grossman and Helpman (1991) explore to the externalities due to technological spillover from trade and foreign direct investment. These are among a few studies that are widely referred to in the empirical literature of endogenous growth. Further studies have stressed the role of other considerable factors that affecting growth, such as infrastructure investment and other types of investment. Thriwall (2002, p. 30) underlines that the formulae is essentially to make capital output ratio rise.

New knowledge (R&D) and growth

Romer (1986) develops an endogenous growth model with technological change by modifying Arrow's (1962) learning by doing setup model to eliminate the tendency for diminishing returns to capital accumulation, by assuming that a byproduct of investment can create knowledge. The knowledge accumulation from forward looking and profit maximizing agents, under the condition of the absence of government intervention is emphasized to be the primary driving force behind the long run growth.

[6] The Kuhn-Tucker theorem has technically been employed to calculate the dynamic competitive equilibrium.

The production function $F(K,T,L)$ has similar properties to the neoclassical, where K and L are conventional inputs which exhibit constant returns. T is the index of knowledge available to the firm, but does not grow exogenously at the rate x. This is different from the neoclassical production function. The new knowledge is assumed to have a good public characteristic which provides positive external effects on the production possibilities of other firms, and has decreasing marginal productivity. In addition, T is the contributing factor to the increasing returns in the aggregate output production, such that any private investment in capital K can simply be assumed to have a positive one-for-one effect on public knowledge T. Clearly, once new knowledge is discovered, it will spill over instantly across the whole of the economy. Therefore, the economy's overall learning and its proportion to the change in the aggregate capital stock, K, result from the change in the firm's technology term, ΔT.

In order to provide the possibility of having boundless growth in per capita income without increasing population growth, other factors such as labor, physical capital and the population size are assumed to be constant. Expanding K would increase T accordingly and provide spillover benefits that raise the productivity of all firms, as the production function is homogenous of degree one in K and T for given L. The key factor in this model is diminishing returns in research technology which restricts the growth rate of the state variable (i.e. new knowledge), and assures the existence of finite-valued social optimum. Barro and Sala-I-Martin (2004) judge that such a model has appeared in Frankel (1962) and Griliches (1979).

In Romer (1986), the model of competitive equilibrium with knowledge externality is articulated by the maximization problem:[7]

$$\max \quad \int_0^\infty e^{-\rho t} u(c)dt \qquad (2.3.2.2)$$

[7] This description is mostly taken from Lim (1999), Barro and Sala-I-Martin (2004), Greiner, et. al. (2005) and Aghion and Howitt (2009).

Subject to

$\Delta k = f(k(t), T(t)) - c(t)$ for all $t \geq 0$

$k(t) \geq 0$ for all $t \geq 0$,

where u is the utility function. It refers to $c = C/L$, for C is the aggregate consumption and L is the number of person employed in production. This utility function is performed by $u(c) = (c^{1-\sigma} - 1)/(1-\sigma)$, where $\sigma > 0$. The ρ is the discount factor, $f(k,T) = F(k,1,T)$ is the net output per worker, k is capital per worker, Δ is the rate of change, and $T = \sum_{j=1}^{L} k_j$ is aggregate capital and knowledge in fixed proportions. It is assumed that the number of firms is equal to the number of consumers and workers, and is constantly seized.

Defining the Hamiltonian (H) equation $H^*(k, \phi, T) = \max_c u(c) - \phi(f(k,T) - c)$, the solutions to the maximization problem in applying the Kuhn-Tucker theorem are as follows (Romer, 1986, p. 1023-1024):[8]

$$\Delta\phi(t) = \rho\phi - D_1 H^*(k(t), \phi(t), T(t)), \quad (2.3.2.3)$$

$$\Delta k(t) = D_2 H^*(k(t), \phi(t), T(t)), \quad (2.3.2.4)$$

where $\phi = e^{\rho t}\lambda(t)$, for λ is the present value Lagrange Multiplier or shadow price of ϕ. By substituting $Lk(t)$ for $T(t)$, this equations system can be independent, as LK is equal to T under the equilibrium condition. As in the Kuhn Tucker theorem, the

[8] Description on the application of the dynamic optimization using the Hamiltonian can be found for example in Aghion and Howitt (2009, p. 43-45)

solution to the maximization problem is the competitive equilibrium with externalities only if the equilibrium condition $Lk = T$ is satisfied.

Specification in the functional forms of the utility function and the production function must be inaugurated to explore the behavior of this system. Further, the utility function is assumed $u(c) = \ln(c)$, the first order for maximizing H^* over c yields $u'(c) = \phi$, or $1/c = \phi$. Normalizing the production function $F(K,L,T) = K^{\alpha} L^{1-\alpha} T^{\eta}$ (which presents constant returns to scale in K and L) by L produces $f(k,T) = k^{\alpha} T^{\eta}$. Putting these into equation (2.3.2.3) and (2.3.2.4), obtains,

$$\frac{\Delta\phi}{\phi} = \rho - \alpha L^{\eta} k^{\alpha+\eta-1}, \tag{2.3.2.5}$$

$$\Delta k = L^{\eta} k^{\alpha+\eta} - \frac{1}{\phi} \tag{2.3.2.6}$$

These equations present the sustainability of growth. In the time when the private marginal product is equal to the rate of preference ρ, the growth will stop. If the private marginal product does not reduce too quickly as the capital grows, it will sustain growth. Aghion and Howitt (1998) highlight some main results from this specification, that is: firstly, the characteristic of the economy such as discount rate will generate long run growth in the case of constant social return to capital. Secondly, the equilibrium growth rate would be less than the socially optimal rate of growth, because the effect of capital accumulation is not internalized in the knowledge. And thirdly, growth entirely relies on external knowledge accumulation, even though it has been endogenized. These main points are empirically supported by Greiner et. al. (2005, p. 24-51) in their study of externalities of investment employing the Romer (1986) model in time series formulation for Germany, France, Japan, Great Britain and USA.

Romer (1990) further develops the framework of model to treat new knowledge as partial public good, with rival and non rival components. This is due to the fact that the assumption of knowledge as free and publicly available is the main point of criticism to be highly unlikely (see for example: Stiglitz, 1990). The model enables profit incentives to be provided to the holder of new knowledge. Therefore, the government has a role to stimulate growth through subsidies in research and development; the accumulation of capital goods which is associated with the research and development incentives. The economy with a higher stock of human capital (in term of skilled labor force) and are more open to international market will achieve quicker growth.

In the more current study, Gancia & Zilibotti (2005) extensively survey the properties of Romer (1986, 1990), expand the variety model through exploring its scrutiny to trade and biased technological change, its effect on growth and inequality, financial development, complementarily in the process of innovation and endogenous fluctuation. They point out that the key feature of increasing returns through the introduction of new products that do not displace the existing ones and the incumbent monopoly rents provide an incentive to undertake research investment. This can incorporate a number of general equilibrium effects that are fundamental in the analysis of growth and development. This is different to another R&D model of creative destruction by Schumpeter which was formalized by Aghion and Howitt (1992). The model has then a tremendous impact on the growth and development literature.

Human capital and growth

The effect of human capital accumulation on the adaptation of economic growth is modeled by Lucas (1988). By relaxing constant return to scale in the production function of the Uzawa (1965) model, Lucas established an increasing return to scale with the external effect of human capital. Human capital is identified by skill or worker effectiveness h. Each worker has a time budget to spend in non-leisure time (u) of the production of final output, and in the acquisition of new skills ($1 - u$). When there are L workers in total, then the number at each skill level is $L(h)$, and the skill weighted man hours in production is $L^e = \int_0^\infty uL(h)h \ dh$, where L grows at an exogenous rate n, while technology to produce human capital is,[9]

$$\Delta h(t) = h(t)\delta[1 - u(t)], \tag{2.3.2.7}$$

In the case that all exertions are allocated to human capital accumulation, the maximal rate of growth for $h(t)$ is then indicated by δ. In this model, the internal (h) and external (h_a) effects of human capital are differentiated, such that h_a is not affected by individual capital accumulation decisions. The final aggregate output is produced by technology:[10]

$$Y(t) = TK(t)^\beta [u(t)h(t)L(t)]^{1-\beta} h_a(t)^\gamma \tag{2.3.2.8}$$

with the constraint $L(t)c(t) + \Delta K(t) = Y(t)$, where c is per capita consumption. To analyze the optimal path of the economy, it takes into account $K(t)$, $h(t)$, $H_a(t)$, $c(t)$ and $u(t)$ under consideration to maximize $\int_0^\infty e^{-\rho t}u(c)L(t)dt$ subject to (2.3.2.7), (2.3.2.8) and the restriction $h(t) = h_a(t)$ for all t. The optimal problem of the current-value Hamiltonian[11] is then,

$$\begin{aligned} H(k,h,\varpi_1,\varpi_2,c,u,t) = \frac{L}{1-\sigma}(c^{1-\sigma} - 1) + \\ \varpi_1\left[TK^\beta (uLh)^{1-\sigma} h^\gamma - Lc\right] + \varpi_2\left[\delta h(1-u)\right] \end{aligned} \tag{2.3.2.9}$$

---

[9] This description is mostly taken from Lim (1999), Barro and Sala-I-Martin (2004), Greiner, et. al. (2005) and Aghion and Howitt (2009).
[10] This treatment follows Meeks (2005).
[11] The current value Hamiltonian is to restructure the problem in terms of current-value prices (see for example: Barro and Sala-I-Martin, 2004, p. 616).

In that equation, the prices for value increments to physical and human capital are represented by ϖ_1 and ϖ_2, respectively. To allow for the process of externality, it is set that $\gamma > 0$. Maximization of H with respect to c and u in the first-order condition are,[12]

$$\frac{\partial H}{\partial c} = 0 \Rightarrow c^{-\sigma} = \varpi_1 \tag{2.3.2.10}$$

$$\varpi_1 (1-\beta) TK^{\beta} (uLh)^{-\beta} Lh^{1+\gamma} = \varpi_2 \delta h \tag{2.3.2.11}$$

with the rate of change of ϖ_1 and ϖ_2 prices are

$$\Delta \varpi_1 = \rho \varpi_1 - \varpi_1 \beta TK^{\beta-1} (uLh)^{1-\beta} h^{\gamma} \tag{2.3.2.12}$$

$$\Delta \varpi_2 = \rho \varpi_2 - \varpi_1 (1-\beta+\gamma) TK^{\beta} (uL)^{1-\beta} h^{-\beta+\gamma} - \varpi_2 \delta (1-u) \tag{2.3.2.13}$$

The optimal evolution of $K(t)$ and $h(t)$ from any initial values of physical and human capital are expressed in the equation (2.3.2.7) to (2.3.2.13) and the two transversality conditions.[13] These two transversality conditions are,

$$\lim_{t \to 0} e^{-\rho t} \varpi_1 (t) K(t) = 0 \tag{2.3.2.14}$$

$$\lim_{t \to 0} e^{-\rho t} \varpi_2 (t) h(t) = 0 \tag{2.3.2.15}$$

---

[12] See Aghion and Howitt (2009, p. 43-45) for a necessary first order condition for maximizing the Hamiltonian.

[13] Transversality condition is the boundary condition which suggests of infinity loosely as the end of the planning horizon. The intuition is that optimizing agents do not want to have any valuable assets left over at the end. If the asset which is effectively being utilized, was used instead to raise consumption at some dates in finite time, the utility would increase (Barro and Sala-I-Martin, 2004, p. 91-92; Aghion and Howitt, 2009, p. 35).

to ensure the existence of a finite-valued optimum. To find the growth rate of this economy on a balanced growth path is to derive the solution for the system of equation (2.3.2.7) to (2.3.2.13). Substituting $\kappa = \dot{c}(t)/c(t)$ into equation (2.3.2.10) and (2.3.2.12) obtains:

$$\beta TK(t)^{\beta-1}\left[u(t)h(t)L(t)\right]^{1-\beta} h(t)^{\gamma} = \rho + \sigma\kappa \tag{2.3.2.16}$$

This equation indicates that in a balanced growth path, $K(t)$ must grow at the rate $\kappa + n$, and the saving rate s is constant. The common growth rate of consumption and per capita capital is generated by the differentiating equation (2.3.2.16) and bounded u between zero and unity, such that,

$$\kappa = \frac{\upsilon(1-\beta+\gamma)}{1-\beta} \tag{2.3.2.17}$$

where υ is the new label for the growth rate of h (equation (2.3.2.7)). Therefore, the equilibrium value of u ultimately determines the growth rate of the economy through equation (2.3.2.7), and its effect on the rate of growth of human capital. This growth rate can be generated by differentiating both first order conditions (2.3.2.10) and (2.3.2.11), and using (2.3.2.11) and (2.3.2.13), to obtain:

$$\frac{\Delta\varpi}{\varpi} = \rho - \delta - \frac{\gamma}{1-\beta}\delta u \tag{2.3.2.18}$$

The efficient rate solution of human capital growth is produced upon substitution and elimination, such that,

$$\upsilon^* = \sigma^{-1}\left[\delta - \frac{1-\beta}{1-\beta+\gamma}(\rho - n)\right] \tag{2.3.2.19}$$

The analysis is to select *h*(*t*), *k*(*t*), *c*(*t*) and *u*(*t*) in the equilibrium path, so as to maximize $\int_0^{\infty} e^{-\rho t} u(c) L(t) dt$, subject to (2.3.2.7) and (2.3.2.8). The valuation of human capital becomes the only difference between equilibrium and optimal allocation, since market clearing needs that $h_a(t) = h(t)$ for all *t.* Consequently, equation (2.3.2.13) can be changed by,

$$\Delta \varpi_2 = \rho \varpi_2 - \varpi_1 (1-\beta) T K^{\beta} (uL)^{1-\beta} h^{-\beta+\gamma} - \varpi_2 \delta (1-u) \qquad (2.3.2.20)$$

In the case that there is no external effect $(\gamma = 0)$, the private valuation of (2.3.2.12) and the social valuation of (2.3.2.13) are the same. Along with the equilibrium balanced growth path, $\Delta \varpi / \varpi = \rho - \delta$, the equilibrium growth rate of human capital is provided by,

$$\upsilon = \left[\sigma(1-\beta+\gamma) - \gamma\right]^{-1} \left[(1-\beta)(\delta - (\rho - n))\right] \qquad (2.3.2.21)$$

It is implied that effectiveness of investment in human capital δ or lower discount rate ρ are associated with the efficiency of both (2.3.2.19) and competitive equilibrium of (2.3.2.20) growth rates of human capital. In the case of equation (2.3.2.17), if $\lambda > 0$ then $\kappa > \upsilon$, implies that the external effect generates faster growth in physical than human capital. It is suggested that the long run growth of an economy with low initial levels of physical and human capital will always be lower than an economy having better initial endowments.

Using Denison's (1962) estimates of *n, κ, β,* and *s*, Lucas attempts to empirically fit the model to the US economy. Based on the given parameters, the efficient growth rate of human capital can be computed as a function of *σ*. As it does not examine the role of human capital accumulation in enlightening the growth, this approach is considered to be unsatisfactory. However, Greiner et. al. (2005, p. 52-80) emphasize that this model explicitly takes into account the need of resources to perform human capital to be effective, the process which does not appear in Romer (1986, 1990), because knowledge is simply a byproduct of physical capital formation. Another difference of this model is on emphasizing the creation of human capital, while the other (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992) stresses R&D to perform knowledge accumulation to promote growth. This model which is popularly called the Uzawa-Lucas model becomes the prototype endogenous growth model with human capital.

Further endogenous studies

Using a similar maximization solution as in Romer (1986) and Lucas (1988), there are further studies in the endogenous growth framework where the models generate the variables which consider endogenously in a variety of ways. They originate various factors influencing growth, such as: government activities, financial systems, and innovation and R&D.

Government activities

The externalities effect of government activities on growth is initially constructed by King and Rebelo (1990) and Barro (1990). King and Rebelo (1990) formulate an endogenous growth based on Uzawa's (1965) model, considering the externalities of government policy, particularly national taxation, on the rate of long run growth. In a two sector endogenous growth model, it is hypothesized that public policy can influence the incentives for individuals to accumulate both physical and human capital. At a uniform rate, both sectors are taxed, then, compensation as a lump sum ensues. When human capital stock grows at the same rate as capital stock, physical investment, consumption and each sector outputs, the model provides an array of feasible balanced growth paths. In a small open economy, it is indicated that national taxation can substantially affect long run growth rates. In general, an increase in the rate of income tax decreases the rate of return to private sector investment, and subsequently leads to a permanent fall in the rates of capital accumulation and growth. It is arguable therefore, that differences in economic policy trough taxation lead to heterogeneity in growth experiences across countries.

Barro (1990) articulates another formulation of the endogenous growth model by emphasizing the externalities of the tax financed government services and its relation to the rates saving and economic growth. Some implications have been indicated from the formulated model. Firstly, even though there is no direct effect of the share of non productive government expenditure on the productivity of the private sector, it results of reducing after tax marginal return on capital. Consequently, an increase in the share of non productive government expenditure allows the rate of growth and saving to decrease. Secondly, the variation of productive government expenditure in the share of GDP is indicated to have a positive affect on the growth and saving rate. However, because its source is also from tax, increasing the share of productive government expenditure has therefore also negative impacts on the growth and saving rate. Thus, the effect is in fact non-monotonic due to two opposing aspects. Barro (1990) highlights that the positive effect is durable when the government size is relatively small, and vice versa for the negative effect when the size of government is large. A recent survey on productive government expenditure and economic growth conducted by Irmen and Kuehnel (2008) however, finds a point of criticism in the model formulation: the steady state growth rate generated by non scale models is independent of government activity and the size of the economy (see also for example: Peretto, 2003).

Financial system

The importance of financial development in endogenous growth is modeled by King and Levine (1993b, 1993a) and Pagano (1993). In their model, King and Levine (1993b, 1993a) articulate that a financial system, indicated by good institutions, facilitates productivity improvements by providing services on best investment criterions considering the risks and prospects. The idea basically returns to the Schumpeter thought on the role of a financial system on economic growth. Meanwhile, according to Pagano's (1993) model, financial development through changing either the proportion of savings lost in financial intermediation, marginal productivity of capital or private saving rate can affect long run economic growth. A more recent study by Levine (2005) supports the external financing constraint facing firms, which elucidates one mechanism through which financial development influencing growth can be facilitated by a better developed financial system.

Innovation and R&D Spillover

Another important factor of endogenous growth formulation is the innovation and R&D which is based on the knowledge-creation function as the central component of externalities. Ha and Howitt (2007) categorize three versions of the formulation of the innovation and R&D based endogenous growth model. Firstly, the first generation of a fully endogenous growth model developed by Aghion and Howitt (1992), Grossman and Helpman (1991) and Romer (1990). Secondly, a semi-endogenous model developed by Jones (1995a). And thirdly, fully endogenous models with product proliferation presented in Aghion and Howitt (1998) and Howitt (1999). The general view of the model is that the growth rate is a function of the total amount of current research and the expected amount of the next period of research. The difference with the other endogenous growth model where intertemporal spillover effects tend to generate growth slower than its optimal, such as Romer's (1990), the stationary equilibrium of growth of the Aghion and Howitt model of creative destruction is close to socially optimal. Ha and Howitt (2007) argue that the long run trend in R&D is more supportive of a fully endogenous Schumpeterian growth model than the semi-endogenous growth theory.

In an empirical work, Sedgley (2006) argues that per worker output growth is a function of the growth rate of knowledge and capital stock, and the variation in degree of the human capital. Using the annual patent issued by the US Patent and Trademark Department as a proxy of knowledge, Sedgley tests the innovation-driven endogenous growth to the USA data in a time series approach. The author finds that knowledge growth series play a significant role in the growth process.

It is in general recognized that most endogenous growth formulation is an extension of the exogenous growth theory, which is assigned to analyzing the equilibrium growth path. The role of investment is heavily emphasized to produce various external factors such as human capital, new knowledge, and government services which then generate productivity in the economy. This process enables easing the assumption of diminishing return in the production function. The key feature is the presence of positive externalities of factors, which prevent the marginal product of capital from falling and the capital-output ratio from rising. This can be in effect when investment takes place, which then makes the productivity of economy increase.

Based on the discussion in this section, it can be concluded that in general, there are several implications that can be drawn from the model and framework of the two modern growth theories of the exogenous and endogenous model in relation to their use in an empirical study.

- First, according to the exogenous growth model, growth is exogenously generated by technological progress. Hence, government policy does not have a permanent impact on long run growth. In the endogenous growth model, the growth is generated by factors that can be influenced by appropriate government policy.
- Second, according to the exogenous growth model, a developing country grow faster than a developed country, because of diminishing returns to capital and because capital tends to flow toward economies that provide higher return. In the endogenous growth model, a developing country can grow faster than a developed country because of productivity catching up. Developing country can catch up frontier technology of developed country in order to accelerate its productivity and growth.

It is obvious therefore that in order to analyze the driving forces of economic growth of a specific developing country, the first step is to determine which of the models is most suitable, by investigating whether the characteristic of the long run growth is exogenous or endogenous. The second step is to examine how productivity related to growth is generated and measure how rapidly this productivity accelerates growth. The third step is to identify the driving forces of the level, and the growth, of real per capita income, using the model found in the first and second steps. The next section discusses these three steps procedure to analyze economic growth of a developing economy.

2.4. Three steps procedure to analyze economic growth

The three steps essential to study economic growth of a developing country are related to the fact that the growth theories have provided two competing models. This section further discusses and reviews the three steps concerning the testability for empirical purposes.

2.4.1. Testing exogenous or endogenous growth model.

The model and framework of economic growth theories have provided two competing views of modern growth theories, exogenous and endogenous. An essential issue is which of these models is appropriate to analyze the long run economic growth for an economy for the purpose of economic development.

Essentially, the main difference between exogenous and endogenous models lays in the impact of government policy on long run growth. In the exogenous growth model, any change in the factors and policy variables that can be conducted by the government has only a transitory effect, while the endogenous growth model predicts that any changes in the policy variables have a permanent effect. If an economy is consistent with the exogenous growth characteristic, diminishing returns to reproducible factors; and saving rates, population growth and technological progress determine exogenously, then policies do not have role in silhouetting long run growth. In contrast, endogenous growth attempts to relax the diminishing returns to reproducible factors by constant or increasing returns. This process is characterized by adding the concept of human and physical capital and introducing externalities, so that the long run growth rate is determined endogenously, in the sense that it depends on the investment decisions that in turn could be influenced by the government's policy.

For the purpose of analyzing a specific country, recognizing an economy to which its economic growth characteristic belongs to, either exogenous or endogenous, is essential and is the first fundamental procedure of economic growth research of a specific country.

It is observed that an economy characteristic is highly persistent, whereas country growth rate of income is highly unstable over time. In fact, the long run growth behavior differentiates the exogenous and endogenous growth models. The development of econometric analysis tools, specifically in time series literature makes the implications of exogenous and endogenous growth models testable. There have been some methods developed to empirically test whether the long run economic growth of an economy belongs to the exogenous or endogenous model. Those methods are basically classified into two approaches, namely, the regression equation of time series, and cointegration and ECM approach.

Regression equation of time series

Jones (1995b) and Kocherlakota and Yi (1996) separately constructed a dynamic time series model to tests the exogenous and Rebelo-type endogenous model through the effect of certain policy variables on economic growth. If policy variables have a significant effect, it is revealed as endogenous, otherwise, exogenous model. The original model has the following form:

$$g_t = A(L)g_{t-1} + B(L)i_t + \varepsilon_t \qquad (2.4.1.1)$$

where g_t is the growth rate of output, i_t is certain policy variable, $A(L)$ and $B(L)$ are two lag polynomials, each order *p,* with root outside the unit circle, and ε_t is a zero mean stationary process. In this model, the variables can effect output growth all the way through contemporaneously or no contemporaneously.

The main difference between Kocherlakota and Yi (1996) and Jones (1995b) is that variable i (policy variable(s)) in Kocherlakota and Yi (1996) does not have a contemporaneous effect on output. Kocherlakota and Yi (1996) argue that policy variables such as tax rates and government capital effect growth rates largely through their effect on private and / or public capital accumulation. It appears in most macroeconomic models to treat lagged capital, not current capital as the relevant input production. Hence, only policy variables, not current variables should effect growth. This argument is supported by Bleaney, et. al. (2001) in their investigation of a long run endogenous growth model in relation to public expenditure and taxation.

Theoretically, the exogenous growth model predicts that permanent shock to i_t has only a temporary or transitory effect on economic growth. If $B(1)$ in equation (2.4.1.1) is statistically different from zero (< 0 or 0 <, correspond to economic theory), it indicates that a permanent shock to i_t has a permanent effect on the growth rate, which corresponds to the endogenous growth model.

Durlauf et. at. (2005) point out that this form of test is typically related to the Granger causality testing. The hypothesis of interest is the explanatory power of lags of i_t on g_t conditional on lags g_t. The same opposite direction could therefore happen, in case that g_t actually affects i_t conditional on lags i_t. Further, the existence of interaction among the policy variables are not themselves discussed.

Karas (2001) modifies equation (2.4.1.1) by omitting the lags of dependent variable on the right hand side, putting the level of the policy variables and performing leads and lags of the policy variables differenced on the right hand side.[14] The point is that

[14] The purpose of performing the lead and lags is to solve any endogenity and super consistency problems in the model. Karas adopts this correction from Hamilton (1994).

the parameter estimates are still the coefficient of the policy variables in level (Wooldridge, 2008, p. 642). Karas (2001) uses this formulation to investigate twenty European countries and found that most European countries have exogenous growth characteristics.

The regression equation of time series shows its simplicity to test the competing exogenous and endogenous models. The policy variables can affect the output growth all the way through contemporaneously and no contemporaneously. This effect is to determine whether the impact is permanent or transitory, through its significance in the estimates of the model. In utilizing the model, it is imperative to always consider the degree of freedom, to attain an accurate outcome. As for example in Karas (2001), it is obvious that the willingness to add the policy variables will consequently require an additional sample size, because every independent variable will be performed in its differenced leads and lags, if they are I(1). Therefore, it is essential to only consider the variable that is really representative and have growth effect.

Cointegration and ECM

The cointegration and error correction approach is another form of time series properties which is employed to test the exogenous and endogenous growth model. The empirical methods of examining two competing growth theories, have been developed in a univariate (Lau, 1997), multivariate (Lau, 1994; 1999), and bivariate (Lau, 2008) model.

Lau (1994; 1997; 1999) shows that to exhibit sustained growth in the steady state growth path in the endogenous growth model, it is necessary that the autoregressive polynomial in the observed variables presents one unit root in order to generate perpetual and non explosive growth. In the bivariate model, the main analytical framework of the test is to observe the structural innovation if the output and the policy variables are cointegrated. The structural innovation has two characteristics, namely: transitory and permanent. The transitory has by construction no long run impact on the variables in the system, while permanent shock must have significant long run impact on at least one of the variables in the system. If the growth is generated by the exogenous model, the structural innovation exhibits transitory shock. Conversely, if the growth is generated by the endogenous model, the innovation exhibits permanent shock.

Zhu and Oxley (2001) empirically employ the concept of unit root and cointegration to examine the role of human capital, and R&D in the economic growth of the USA for the period 1959-1990. The inclusion of human capital and R&D is an extension of the two sector growth model. Using Johansen's type of cointegration and ECM, and Toda and Yamato's (1994) type of causality tests, they find weak support favoring the exogenous growth model. In another case, Zhu and Oxley (2002) investigated New Zealand's economic growth using the same method, and extended the standard two sector model to consider *m*-types of capital, where one of these is human capital. The conclusion was that the growth did not support the exogenous model.

In a bivariate ECM form, Lau (2008) specifically investigated the long run effect of change in investment share on per capita output for France, Japan, and the United Kingdom. The author uses the Solow-Swan exogenous model and the Rebelo (1991) endogenous model, and tests them utilizing the cointegration and ECM approach. The evidence is unfavorable to the class of endogenous growth model.

The cointegration and ECM approach demonstrates its logical system in the testing of the two competing growth models. In this approach, all variables, including output level and the policy variables are considered endogenously. The strict requirement is that they must be cointegrated; otherwise the outcome will be inconclusive. The impact of the policy variables on the output level in the error correction system is determined through the coefficient estimates of the error term and the impact of shock of the variables to the output level. To get more outcome accuracy, the approach requires data of a larger sample size. Therefore, given the limited data available, it is essential to only consider the variables that are really representative and will have a growth effect in the studied economy.

Overall, it is possible that both the times series equation and the cointegration and error correction procedures can have different outcomes in testing whether the economy belongs to the exogenous or endogenous growth model. The dynamic time series equation properties approach has its simplicity, but needs construction to make the inference procedure valid. The selection of policy variables is not an easy task as well, which needs further consideration to be appropriate and representative, and have a strong sense of theoretical macroeconomics. Differently, the cointegration and ECM approach represents a stricter test on the endogenous specification. However, the cointegration and ECM approach enables the translation of the basic theoretical concept of endogenous growth to simplistic empirical models. In essence, it is concluded that to investigate the long run growth, the exogenous or endogenous is testable using econometric methodology.

2.4.2. Examining productivity related to growth – catching up hypotheses study

The second fundamental component and mechanism of modern economic growth theories is the process of generating productivity. Both exogenous and endogenous growth models have the same supposition but different cause roots (Scoppa, 2009). In both models of modern growth, developing economies tend to grow faster than that of developed countries. According to the exogenous growth model, it is because of diminishing returns to capital. In the endogenous growth model, developing economies tend to grow faster than that of developed countries because of technology catching up. Accordingly, investigating and measuring the productivity related to growth is an essential step in studying economic growth of a developing country.

The fundamental assumption of the exogenous model is diminishing marginal returns to capital leading the growth process within an economy to eventually reach the steady state where output per capita, capital stock, and consumption grow at a common constant rate equaling the exogenously given rate of technology progress. Poorer country tends to grow faster than that of richer countries because of diminishing return to capital. Poorer countries which have lower endowment of capital, accumulate greater physical or human capital and, in addition, capital, characterized by higher return, tends to flow toward these economies. Consequently, developing countries can achieve high output growth and catch up developed countries in terms of income level in the long run.

The conception of a poorer country growing faster than a richer country in the exogenous growth model brings about to the notion of income level catching up, which in turn can be understood in two different ways. First is convergence in terms of income level. The steady state of the income level of the countries will be the same, and with time they will all tend to reach that level of per capita income, if they have similarities in terms of preferences and technological progress. Second is convergence in terms of the growth rate. All countries will eventually attain the same steady state growth rate, given that technology progress which is exogenously determining growth, is available to be equally shared. Therefore, if both countries have the same preferences, a poorer country tends to grow more rapidly than a richer country in terms of per capita income. In the long run, they will reach the same level of per capita income.

Outside the exogenous growth paradigm, a body of literature on the endogenous growth model assigns the concept of catching up which argues from the view that economic growth is inversely related to the initial level of productivity. A poorer country tends to grow more quickly than that of richer country because of productivity catching up. The more backward a country is in productivity, the greater the scope for catching up through the adoption of technology. Consequently, because of a more rapid shift of resources from a low productivity to a high productivity sector, the backward country would grow faster than the rich, developed country (Thirwall, 2002). As it is widely and empirically acknowledged that the level of productivity is identical to the level of technology, this kind of notion is commonly called technology catching up.

The technology catching up hypothesis states that the developing country, as the lagging or relatively backward country, can catch up a leading country through adoption and implementation of frontier technology in order to accelerate its productivity and growth. This process is strategic, because it is not overly associated with the R&D cost which most developing and laggard countries suffer from. Barro and Sala-I-Martin (2004) point out that imitation and implementation have been one development strategy chosen by the follower country, since it is cheaper than innovation. There are some channels through which technology adoption takes place, such as foreign direct investment and international trade. However, even though the relatively backward country benefits, the process of adoption and implementation of frontier technology itself is not automatic. It is imperative for the backward country to have a certain degree of adoption and implementation capacity.

The two notions of catching up are then conceptually important for developing countries. In a specific country, the technology catch up can be used to accelerate its productivity and growth through adoption and implementation of frontier technology, while the income level catching up can be used to measure whether the growth rate in output level achieved by the country has been able to bring the economy into the process of catching up to the leading economy, in term of income level. Therefore, the latter can be used to measure the success of the former. Dowrick & Rogers (2002) emphasize this relationship, that technology transfer is an important contributor for the income level catching up (convergence) process. Durlauf et. al. (2005) point out that many authors view convergence as the process of laggard countries catching up to the leader countries by adopting leading technologies. Therefore, this study utilizes those catching up hypotheses in order to investigate the cause of productivity and to measure the rapidity of the productivity growth.

Technology catching up (diffusion of technology) studies

The concept of technology catching up states that a lagging (developing) country can achieve higher economic growth compared to a developed country because of adopting and implementing frontier technology innovated by a leading country, and that the developing country does not necessarily need to expend too much resources in R&D (Nelson and Phelps, 1966; Abramovitz, 1986; Baumol, 1986; Delong, 1988; Barro and Sala-I-Martin, 1997; Durlauf et. al., 2005). Benhabib and Speigel (2005) affirm that the technology catching up hypothesis was originally proposed by Gerschenkron (1962). Nelson and Phelps (1966) then formalized it which applied to the diffusion of technology between countries, with the country leading in total factor productivity representing the technology frontier. This concept of technology catching up has been one development strategy chosen by many developing countries.

The importance of technology in economic performance is that it can produce intrinsic factors of productivity. The study of economic growth is also devoted to explore how developing countries, which are technologically left behind, set up their development strategies to catch up to the frontier technology of developed countries in order to accelerate productivity and growth. This area has been attracting interest by researchers to analyze the capacity and capability of the developing countries to catch up this frontier technology of advanced economies.

In empirical studies, the existence of the process of technology catching up is commonly examined by regressing the growth rate of productivity against the technology gap between leading and laggard country (see for example: Kang, 2002; Rogers, 2004). The significance of the parameter estimate of technology gaps then indicates the existence of technology catching up. Some variables have been included to the model to reflect the role of absorption and implementation capacity of laggard country, such as human capital development, macroeconomic performance, international trade and so on.

The visible benefits of the laggard countries which have low initial income and productivity levels is that they can employ copied frontier technology to generate growth without having associated with the cost of R&D. Therefore, as the catching up hypothesis states, the laggards countries will tend to grow more rapidly than advanced countries not only because of a more rapid shift of resources from a low productivity to high productivity sector, but also because they are not burdened by innovation costs. As for the frontier technology country, it is not free from incentives as well to maintain their leading technology, by spending their resources on research and development. The financial outcome is commonly generated by these types of rent with the intention to cover innovation cost, which becomes an incentive to sustain research and development.[15]

Kang (2002) argues that the relative backwardness holds the potential for rapid growth, but, its realization depends on the laggard country's adoption capacity: the capacity of the lagging country to adopt the advanced technologies and adapt to their own needs. Hence, technology catching up is strongest in countries that are not only technologically backward but also in those that have policy determinants conducive to technology adoption. Therefore, the concept of absorptive capacity and national innovation help to answer the question of the technology catching up, why developing countries can not catch up to the leader at the same rate or even fall behind.[16]

Roger (2004) and Kang (2002) investigate the importance of adoption capacity factors for the purpose of technology catching up. Roger (2002) uses students studying abroad and information and telecommunication technology, and Kang uses policy variable factors, to proxy adoption capacity. Both studies find that adoption capacity is important to the process of technology catching up. This result is supported by Stokke's (2004) observation using an extension of Papageorgiou's (2002) model to see the specific role of human capital in technology catching up for

[15] Furman and Hayes (2004) show frontier country's efforts in order to maintain and increase their innovation. They argue that development of innovation-enhancing policies and infrastructure are necessary for achieving innovative leadership, but these are insufficient unless with ever-increasing financial and human capital investments in innovation.

[16] See Verspagen (1991) who propose the model of catching up and falling behind test.

Thailand. Stokke exclusively suggests improving the absorptive capacity through investment in basic education.

The successful portraits of policies for the purpose of technology catching up are empirically shown by many East Asian countries whose level of technology is initially low compared to that of leading countries. They have successfully put their policies in place in order to build absorptive capacity for the purpose of adoption and implementation of frontier technology (Han et. al., 2002; Lim and McAleer, 2002; Cameron, 2005; Wang, 2007). In the early 1960s, the per capita income for countries like South Korea, Singapore, Hong Kong, and Taiwan are almost the same as the low average of a developing country. At present, their per capita income is almost the same as the high income country. The studies find that adoption and implementation of frontier technology have been able to accelerate their productivity and growth. Policies related to physical and human capital accumulation are arguably the most influential factor in those countries.

The empirical studies have made an unambiguous portrayal of technology catching up (diffusion of technology) enables a developing country to break the wall of differences between the developing and developed country. There have been some predictions if this is the most appropriate process. Guest and McDonald (2007) argue that, at present, the large differences in total factor productivity (TFP) between countries of the world are suggestive of a substantial disequilibrium. Guest and McDonald subsequently emphasize the Lucas (2000) argument that for long run projections, the assumption of diffusion is the appropriate one. Guest and McDonald (2007) studied the projections of future shares in worldwide GDP - divided into nine regions, namely: Africa, Asia (excluding China, Japan, and India), China, Japan, India, Europe, Latin America, North America and Oceania. Their simulation suggests that there will be a decreasing share (by 32 per cent) of the worldwide GDP in high income regions (North America, Europe, Oceania, and Japan) by 2050. This decrease is due to TFP catch up (66 per cent) and demographic change (33 per cent) .With the assumed speed of TFP catching up, over 150 years the laggard regions will substantially catch up with the leader region by which time TFP levels equalize. This is longer than Lucas' (2000) prediction, in which by 2100, all countries should be equally rich and growing.

Another empirical prediction is made by Taylor and Rada (2007) who illustrate projections of per capita income between two groups of developing economies and rich economies for the period 1998 – 2030. This projection is made on the basis of an extended growth accounting framework which accounts for the interaction between trends in capital and labor productivity. This extension enables to take into account policy factors which influence technology diffusion, such as openness, industrial policies and physical and human capital accumulation. Conditionality is found in that the gap between poor and rich countries will narrow only if poor countries' growth is at a steady state and uninterrupted over several decades. If this holds, the Asian Tigers (Hong Kong, Republic of Korea, Singapore, and Taiwan) will narrow their gap from $12,063 in 1998 to $1,728 in 2030, which is faster than that of Latin America, $15,475 to $12,063.

The intrinsic process of technology catching up has empirically shown its magnitude for developing countries to accelerate productivity and growth. Therefore, it is a fundamental reason for a developing country to set technology catching up as one of its development strategies. This process has in fact been the most selected strategy of successful developing countries, especially in many South East and East Asia countries, such as Korea, Taiwan and Singapore (Zhang, 2003; Wang, 2007). Nonetheless, this process is not automatically gained but rather, the developing country should also develop their absorption capacity. This is the area that decision makers should establish their policy.

This study intentionally put forward that the specific aim of examining technology catching up of developing or laggard countries is to observe whether the process of adoption of technology from frontier country to accelerate productivity and growth exists. This study also intends to identify factors in order to develop stronger adoption capacity to support the process of catching up. The outcome of this investigation is to provide one alternative development strategy in order to accelerate productivity related to growth. Development of econometric has confirmed that this process is testable (see for example: Kang, 2002; Rogers, 2004). However, most empirical studies in this technology catching up only deal with the cross country approach, and still lack in employing the times series method. Hence, examining the technological catching up utilizing a time series procedures will fill this gap.

Income level catching up (convergence) studies

The concept of income level catching up refers to the process that a developing country can accelerate the growth of per capita income, so that the income level can attain the level of per capita income of a developed country in the long run. This process is also called the convergence hypothesis. Barro and Sala-i-Martin (2004) verify the two concepts of convergence, firstly, that the lower levels of per capita income, which are expressed relative to their steady state levels of per capita income, tend to grow faster, so that they will converge in the long term. Secondly, the concept of convergence refers to the behavior of the dispersion of real per capita income across a group of economies or individuals which tend to fall over time. This review of income level catching up will focus on studies that have used a time series approach.

King and Ramlogan (2008) define the convergence hypothesis in one of three ways, namely: unconditional or absolute convergence, conditional convergence and convergence clubs. Absolute convergence is the idea that countries will be in a position of equal per capita income level, and growth path, in the long run. It means that the poor countries eventually have higher growth rates of per capita income to catch up to the higher per capita income. The conditional convergence corresponds to the idea that countries which have the same structural characteristic will converge at the same per capita income level. The convergence clubs refer to the conditional convergence which necessitates the initial conditions to be similar as well.

In the study of catching up as convergence, much empirical work has been on exploring a cross sectional approach. Bernard and Durlauf (1995, 1996) have pointed out however, that a cross sectional approach has a number of drawbacks: (i) it just provides a general report concerning the convergence and it does not show each country's position to their steady state, (ii) it looks at a negative correlation between countries' average per capita growth rate and initial per capita income level. Hence, the approach requires the countries to be in transition to the steady state. If the country has been in that position, then it will not exhibit correlation.

Bernard and Durlauf (1995) further propose to use the time series framework. In their concept, convergence is to determine whether there is a common deterministic and or stochastic trend for different countries. It means that the convergence exists if each country has identical long run trend. In their definition, the concept of catching up and convergence implies that countries *i* and *j* converge between dates *t* and $t+T$ if the per capita output disparity at time *t* is expected to decrease in value (if $y_{i,t} > y_{j,t}$).

$$E(y_{i,t+T} - y_{j,t+T} \mid \Im_t) < y_{i,t} - y_{j,t} \qquad (2.4.2.1)$$

This definition leads to the consideration of the behavior of output difference between two economies over a fixed time interval and equates convergence with the tendency of the difference to narrow. This definition however, has a prerequisite[17] from the second definition of convergence as equality, which states that long term forecasting of per capita output for both countries are equal at a fixed time *t,*

$$\lim_{k=\infty} E(y_{i,t+k} - y_{j,t+k} \mid \Im) = 0 \qquad (2.4.2.2)$$

[17] See the Proposition 2 of Bernard and Durlauf (1996, p. 166) concerning the relationship between definitions.

In this hypothesis, economies can converge if their deviation of output has the stationary process. The ADF unit root test has been typically used to test this hypothesis in empirical studies. Some extensions have also been considered by allowing for structural breaks in the catching up process (see for example: Oxley and Greasley, 1995; Lumsdaine and Papell, 1997; Li and Papell, 1999; Tomljanovich and Vogelsang, 2002; Maeso-Fernandez, 2003; King and Ramlogan, 2008).

Another articulation of Bernard and Durlauf (1995, 1996) implies that the catching up process holds if the output level among the countries is proportional and cointegrated (Giles, 2005). This notion is testable using cointegration and ECM. The limitation of this concept is the strict prerequisite to have a stationary disparity condition for the countries to be able to converge, otherwise, they can not be defined. In a recent study, Phillips and Sul (2007) argue that the two hypotheses of cointegration and convergence are related, but they have different attributes. They prove that two series can have co-movement or convergence even though there may be no empirical evidence for cointegration between them.

Another proposition of income level catching up is due to Nahar and Inder (2002). They argue that the process of convergence and catching up can happen even when the deviation of output between the leading and developing country is non stationary. According to Nahar and Inder, whenever the deviation of output comes closer to zero as time progresses, it should be considered that convergence or catching up takes place. Nahar and Inder then propose a polynomial time trend model for empirical application, which defines the output deviation as a function of time. The significant of the average slope which directs the output deviation to move to zero indicates that the income level catching up occurs. Employing this method, Nahar and Inder (2002) show that the countries can converge or catch up, even though their deviation output is not stationary.

Bentzen (2005) employs Nahar and Inder's (2002) polynomial time trend model and incorporates detection for specific sub periods with respect to the catching up process of 22 OECD countries to the leading of USA in a pair wise. Bentzen finds that GDP per capita in 20 OECD countries catching up to the USA income level, take place in the first decades after World War II (with Ireland as an exception).

This study intentionally proposes that the specific and main aim of examining the existence of income level catching up in an economy can be used to measure whether the growth rate achieved by a country has been able to bring the country to the level of the developed country's income level in the long run. The development of the methodology in time series econometric facilitates investigations of the existence of the process of catching up in income level (convergence) or partial convergence[18] hypothesis. The time series method also does not necessarily need that the country studied to be in transition to the steady state. Further, the advantage of using time series approach to examine the income level catching up is to uncover some drawbacks of the cross section approach that, with others, can provide information on a specific country in much more detail. The rigidity of the unit root test approach in investigating output level catching up, has been uncovered by Nahar and Inder (2002), who propose the polynomial time trend method facilitates investigating output level catch up when the output level differential between studied countries is non-stationary.

The importance of both technology and income level catching up can therefore be a useful combination analysis tool for a developing country in their development process. The technology catching up can be used by the developing country to accelerate productivity and growth through adoption and implementation of frontier technology of an advanced country. Developing absorptive capacity is then crucial in this regard. Meanwhile, income level catching up is an important tool to measure whether the growth rate achieved by the developing country as a result of successfully implementing technology catching up, is able to catch up to the

[18] The term of partial (weak) convergence is drawn from King and Ramlogan (2008) to describe the process of convergence when one of the countries studied has not been in steady state condition (Bernard and Durlauf, 1996). Thus, the catching up is simply that the per capita output differential diminishes over time.

developed country in the long run in terms of income level. It is also confirmed that those catching up hypotheses are testable using econometric methodology.

2.4.3. Discovering the driving forces of the level and the growth of real per capita income

The third fundamental component and mechanism for analyzing economic growth of a developing country is to discover the driving forces of growth. One of the biggest challenges faced by the growth economists is to identify the driving forces of the long run growth rate of output. This task has always been a central concern of growth studies. Given two models of growth in modern growth theories, the model to be used to identify the driving forces of growth is determined based on the result of the first and second investigation, that is, the result of testing exogenous and endogenous, and the catching up hypothesis. The main objective of this subsection is to identify the main sources and determinants of economic growth. Two basic categories of economic growth models are identified, namely, those based on the exogenous growth model and those based on the endogenous growth model.

Modern growth theories attempt to explain the factors affecting the levels, and the growth rate, of output over time. Both the exogenous and endogenous growth models have the ability to articulate with this issue and guide the policy makers bringing about an increase to the standard of living of an economy. However, there is very little agreement on the process on which they articulate the driving forces into the sources and determinants, since their departure and mechanism is different. In the present consensus, a number of proximate sources stand as basic determinants of growth, including the accumulation of physical and human capital and knowledge that can be used in production, have largely determined economic growth. Meanwhile, other deep determinants may work through the proximate sources and cause variation in macro economic performance (Kong, 2007).

The capital accumulation, rate of change in population and technological progress are emphasized as sources of economic growth in the exogenous model. The underlying model believes that if all market based economies have the same technological progress and population growth, they will eventually reach the same growth rate. In contrast, the endogenous growth model argues that over the long run, countries appear to accelerate their growth rates, and their per capita income differs substantially. Hence, in the long run, economic incentives for the purpose of technology spillover to lower the cost of future innovations and an educated work force determine economic growth.

A body of literature on the determinants of growth also explores and discusses the role of productivity. The different treatments of the two competing growth theories have underlined the debate on the productivity role in determining growth. The exogenous growth model suggests that productivity growth which is embodied by technological progress is the source of growth, and then capital accumulation facilitates the process of income level catching up. In contrast, the endogenous growth theory explains that difference in the productivity (technology level) among countries makes even per capita income level vary between countries. Chen (1997), extensively surveys and examines the studies of technology progress or total factor productivity as a source of growth in East Asian economies. This study emphasizes from the debate concerning the role of productivity as a source of economic growth after the empirical finding initiated by Young (1992; 1994; 1995), shows that the issue of the importance of productivity on growth is subject to its measurement and definition. In most cases, the measurement of productivity is sensitive to the input factor in the formulation of production function.[19] Therefore, even though most growth theories suggest the importance of productivity, the measurement is a problematic one, and hence the effort to enrich this factor needs attention. The empirical studies of economic growth have also been exploring these factors including non-economic variables to determine productivity.

---

[19] This case can be seen in the Chapter IV, when it is determining technology level of Indonesia and leading countries. In a Cob Douglas production function which constant return to scale, the assumption of the elasticity of capital and labour to output and the assumption of depreciation rate heavily influence the outcome of productivity level.

Theoretical and empirical studies of growth have reached a consensus, in that one of the main factors determining the level of real per capita income is the physical capital. Even though it does not have long run impact in the exogenous model, capital accumulation facilitates the process of income level convergence, in the sense that a lower income country tends to grow faster than that of the richer (Kong, 2007). In endogenous growth, the impact of physical capital which is enhanced by investment and its externalities is straightforward, because it impacts endogenously (Bassanini and Scarpetta, 2001), and permanently (Bond et. al., 2004).

The common way to proximate the physical capital in analyzing economic growth is to utilize the investment rate or saving rate. Weil (2005, p. 50) points out that investment is the process of producing capital; this then distinguishes to natural resources.

The role of human capital has been the core attention of economic growth studies since Adam Smith, by emphasizing specialization in labor. Recent studies assume that human capital is an enrichment formal skill, and experience in labor. Bassanini and Scarpetta (2001) argue that there are two treatments of human capital. On the one hand, a more and highly trained and skilled workforce would enjoy a higher level of income, due to human capital that is subject to diminishing returns. On the other hand, if high skill and training go hand in hand with more intensive research and development and a faster rate of technological progress, or if the adoption of new technologies is facilitated by a highly skilled workforce, investment in human capital could have a more permanent impact on the growth process. By augmenting Solow's exogenous growth model with the human capital, Mankiw, et. al. (1992) find the estimated rates of convergence equal to approximately 2 per cent per year. Further, the endogenous model also heavily emphasizes the accumulation of human capital to generate long run growth (Romer, 1986; Lucas, 1988).

In empirical studies, a body of evidence that human capital plays an important role in economic growth has been shown. However, the measurement of human capital varies across different studies, and the data for empirical purposes is not readily available. For that reason, human capital data is usually available by construction or proxies. Nonetheless, there is no generally consensus of correctly constructing and approximating the stock of human capital (Greiner et. al., 2005, p. 62). Greiner et. al. (2005, p. 62) point out that in essence, human capital consists of stock of knowledge and abilities of a person, by which its increase will raise his/her productivity. Hence, its accumulation can come through education and on the job training.

There have been many methods in empirical studies to construct and approximate the human capital. Greiner et. al. (2005, p.65) classify two measurement approaches, namely the input-based approach and output-based approach. The input-based approach relies on using years of schooling related to efficiency parameters (Greiner et. al., 2005), years of schooling (Psacharopoulos and Arrigada, 1986; Barro and Lee, 1993), and years of schooling and return on education (Mincer, 1958; Psacharopoulos, 1994; Psacharopoulos and Patrinos, 2002; Prodromidis and Podromidis, 2008), and expenditure on education and gross enrolment ratio in primary, secondary and tertiary education (Hanusek and Kimko, 2000). Output-based approach measures human capital as years of schooling and wage relationships (Mulligan and Sala-I-Martin, 1993).

A further factor that is considered having influence on output growth rate is both macroeconomic and political stability (Campos and Karanos, 2008). For the success of long term development and growth, one important condition required is the ability of the government to manage its economy and have flexibility to adapt to the changing circumstances. The political and macroeconomic stability is imperative to stimulate growth of an economy. In empirical studies, low inflation rates, manageable public debt (external and internal), competitive real exchange rates and prudent fiscal policies are the common indicators of macroeconomic stability.

Stable and low level inflation is conducive for the process of capital accumulation. This is precisely in cases of tax distortions or when investment decisions are made with a long term perspective (Bassanini and Scarpetta, 2001). The relationship between inflation and economic growth has been explored since the mid 1960s by Tobin (1965) and Sidrauski (1967). A recent study conducted by Chen, et. al. (2008) find that there is negative relationship in the steady state, which is in line with Tobin (1965). Further, as an effect of inflation on consumption and real balances (Becker and Mulligan, 1997), a higher inflation reduces capital and wealth, which is the reverse of Tobin's (1965) finding.

The study of the driving forces of economic growth also pays attention to the volatility of exchange rate and its determination. Even though it does not have a direct effect on economic growth, the volatility may effect growth through the channel of trade (Baak, 2008), inflation and investment, which is closely associated with the growth (Macdonald, 2000; Feng and Wu, 2008; Miles, 2008). Theoretically, an appropriate exchange rate policy which provides a relatively stable and proper real effective exchange rate facilitates conducive economic for trade and investment.

The role of openness, consisting of trade and foreign investment, is considered as one of the driving forces in the endogenous growth model. Empirical work on the role of openness has emerged into two views. On the one hand, openness would shrink domestic investment, and its reduction would be greater than that of an increase in capital inflows (Leamer, 1995; Batra and Beladi, 1996; Jin, 2006). Another channel could possibly work through domestic dislocate as a result of the tariff deduction which generates reducing import prices. On the other hand, openness through international trade and foreign investment could accelerate productivity and finally generate growth (Begum and Shamsuddin, 1998; Dollar and Kraay, 2001; Mountford, 2006; Tsai and Huang, 2007; Awokuse, 2008). Therefore, the effect of openness on the output is still vague, depending on each country's case.

Since the documentation of Goldsmith (1969), a body of literature on economic growth has also emerged to observe to the role of financial development. The strong positive link between the functioning of the financial system and long run growth studies have been demonstrated in the empirical study (see for example: Levine, 1997; 2005). A recent study conducted by Singh (2008), and Yang and Yi (2008) for example, find a strong positive effect of financial development and economic growth in India and Korea, respectively. While the relationship is bidirectional in India, a one direction that financial development causes economic growth is found in Korea. Levine (2005) highlights that theory and evidence imply external financing constraints facing firms, which illuminates one mechanism through which financial development influences economic growth can be eased-better developed financial systems. There are various measures to stand-in financial development in empirical study.[20] Further, saving rate, investment decisions and technological innovations are among the channels through which a financial system can influence growth.

One country's characteristic and its level of development distinguish the factors affecting the rate of economic growth from another country. It is the most worthy assignment therefore to be able to identify the driving forces of economic growth of an economy based on the properties of the available models and developed methodologies.

Based on the discussion in this section on the fundamental procedures or steps for analyzing economic growth of a specific developing country, it can be concluded that overall, in order to obtain a theoretically and empirically strong outcome, the study of economic growth of a specific developing country has to be conducted in three fundamental steps:

- Firstly, identify if the characteristic of long run economic growth, related to the impact of government policy, is permanent or transitory.
- Secondly, investigate and measure the productivity related to growth through testing both the technology and income level catching up. And
- Thirdly, identify the driving forces of growth using the growth model identified at the first and second steps.

[20] See for example Yang and Yi (2008) and Beck, et. al. (1999).

The development of econometric methodology has made these three steps empirically testable.

2.5. Chapter conclusion

Understanding economic growth theories helps explore the driving forces of economic growth of a country and explain how a country can attain high growth.

The development of economic growth theories from the classical to modern has established a strong framework within modern growth theories, namely exogenous and endogenous growth models. The exogenous growth model postulates that the growth of output is exogenously determined by technology progress. Hence, government policy does not have a permanent impact on long run growth. Endogenous growth implies that growth is endogenously determined. Thus, government policy could have a permanent impact on long run growth.

In terms of productivity growth, a developing country tends to grow faster than a developed country, because of diminishing returns to capital in exogenous growth or technological catching up in endogenous growth.

The outcome of the review of economic growth theories suggests that in order to conduct a study of economic growth for a specific country, specifically to identify the driving forces of economic growth, the study has systematically to address: (i) If the characteristic of the long run economic growth is exogenous or endogenous; (ii) The productivity related to growth, by testing the catching up hypotheses; and (iii).The driving forces of the level and the growth rate of real per capita income using the growth model resulted from the first and second steps.

The development of econometric methodology hints that these three steps are empirically testable. Therefore, conducting a study of economic growth by implementing these three steps will produce outcomes with a strong theoretical and empirical background.

The next chapter provides a critical discussion on the extant literature on economic growth in Indonesia and then highlights the gaps in the literature. It will be shown that there has been no study on economic growth in Indonesia employing systematically to address the long run characteristic of growth, the productivity related to growth and the driving forces of the level and the growth rate of real per capita income using the model derived from the testing long run growth and productivity related to growth.

Chapter III. Indonesian economy

Abstract

Indonesia is counted as one of the rapidly growing countries in Asia in the period 1966-2005 (IMF, 2006). During that period, the Indonesian government implemented policies related to physical and human capital accumulation, openness to trade and investment and macroeconomic stability. The government was also active in response to the development of the world economy.

Many studies link the growth rate of Indonesia to these policies. However, the ultimate reason and the proximate causes underlying Indonesia's economic growth are still unclear. In the literature on economic growth in Indonesia, the studies have not been conducted systematically to address: (i) If the long run growth characteristic is exogenous or endogenous; (ii) Productivity related to growth through testing the catch up hypotheses; and (iii) The driving forces of the level, and of the growth rate, of real per capita income using the growth model identified in the first and second steps.

Therefore, conducting this study based on the three steps is essential in order to provide policy decision makers with a strong theoretical and empirical background for the purpose of improving the Indonesian development strategy. This study also fills existing gaps in the literature of economic growth in Indonesia.

3.1. Introduction

The IMF (International Monetary Fund) (2006) counts Indonesia as one of the rapidly growing countries in Asia. During the period 1966 to 2005, the average economic growth is about 6 per cent per annum (World-Bank, 2008). The economic policies and changes in institutions related to economic growth have been the focus of most studies on Indonesia's economic development. However, the ultimate reasons and the proximate causes underlying the country's economic growth since the mid 1960s are still unclear (Van der Eng, 2006).

This chapter provides an overview of the Indonesian economy and reviews the empirical studies of economic growth in Indonesia. In the overview, there are some factors that can be linked to economic growth in Indonesia, such as openness, physical and human capital accumulation and macro economic stability. Further, in the literature of economic growth, there have been many studies investigating economic growth in Indonesia yet none were conducted systematically based on the three fundamental steps suggested by economic growth theories. As advocated in the previous chapter, in order to provide a sound theoretical and empirical background for a development strategy, the study of economic growth has to address: (i) if the long run growth characteristic is exogenous or endogenous; (ii) productivity related to growth by testing the catching up hypothesis; and (iii) the driving forces of the level, and of the growth rate, of real per capita income using the model identified in the first and second steps.

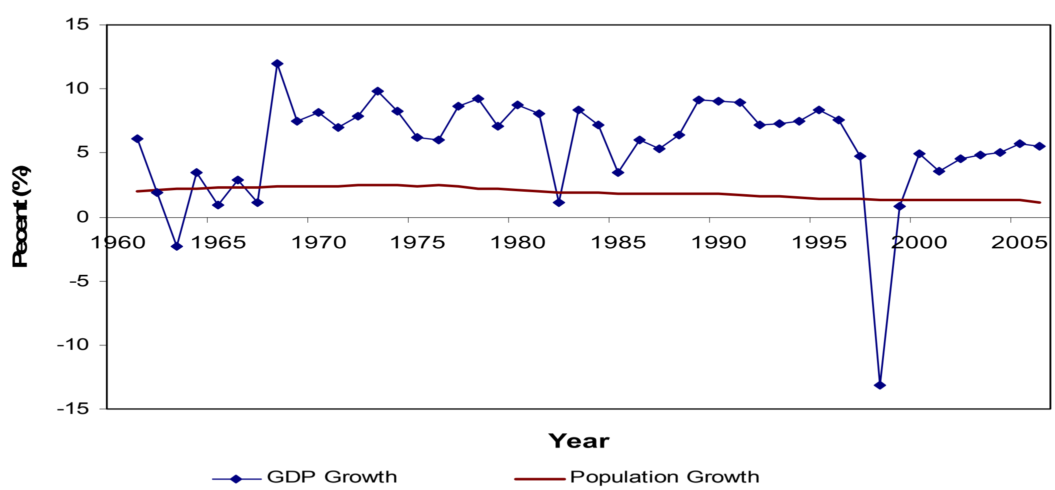
The chapter is organized as follows; the next section presents an overview of the Indonesian economy since the mid 1960s; Section three reviews the empirical studies of Indonesia's economic growth. The last section provides chapter conclusion.

3.2. Overview

This section provides an overview of the Indonesian economy since the 1960's. The beginning of the section outlines the performance of the Indonesian economy, followed by a discussion of the factors that are considered to influence the Indonesian economy.

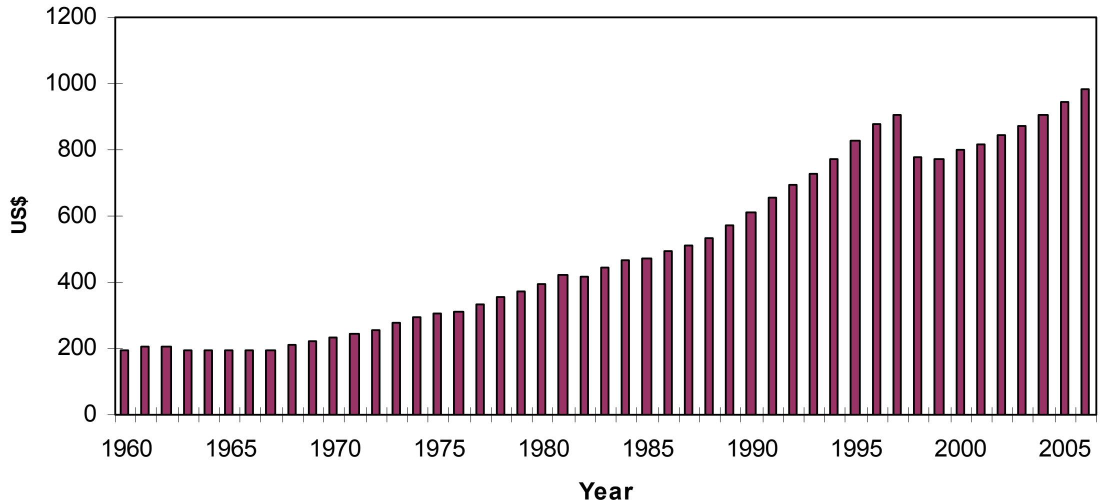
Indonesia is counted as one of the rapidly growing countries in Asia in the period 1966-2005 (IMF, 2006). Economic growth has increased per capita income of the people more than fivefold. During the period 1960 to 2005, Indonesia records an average of real GDP growth (at 2000 prices) of about 6 per cent per annum, while the population growth rate is about 1.94 (Figure 3.1) (World-Bank, 2008). This implies that during that period, the real per capita income which is indicated by real per capita GDP has absolutely increased. The relatively high growth particularly occurs during 1967 to 1997, which is 7.44 per annum (at constant prices 2000). The real per capita GDP has increased consistently for almost 30 years from US$ 176 in 1967 to US$825 in 1997 (in 2000 prices) (see Figure 3.2). There are a number of characteristics in economic development and policies that have been argued as driving forces of economic growth, namely: opening to foreign direct investment and international trade, emphasizing physical and human capital accumulation, and managing macroeconomic stability.

Figure 3.1
Indonesia: GDP growth and population growth



Source: World Bank World Table (WBWT) (World-Bank, 2008)

Figure 3.2
Indonesia: per capita GDP



Source: WBWT (World-Bank, 2008)

3.2.1. Openness

Foreign direct investment (FDI)

FDI starts to operate in Indonesia when the Government issued the first law on foreign investment in 1967 that formally established the relevant legal framework (Wie, 2006). In the 1970s, FDI in Indonesia is concentrated in the oil and gas sector, and just stood at about 2 per cent of GDP (Hofman et. al., 2007, p. 180). From 1980 to 1997, FDI is tempted into other sectors of the economy. In this period, Indonesia experienced a surge in FDI as well as domestic investment. Wie (2006) argues that it is attributable to the successive deregulation measures which the Indonesian government introduced after the end of the oil boom in 1982 to improve the investment climate for both foreign and domestic investments. Gray (2002) and Ikhsan (2006) point out that the government's economic policy to attract FDI in the broad based manufacturing sector and to stimulate an export oriented and diversified economy in the mid 1980s and late 1990s have been able to bring the country to a more diversified manufacture based economy. FDI has functioned as major source of non oil export revenues to offset the fall in oil export revenues in that period.

In the crisis period, Indonesia experiences a net FDI outflow (negative of FDI).[21] Wie (2006) argues that, to a large extent, this net outflow is caused by the fact that FDI inflows in the form of equity and long term loans to FDI projects, as well as the proceeds from privatization and banking restructuring are exceeded by the amount of repayment by FDI projects of long term loans to their principal overseas or to a foreign bank.

Table 3.1
Indonesia: foreign direct investment

Year	US$M
1971 – 1975	788
1976 – 1980	1,267
1981 – 1980	1,182
1986 – 1990	2,994
1991 – 1995	11,114
1996 – 2000	3,220
2001 – 2005	-211

Source: Global development indicator, Asian Development Bank (some publications)

The impact of FDI on economic performance and growth does not however, fully satisfy the premise that FDI promotes growth. Effendi and Soemantri (2003) study the effect of FDI on regional economic growth in Indonesia using provinces as the cross section units, and find only weak support for the argument that FDI accelerates economic growth. This finding seems to uncover the previous study conducted by Wie (2001). Wie concludes that Indonesia in general has not been very successful in taking full advantage of the presence of FDI projects to promote the development of its indigenous industrial technological capabilities.

In the real sector, Dhanani and Hasnain (2002) underline the relatively sensible contribution of FDI such as in spawning capital formation, generating export

[21] The different convention on defining FDI makes it possible that FDI in Indonesia can be negative. Hofman, et. al. (2007) point it out that the definition of FDI for Indonesia includes overseas bank loans to subsidiaries of foreign companies, which is usually included as other capital flows in international standard definition.

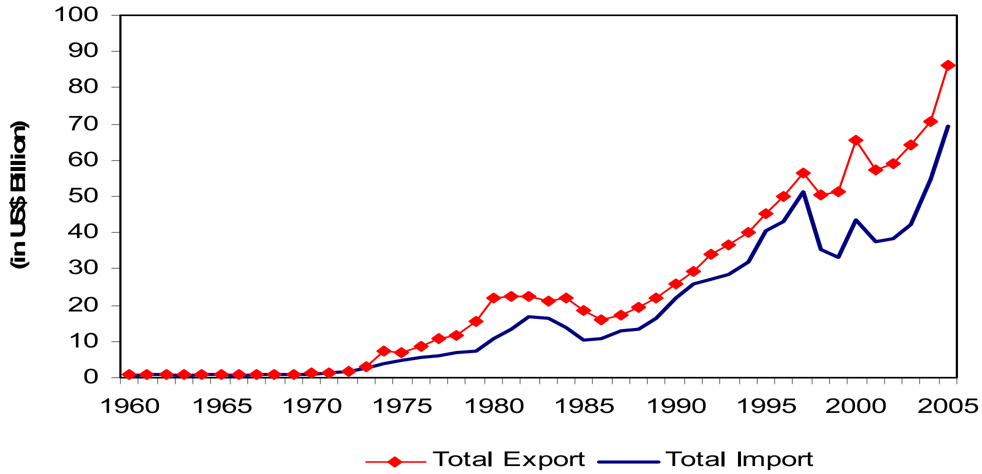
revenues, creating manufacturing employment, developing supplier and support industries, transferring technology and generating tax revenues. Another positive evident is provided by Lipsey and Sjoholm (2004), who show that foreign firms pay higher prices for labor of a given educational level than domestically owned ones. While in the monetary sector, FDI has a negative impact on the balance of payment, and contributed to the persistent deficit in manufacturing goods due to larger propensity to import production inputs from abroad.

In general, the presence of FDI has diversified the economy in more broad-based sectors, which mostly result in increases in manufacturing to export. However, in terms of national impact, concerning the correlation to the GDP per capita in both level and growth, it is still questionable.

International trade (export and import)

Many studies have considered the importance of international trade in the economic growth of Indonesia. During the period 1960-2005, the volume of export and import has increased. The signs of growth are evident after 1967 (Figure 3.3); in the first seven years since 1967, the average of growth export volume was 27.21 per cent. This is mainly contributed by agriculture and mining (oil and gas) which take a portion more than 60 per cent (Figure 3.4a). These two sectors contribute over 40 per cent of total growth of GDP (Booth, 1998).

Figure 3.3
Indonesia: Total export and total import



Source: WBWT (World-Bank, 2008)

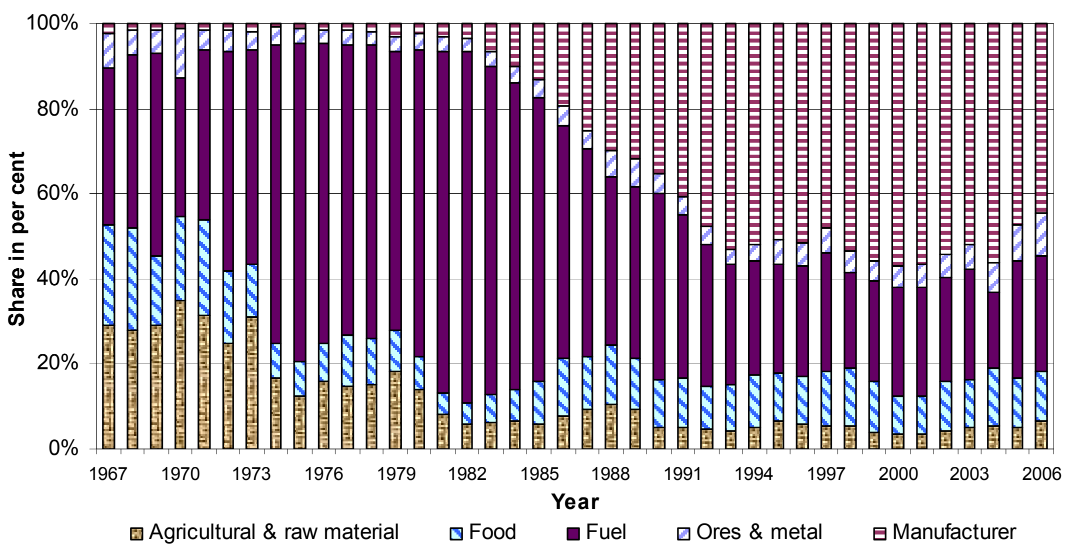
After 1973, the growth rate of export declined tremendously. Booth (1998) argues that this decline is partly due to OPEC quotas effectively placing a ceiling on petroleum production. The volume of export starts to accelerate again in 1976, while the import is still moderate. This leads to a widening of the gap between export and import until 1981 (Figure 3.3).

As the oil has the highest proportion of total export volume in Indonesia (see figure 3.4a), the economy is in difficulty when the oil price begins to decrease in the early 1980s. In addition, the government makes crucial policies to restructure the economy, especially to develop the manufacturing sector; this positively impacts the economy as a whole. By 1990, total export earning has recovered to $25.7 billion which is slightly above the 1982 peak of about $25.2 billion. The growth of the non oil sector, mainly in the manufacturing sector has continued, and made the change in the structure of the component of the export (Figure 3.4a). It is apparent that the manufacturing sector dominates the share of the exports started in 1990. Arthukorala (2006) argues that the dramatic shift in the commodity composition of exports away from crude oil as the principal export; towards non-oil primary products and manufacturing and acceleration export growth underscore the economic boom in Indonesia from the late 1980s to the onset of the 1998 financial crisis.

During the 1998 financial crisis, export volume declines significantly. Even though the crisis is marked by currency depreciation, which in some sense benefited exports, the large content of the manufacturing exports are imported, that makes the export volume decline sharply. This drop happens in 1998 and 1999, before recovering in 2000 and growing modestly afterward.

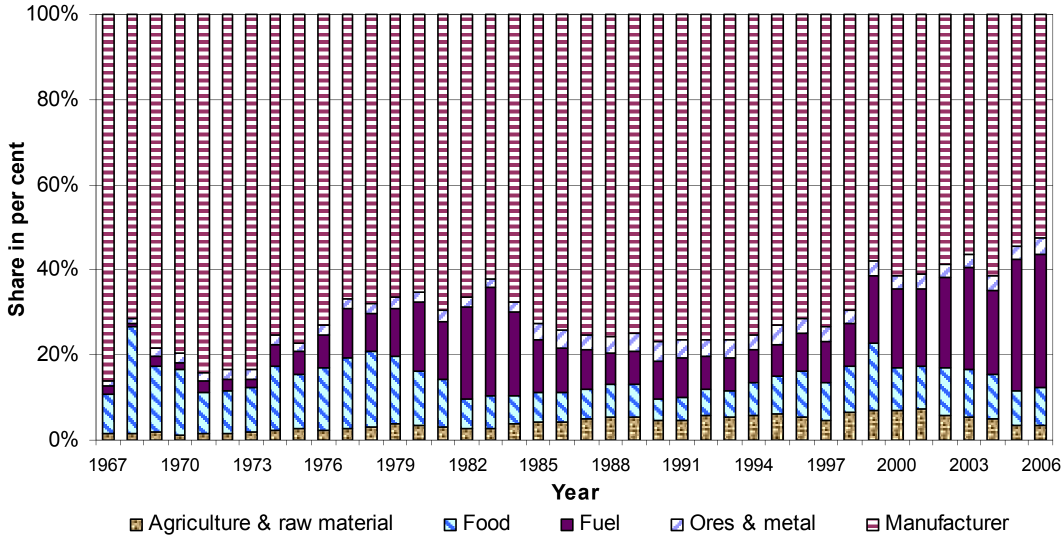
Figure 3.4a and 3.4b provide a description on the share of exports and imports by five main sectors. In 1967, manufactures contribute less than 5 per cent, while fuel, agricultural and raw material contribute more than 20 per cent each. The increase of the oil price in the early 1970s changes the structure of the component of exports which make this sector dominate the export share. When the oil price starts to decline in 1981, the dominance of oil in exports also declines and manufacturing begins to take the role. By the 1990s, manufacturing takes the position as the main contributor to exports.

Figure 3.4a
Indonesia: Share of components to total export



Source: WBWT (World-Bank, 2008)

Figure 3.4b
Indonesia: Share of components to total import



Source: WBWT (World-Bank, 2008)

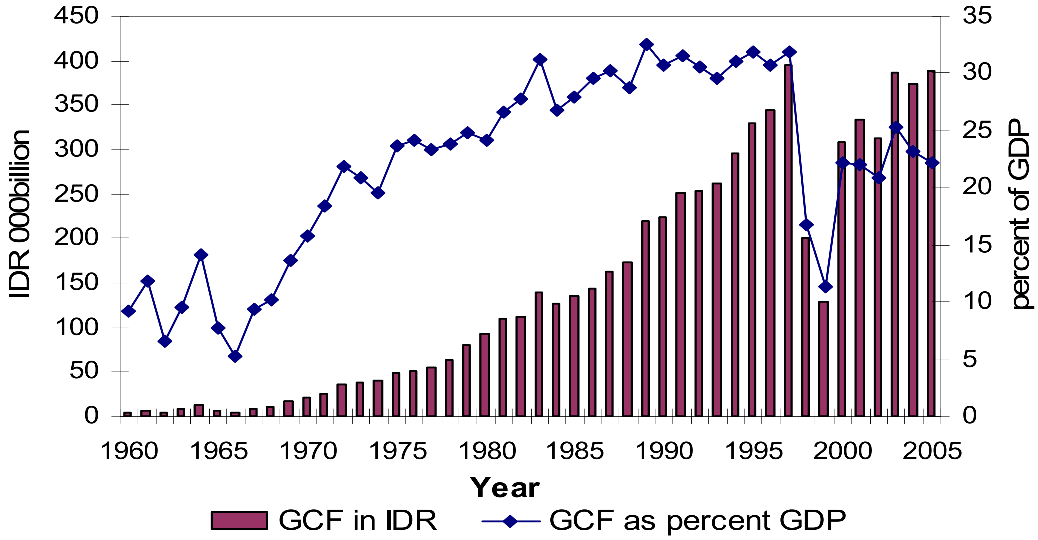
Thangavelu and Rajaguru (2004) show that trade has an important impact on productivity and output growth. However, it is imports that provide an important virtuous link, and there is no strong indication for export led productivity growth. This result contradicts the recent study conducted by Liwan and Lau (2007) which examine the relationship between export, inflation and economic growth for three ASEAN countries, namely Indonesia, Malaysia, and Thailand. The result for Indonesia reveals that export has a positive impact on growth. Blalock and Veloso (2007) take a different view to investigate the impact of trade on growth, by presenting evidence that importing is a source of international technology transfer. They use detailed panel data of Indonesia manufacturers to show that firms in industries supplying increasingly import-intensive sectors have higher productivity growth than other firms. These studies imply that the role of international trade on economic growth is still vague.

3.2.2. Physical and human capital accumulation

Physical capital encompasses a very broad area, and includes machines that sit in factories, the buildings, and all forms of infrastructure. Weil (2005) considers five key characteristics of capital for the purpose of the capital-based theory of income differences, these are: it is productive, its use is unlimited, it can earn a return and it wears out. In the growth literature, investment in physical capital has been a significant contribution to growth. Empirical studies have shown that physical capital as one determinant of economic growth.

Hill (2000) points out that investment rate has facilitated rapid technological change and provided the base for sustained economic growth in Indonesia. Both public and private sectors contribute to the accumulation of physical and human capital in Indonesia. Figure 3.5 displays Indonesia's gross capital formation which outlays Indonesia gross domestic investment, that is in addition to the fixed asset of the economy plus net changes in the level of inventories since 1960. In local currency, it increases from 1967 to 1997; this is also in terms of percentage of GDP. The share of gross capital formation as percentage of GDP starts to rise confidently after 1967. The government continues to increase this share during the oil boom with the government's massive investment programs. It experiences a little decline in 1975, which was possibly affected by the government funds further allocated to recover from the crisis of state owned oil enterprise (the Pertamina). At the end of the 1970s, it reaches the level of more than 24 per cent of GDP. A surprising feature of the 1980s is that, notwithstanding the reduction in the government's development budget, investment levels hold up strongly (Hill, 2000, p. 18). There is a moment that the government reduces the share of investment as well as its level in 1984, but it then recovers afterward, and achieves more than 30 per cent of GDP, with the peak value of more than IDR 200 trillion (2000 prices). During the 1998 economic crisis, there is a significant decrease of gross capital formation in level, as well as in percentage of GDP. Until 2005, the share of gross capital formation is still at the level of 20 per cent, which is much below the pre crisis level.

Figure 3.5
Indonesia: Gross capital formation
(in Indonesia Rupiah (IDR) 000 Billion and per cent of GDP)



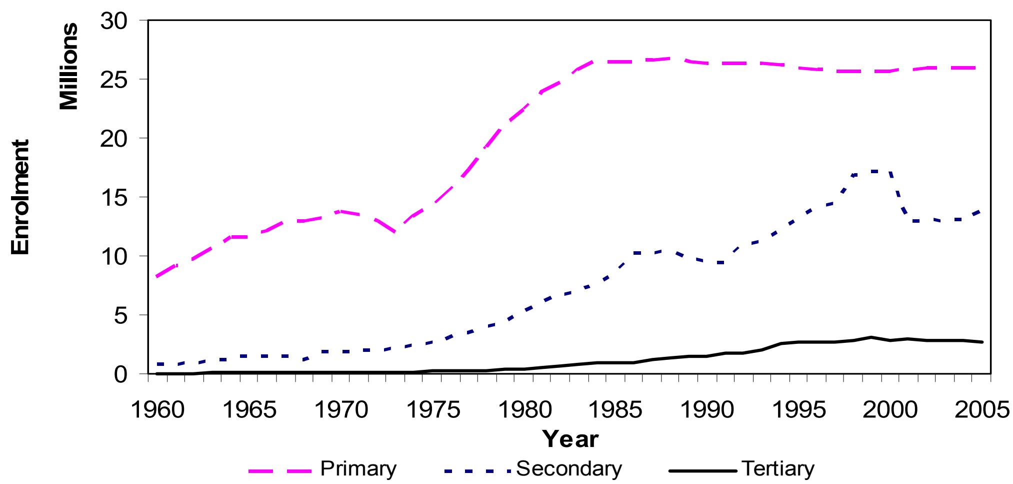
Source: WBWT (World-Bank, 2008)

Studies on the determinants of economic growth in Indonesia have proved the importance of physical and human capital accumulation (see for example: Baier et. al., 2006; Hossain, 2006). van Leeuwen (2007) studies more specifically on human capital and economic growth in Indonesia from 1890 to 2000, with a comparison against Japan and India. van Leeuwen (2007) finds that the process of human capital development makes Japan and Indonesia (and India) different in terms of current income per capita. Those three countries had almost the same level of per capita income in the 1800s, but after a hundred years of different human capital accumulation processes in each country, Japan has the highest income per capita.

With the emphasis on the positive role of human capital in determining economic growth, the Indonesian government has endeavored to increase the accessibility of education to the people, from primary, secondary and higher levels, to improve its respective level of human capital. In 1973, the Indonesian government launched a major school construction program (INPRES program), and between 1973-1974 and

1978-1979, more than 61,000 primary schools were built (Duflo, 2004). As a result, the enrolment in primary school increases dramatically after 1975 (see Figure 3.6).

Figure 3.6
Indonesia: Education enrolment



Source: Van der Eng (2008b)

In terms of expenditure on education however, the World Bank (2007) reports that Indonesia's spending level on education is still relatively low compared to its East Asian neighbors. As a proportion of the budget, Malaysia and Thailand invest more than any other country in the region. Malaysia spends more than 27 per cent, while Indonesia 14.2 per cent, below the Philippines (16 per cent). This is also the case in terms of percentage of GDP. Indonesia is lower compared to that of Malaysia, Thailand and the Philippines. Not surprisingly, it causes a deterioration of school buildings and contributes to persistently low learning outcomes by students (Duflo, 2004).

Another issue of education development in Indonesia is underlined by Duflo (2004) who argues that human capital development is not accompanied by appropriate development in physical capital. The school construction program in the 1970s led to an increase in education among individuals who were young enough to attend primary school after 1974 but not among their older cohorts; Duflo (2004) finds that a

10 per cent increase in the proportion of primary school graduates in the labor force reduces the wages of the older cohorts by 3.8-10 per cent and increases their formal labor force participation by 4-7 per cent. The author further implies that physical capital did not adjust to the faster increase in human capital.

It is obvious therefore that physical and human capital have important roles in the economic growth in Indonesia. However, the country does not effectively develop these sectors, in particular to human capital.

It is acknowledge that a better educated and better trained labor force can have a significant impact on labor productivity and economic development in the long run. With rising foreign investment and technological upgrading in Indonesia, there is also an increased demand for more skilled labor and better trained workers. Consequently, a substantial increase in the education expenditure has recently been a major program to increase human capital in Indonesia. This policy supports the importance of human capital investment in generating economic growth in the country.

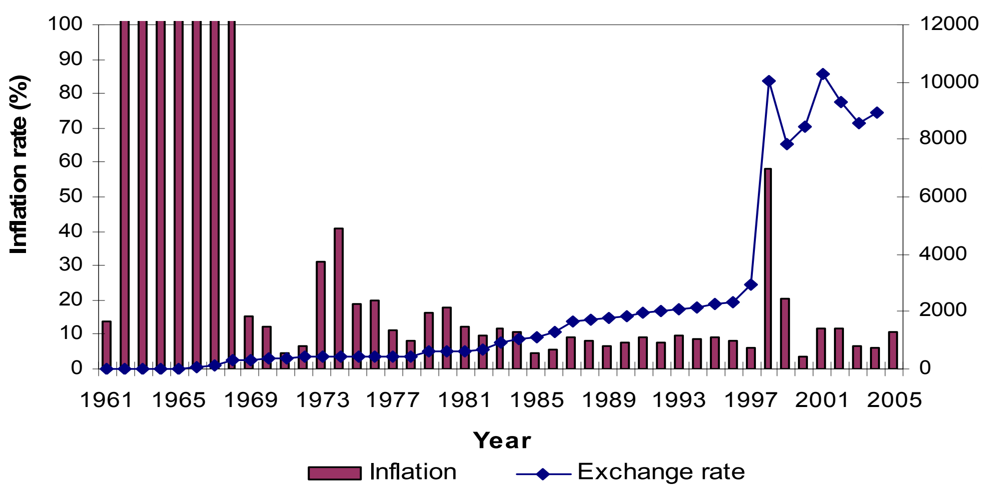
3.2.3. Macroeconomic stability

Macroeconomic stability is one essential factor in order to achieve long term economic development. There are some common indicators of macroeconomic stability, namely: controlled inflation rates, stable exchange rate, positive real interest rates, manageable public debt, and prudent fiscal policy.

Boediono (2005) enlightens that during the last four decades Indonesia has been relatively successful in managing most of the indicators of macroeconomic stability yet also needs improvement in some other indicators. Inflation is the first indicator that was successfully handled in the mid 1960s of the transition time. Hill (2000, p.30) points out that one of the hallmarks of the regime since 1966 is its commitment to control inflation. Inflation has been kept low to moderate during the last four decades. It experiences high rate episodes in mid 1973/74 which is probably due to ineffectively and inefficiently spending of the windfall revenue of the oil boom

(Booth and McCawley, 1981), and in 1998, due to the Asian financial crisis. The benefits of managing inflation under control to trade and investment are to keep a stable real interest rate which is a favorable environment for growth. However, it is fairly high compared to that of the neighbor countries of Singapore, Thailand and Malaysia that are able to keep their real interest rate at one-digit levels on average for the past four decades.

Figure 3.7
Indonesia: Inflation and exchange rate



Source: Inflation data is withdrawn from WBWT (World-Bank, 2008),
Exchange rate data is taken from Penn World Table (Heston et. al., 2006)

The exchange rate fluctuation has also supported the behavior of inflation in Indonesia (Siregar and Rajaguru, 2005). Hill (2000, p. 74-76) argues that Indonesia has adopted prudent exchange rate policies where the government may occasionally intervene in the financial market to avoid severe appreciations / depreciations in the currency. This policy facilitates a relatively favorable environment on every phase of the long term Indonesian economy in relation to the swing of the international dimension. Hofman, et. al. (2007) call the country the best known for its use of the exchange rate as a macro tool. It can be observed, apart from the 1998 Asian crisis which pulled the rate forward to more than IDR8000, the smooth trend and stable exchange rate has been kept during more than three decades since 1967. Before the

1998 Asian crisis, the exchange rate regime was mainly managed by a floating system, which involves the gradual depreciation of the currency via a crawling peg, into an essentially market-determined exchange rate system. It has then been reformed into a free floating system, whereby the objective of the exchange rate policy is to maintain the stability of the currency *vis-à-vis* other foreign currencies in order to boost trade activities and minimize costly fluctuation (Tanuwidjaja and Choy, 2006).

Another indicator of macro economic stability relates to monetary and financial policy is interest rate which influences inflation. During the period 1967 -1997, the government dominated the financial sector policy. This enabled the government to subsidize certain sectors by lowering interest rate credit by ignoring the price mechanism in those government priority sectors. Though, in general, interest rate has become a particular principal instrument for controlling money supply and growth over the decades of Indonesia's economy (Hill, 2000, p 34).

In the fiscal sector, the government has also adopted prudent fiscal policies and has been able to decisively resolve macroeconomic difficulties. Empirical analysis conducted by Marks (2004) indicates that Indonesia has met the fiscal sustainability criterion in the period except when the currency depreciated heavily in the 1998 economic crisis. The author highlights that the objective of government fiscal policy which includes enduring macroeconomic stability, reducing dependence on foreign aid and improving income distribution have been achieved, with a few exceptions.

During the period of the oil boom (1971-1980), the government has been successful in reducing the dependence on foreign aid, but it becomes increasingly important again in the mid 1980s. Chowdhury and Sugema (2005) find that the correlation between aid and economic growth is positive, but is low. Furthermore, aid is crucial for maintaining development and social expenditure, especially at times of crisis. They argue that the certainty of aid flow helps the government to follow the balanced budget principle, but makes the government indolent in terms of domestic resource mobilization. Consequently, despite significant progress, Indonesia's external public debt burden remains high, and the country has little ability to handle it without substantial foreign aid.[22]

Table 3.2
Indonesia: External debt

Year	US$ Million					% of GDP		
	Total	Public and Publicly Guaranteed	Private	Long term	Short term	Public	Total	Short term
1970	4,528	3,582	461	4,043	485	37.09	46.89	5.02
1975	11,498	7,994	2,369	10,363	1,135	24.87	35.77	3.53
1980	20,938	15,021	3,142	18,163	2,775	19.25	26.84	3.56
1985	36,715	26,784	3,837	30,620	6,095	30.67	42.04	6.98
1986	42,916	32,621	3,778	36,399	6,517	40.75	53.60	8.14
1987	52,535	40,888	4,571	45,459	7,077	53.85	69.19	9.32
1988	54,078	41,183	5,545	46,729	7,350	46.38	60.91	8.28
1989	59,402	44,262	6,556	50,818	8,583	43.63	58.55	8.46
1990	69,872	47,982	10,261	58,242	11,629	41.93	61.06	10.16
1991	79,548	51,891	13,176	65,067	14,480	40.49	62.07	11.30
1992	88,002	53,664	16,281	69,945	18,057	38.58	63.26	12.98
1993	89,172	57,156	14,029	71,185	17,987	36.17	56.44	11.38
1994	107,824	63,926	24,441	88,367	19,457	36.14	60.95	11.00
1995	124,398	65,309	33,123	98,432	25,966	32.31	61.54	12.85
1996	128,937	60,012	36,694	96,706	32,230	26.39	56.71	14.18
1997	136,273	55,968	44,469	100,437	35,835	25.94	63.16	16.61
1998	151,347	67,416	54,728	122,145	29,203	70.63	158.57	30.60
1999	151,332	73,790	47,265	121,055	30,277	52.71	108.09	21.63
2000	144,159	69,520	41,169	110,689	33,470	42.13	87.36	20.28
2001	133,828	68,504	34,405	102,909	30,918	41.73	81.53	18.84
2002	132,839	71,145	30,026	101,171	31,668	35.55	66.38	15.83
2003	136,956	74,023	29,754	103,777	33,178	31.18	57.69	13.97
2004	139,723	71,991	33,546	105,537	34,186	28.31	54.94	13.44
2005	138,300	72,335	33,658	105,993	32,307	25.18	48.15	11.25

Source: WBWT (World-Bank, 2008)

[22] Foreign aid considered in their study consists of grants and loans.

During the oil price decline in the mid 1980s there has been a sharp increase in external public debt, and it reached 53.85 per cent of GDP in 1987 (see Table 3.2). This situation, which was handled by outward orientation policies on manufacturing export strategy, has helped reducing the burden of external debt. Before the 1998 economic crisis there was no signs of the uncontrolled position of external debt as a warning of crisis. Hill (2000, p. 277) cites that the unknown portion of short term private external debt supported by poor financial regulation, is the most vulnerable position to generate crisis.

Hofman et. al. (2007) underline that macroeconomic stability has been the focus of the government, and the government has been building strong macroeconomic policy institutions to do so. Apart from some weaknesses, Indonesia has generally achieved macroeconomic stability in more than three decades, which have been conducive for investment and development.

Based on the discussion of the Indonesian economy in this section, it can be concluded that in general, economic factors such as openness, physical and human capital accumulation, macroeconomic stability and non economic factors, such as population growth, can be linked to the level and the growth of real per capita income in Indonesia. The external factors, such as the growth rate of the world economy can also reasonably be considered to make a contribution to the Indonesian economy. Therefore, all of these factors could be used to analyze the driving forces of the level and growth of real per capita income in Indonesia.

3.3. The empirical studies of economic growth in Indonesia

This section reviews the empirical studies of economic growth in Indonesia related to (i) whether the long run economic growth characteristic is exogenous or endogenous; (ii) the catching up hypotheses; and (iii) the driving forces of economic growth.

3.3.1. The long run economic growth, exogenous or endogenous

One of the important aspects of analyzing economic growth of a specific country is to recognize if long run economic growth is characterized as exogenous or endogenous. If long run growth is characterized by the exogenous growth model, then any government policy will have only a temporary effect, while the endogenous growth model suggests that government policy could have a permanent effect. This indulgent is therefore essential for the policy maker and researcher. This subsection reviews studies related to whether Indonesian long run growth is exogenous or endogenous.

Hossain (2006) points out that there is still an ongoing debate surrounding the characteristic of the long run growth in Indonesia. This issue has particularly risen since the 1998 economic crisis. The debate focuses on the characteristic of economic growth, exogenous or endogenous, scrutinized from the lens of the modern growth theory. The endogenous class suggests that, like in other East Asia economies, the long run growth has been through invest-able resources and factor accumulation rather than technology progress. In contrast, the exogenous view criticizes that it is not sustainable to have growth without technological progress. Hossain (2006) empirically investigates the sources of economic growth in Indonesia for the period 1966–2003. The author implements the two steps Engle and Granger (1987) cointegration technique. It was found that during the period of study, capital accumulation contributes 60 per cent to economic growth, while labor and technology progress contribute 32 per cent and 8 per cent, respectively. The result shows the dominance of invest able resources and factor accumulation, which implicitly suggests the endogenous growth characteristic. However, it should be borne in mind that the investigation itself employs the properties of the exogenous growth model, with constant return to scale of the production function in the growth accounting framework. In this framework, technology progress is only embodied by the time trend, and does not indicate the real productivity of technology. Therefore, this result seems an unsatisfactory resolution to the existing debate.

The World Bank (1993) views that the Indonesian growth is characterized by exogenous model. Therefore, it is suggested that the country should give more attention to the outward looking orientation. This view receives many criticisms from the mainstream economist. A body of literature has emerged to provide strong evidence that the industrialization development strategy, taken mostly in 1980s, is the driving force of economic growth (Ishida, 2003; Jacob and Meister, 2005; Hofman et. al., 2007); a view that derived from the endogenous growth properties.

In view of the East Asia economies long run growth, the studies have categorized Indonesia to follow the common scrutiny of those economies (Kim and Lau, 1994; Krugman, 1994; Young, 1994; 1995; Rodrigo and Thorbecke, 1997), whereas the characteristic of the long run growth is still controversial. The exogenous view underlines that investment in machinery obviously leads to higher labor productivity, which explicitly appears in the Solow exogenous model. Further, productivity also derives from better governance, higher managerial efficiency and superior worker skill. Fagerberg (1994) and Nelson and Pack (1996) strongly argue that defining East Asia using the exogenous framework is inadequate, since the growth has been mostly driven by the accumulation of non physical factors, knowledge or human capital which is not subject to diminishing return.

In general, the studies related to defining the characteristic of long run growth for Indonesia have not explicitly and specifically addressed the core issue, exogenous or endogenous. The conclusions are revealed from the implicit outcome that intrinsically relate to exogenous or endogenous properties. Yet, a specific study investigating the long run economic growth for Indonesia has not been conducted. Considering the importance of defining the characteristic of long run growth, related to the development policy and strategy, it is essential to conduct specific investigation on the long run growth for Indonesia, defining whether it is exogenous or endogenous. This investigation also fills the existing gaps in the literature of economic growth study for Indonesia. Departing from this background, the first part of the empirical work in this study is intended to investigate the long run economic growth in

Indonesia. Two methods are employed, namely: regression equation of time series and cointegration approaches. Implementing these approaches can provide an apparent empirical answer, whether the characteristic of the long run growth in Indonesia is exogenous or endogenous. Practically, whether or not the government policy does effect the long run economic growth in Indonesia can be answered empirically.

3.3.2. Catching up hypotheses study

The catching up hypotheses consists of two concepts, technology and income level catching up. For a developing country, the importance of technology catch up is that it can be used to guide the country to accelerate its productivity and growth through adoption and implementation of frontier technology. The income level catching up can be used to measure whether the growth rate of output achieved by the country has been able to bring the economy into the process of catching up to the leading economy, in terms of income level. Therefore, the latter can be used to measure the success of the former. This subsection reviews the two hypotheses, technology and income level catching up, in the study of economic growth in Indonesia.

Technology catching up

There have been some studies examining the technology catching up hypothesis for Indonesia, specifically and as part of studies for East Asian, Southeast Asian and world developing countries. At the micro level, a catching up study was conducted by Dijk and Szirmai (2006) who explore the diffusion and adoption of paper making machinery in the Indonesian pulp and paper industry. They argue that industrial policy has played an important role in the speed and nature of diffusion of paper machinery in Indonesia. The result shows that the Indonesian paper making industry experienced rapid technology catching up which was spurred by the installation of a number of state-of-the-art paper machines manufactured by leading paper machine suppliers. Surprisingly, this technology catching up is limited to only a few firms which have the finance and capabilities to adopt large-scale modern machinery. The author finds this to be in line with the theory of industrial dynamics in developing countries where preferential access to government subsidies, niche market, and abundant labor and scarce capital, result in dualistic structures.

Dijk and Szirmai (2006) also report another substantial finding, in that the type of policy implemented during the export oriented industrialization has been successfully promoting capital embodied technological change in the pulp and paper sector. But, in the sense that the process of successful industrialization and catching up involves more than embodied technological change, that is building complementary skills, capabilities, and facilitation of linkages and spillovers to other sector, Indonesia has been less positive. This finding supports to the previous study by Jacob and Meister (2005) who find that international technology spillover has contributes significantly to the performance of Indonesian manufacturing. However, sectoral characteristics and industrial market structure have strongly influences. Therefore, further development in building absorption capacity should have more attention.

Blalock and Veloso (2007) use a detailed panel of Indonesian manufacturers to examine imports as a mechanism for technology transfer. The study finds that greater productivity growth is exhibited in the firms selling to sectors that rely more on imports than other firms.

For the sectoral purpose, the studies conducted by Jacob and Meister (2005), Dijk and Szirmai (2006), and Blalock and Veloso (2007) are very constructive and informative for industrial development. However, it does not provide the full picture at a country level, given the study only explores the manufacturing sector, and from the channel of import.

In a macro level study, Lim and McAleer (2004) investigate the increasing diversity of the average growth rates and per capita income level across ASEAN countries including Indonesia, using Verspagen's (1991) method of convergence and technology catching up analysis. The results for Indonesia imply no evidence of a technology catching up process, due to the low level of learning capability and long technology distance to the leader (USA). In addition, the education variable does not have a significant effect on the technological catching up. However, the inclusion of education and gross domestic investment variables in the model prevail over the problem of serial correlation in the estimation. This outcome contradicts the finding of Benhabib and Spiegel (2005). A specific disadvantage of this study in the case of Indonesia is it points to USA as the leading country however; USA is not the first economic partner of Indonesia, the avenue through which technology catching up can occur. In fact, Japan is the main partner in terms of investment and trade (Hill, 2000). Another disadvantage points to the adoption capacity factors, since education and gross domestic investment does not act as good adoption capacity in their model. Hence, choosing Japan and other possible frontier economic partner countries, and using variables that represent the adoption capacity to study technology catching up would possibly provide a better picture and outcome, which is so far still lacking in the existing literature for Indonesia.

The incorporation of adoption capacity development in studying technology catching up gives background to the decision makers regarding policies needed, so that the country is able to catch up to leading technologies of the developed country. It also becomes important background for Indonesia as a developing and laggard country to set up its development strategies in order to achieve its economic goals.

Therefore, it is essential to examine the technology catching up (adoption of technology) by Indonesia in relation to the leading economies of its economic partners, to observe how the productivity related to growth is generated. Another purpose is to measure whether the country has benefited, particularly in transferring technology, from its economic partnership for the purpose of economic development, in order to accelerate productivity and growth. The study should also measure the adoption capability and capacity factors. This kind of technology catching up study for Indonesia has not been conducted so far in the existing literature. For that reason, investigating technology catching up by Indonesia toward some frontier technology countries, by incorporating adoption capacity, provides better information to the economic decision makers and fills the existing gaps of knowledge.

Income level catching up

A part of their study on catching up in ASEAN countries, Lim and McAleer (2004) also examine the income level catching up of ASEAN countries including Indonesia toward Singapore and USA using the data span from 1960 to 1992. Two tests of convergence as income level catching up are employed, namely: the test based on the definition of Bernard and Durlauf (1995) and the Kalman filter approach proposed by St. Aubyn (1999). The Johansen (1991) maximum likelihood estimation of convergence as catching up is used in the definition of Bernard and Durlauf (1995). The specific result for Indonesia is inconclusive, since both trace and maximal eigenvalue statistics reject the existence of a long run cointegrating relationship between two countries. A similar outcome is obtained from the test between Indonesia and Singapore. Even though the trace statistic indicates a long run cointegrating relationship exists between Indonesia and Singapore, the maximal eugenvalue statistic does not reject the null hypothesis of no long run cointegrating relationship. Against this disagreement Lim and McAleer (2004) follow Cheung and Lai (1993) clarification, which suggest that the Johansen's likelihood ratio often guides to the rejection of no cointegration under the null, since it tends to underestimate the cointegration space in small samples. Hence, Lim and McAleer state that Indonesia does not catch up to Singapore.

In tests using the Kalman filter, Lim and McAleer (2004) find that Indonesia does catch up toward Singapore but not toward USA. These results, however, invite some caution, since the data used is relatively small, which is insufficient to the application of the method, such as Johansen's (1991) cointegration approach. Lim and McAleer (2004) also admit that the result is not robust due to the small sample sizes of data. As the result for Indonesia is still ambiguous, further research related to methodology improvement and data extension is essential. Additionally, in regard to the leading countries, the study does not include another leading economic partner of ASEAN countries in general and Indonesia specifically, such as Japan and USA.

Using the ADF unit root test and ADF with the structural break advocated by Zivot and Andrews (1992), Lee, et al. (2005) investigated the income level catching up of ASEAN-5 economies including Indonesia toward Japan. This time, the data used is expanded from 1960 to 1998, and the structural break is made in 1966. The result for Indonesia is more surprising, instead of catching up, the study finds that Indonesia is diverging toward Japan.

The other income level catching up studies for Indonesia have also been conducted, mostly as part of ASEAN countries' studies (see for example: Park, 2000, 2003; Zhang, 2003; Lee et. al., 2005). Park (2000, 2003) employs the inequality indices, while Zhang (2003) utilizes the cross-sectional approach to address the partial notion of catching up. The results mostly show no evidence of income level catching up. This is arguably because the method, data proxies and the counter part country of leading economies have been influential to the outcome. The development of econometric tools has recently been able to trim down these matters. Nahar and Inder (2002) for example, have developed a method which enables an examination of the income level catching up hypothesis in the case where the income difference is not stationary. This approach seems to show its advantages, yet still lacks the context of Indonesia data.

It is apparent therefore that in order to measure the achievement of economic development for Indonesia in terms of per capita income, in comparison to the world economy, the test of income level catching up is necessarily conducted with some improvements. First is to examine Indonesia against the top two leading economic countries, namely USA and Japan. Fortunately, these countries are also the main partners of Indonesia in terms of trade and investment. Second is to implement the cointegration and ECM, using longer data, from 1960-2006. Third is to implement the polynomial time trend advocated by Nahar and Inder (2002). Conducting this income level catching up with those improvements will provide obvious results concerning the level of economic development of the country in comparison to the world's leading economies; whether the growth rate achieved by Indonesia is sufficient to catch up leading countries in terms of per capita income in the long run.

3.3.3. The driving forces of the level and the growth rate of real per capita income

A body of literature has emerged to study the remarkable development experience of Indonesia since the mid-1960s. This subsection reviews the studies of economic growth in Indonesia related to the driving forces of the level and the growth rate of real per capita income. It is observed that real GDP and its growth are commonly used to reflect real per capita income and economic growth.

Van der Eng (2006) point out that the ultimate reasons for Indonesia's development in terms of change in institutions and economic policies conducive to economic growth have been the focus of the studies (see also for example: Dowling and Chin-Fang, 2008). Nonetheless, it remains unclear concerning the proximate causes underlying the country' economic growth since the mid-1960s.

There has been debate concerning the driving forces of economic growth in Indonesia. In the current literature of economic growth in Indonesia, there have been at least three ways of methodologically investigating the driving force of economic growth, namely: growth accounting system, regression and causality.

Growth accounting approach

In a growth accounting system, investigation is commonly based on the production function which exhibits constant returns to scale, with the input factors of capital, labor and productivity. The contribution of capital and total factor productivity has gained more attention, since it embodies the role of capital mobility and technology progress in growth behavior. In this growth accounting framework, an ambiguous outcome has emerged related to the contribution of total factor productivity in determining growth, which is positive and negative. Those studies are conducted both in a cross section and time series approach.

A current study conducted by Van der Eng (2006), accounts for the input factors to contribute to Indonesia's economic growth. The author employs a constant return to scale in the production function framework, to discover the residual total factor productivity through subtracting for the growth of capital stock and education-adjusted employment to represent human capital (labor). The study finds that 77 per cent of the GDP growth is explained by the expansion of the capital stock, while the rest is contributed by the education-adjusted employment. The residual as the factor productivity contributes a negative average (-0.1 per cent). This is not surprising because the estimate of capital stock and education-adjustment employment have possibly contained productivity factors. This result is in line with the study by Baier, et. al. (2006) using the cross section approach. They find that the contribution of factor productivity to output growth for Indonesia is about -37 per cent with annual growth of -0.7 per cent. Those studies lend support to the previous study conducted by Sigit (2004) who provides the contribution of productivity factor -15 per cent with the average growth -0.8 per cent annually during the period 1980-2000.

The contrasting outcome of the contribution of productivity factor has come earlier. Even though the contribution of productivity factor is still less compared to the capital accumulation portion, World Bank (1993), Young (1994), Bosworth, et. al. (1995), Drysdale & Yiping (1997), and Sarel (1997) are among studies that find annual positive contribution of the productivity factor and growth rate.

The decomposition of the driving forces of Indonesia's economic growth using growth accounting system has provided an obvious picture for the dominance of capital accumulation to contribute to the long run growth in Indonesia. The ambiguous depiction has been shown by the productivity factor which segregates to the positive and negative contribution, and its growth. Chen (1997) highlights how the input factor is measured gives different effects to measuring the productivity factor. This is also the case for Indonesia studies. The data for constructing capital stock is the first specific issue. The source of the data and determination of depreciation rate are case of sensitive to the result. The assumption of the elasticity of the capital and labor is to further distinguish the outcome. Another possible reason for this is that the study is conducted in a different time period. Sigit (2004) provides an empirical picture pertaining to the difference in the growth rate of productivity factor at different times of economic development in Indonesia.[23] The author notes that the negative growth of the productivity factor since 1976 to 2000 occurs in two episodes: the transition period (1982-1985)[24] and the economic crisis period (1997-1999), recording -2.36 and -6.46, respectively.

As part of the simplicity of the framework to account for the contribution of the input factors to economic growth, there are some major drawbacks that can be recognized from the growth accounting system. The framework is employed by restricting the capital stock and labor as a constant return to scale. In fact, if the behavior of those factors is increasing return, then the calculation is biased. Another defect is that it invokes the productivity factor which usually embodies technology level is simply an unexplained residual. Van der Eng (2006) argues that productivity factors should comprise a wide range of factors such as business environment that impacts to the efficiency of production. Therefore, investigating the driving forces of long run economic growth in Indonesia using the framework of growth accounting system is likely inappropriate.

Estimation approach

In a regression approach, Hossain (2006) estimates the sources of economic growth in Indonesia during 1966-2003, which departs from the exogenous growth framework. Using a cointegral framework model, the author regresses real output (GDP) against the capital, labor and technology progress. In this study, technology progress is

[23] See Table 5 of Sigit (2004).

[24] The transition refers to the period when the end of oil boom (1971-1981) and to start to manufacturing strategy period (see for example: Hill, 2000)

captured by putting the time trend in the model. In order to exhibit constant return to scale, elasticity of capital and labor to the real output is restricted to one. The study finds that the growth rate achieved by the country during the period 1966 – 2003 has been contributed to by capital accumulation 60 per cent, labor 32 per cent and technology progress 8 per cent. From a technical point of view, utilizing the time trend to capture the technology progress does not take any proximate factor that considers factor productivity. As it is trending, any expansion would not contribute much to the output expansion, and less compared to capital and labor which have more variance in the data generating process, even though they are restricted to one. Further, the author utilizes a 5 per cent depreciation rate to construct the capital stock, the level that is very low in terms of a developing country like Indonesia. It is acknowledged that the relatively higher corruption, weak governance and limited maintenance cost in Indonesia should be considered in performing the capital stock to depreciate more quickly. Since it is very sensitive to the outcome, determining the higher rate of depreciation to study economic growth in Indonesia would provide a better outcome. A general drawback of the study belongs to the exogenous framework, which can not explain what factor influences technology progress.

In the exogenous growth framework, any government does not have a permanent effect on the long run growth. Many studies have found (Krugman, 1994; Thangavelu and Rajaguru, 2004; Blalock and Veloso, 2007) however, that Indonesia's growth rate is caused by the input factor, such as investment and trade. Therefore, without strong empirical evidence to do so, it is likely to be inadequate to explain the sustained growth in Indonesia in the frame of the exogenous growth model (see also: Fagerberg, 1994; Nelson and Pack, 1996; Rodrigo and Thorbecke, 1997).

Causality approach

In a causality approach, some studies have specifically examined the factors that possibly have an effect on the output. The Granger causality approach has been typically employed to test this hypothesis.

In the study of the sources of economic growth in Indonesia, Hossain (2006) further individually examines the impact of some key macroeconomic policy indicators on per capita output growth for the period 1967 to 2003 in the frame of the Granger causality approach. The study finds that a bi-directional relationship appears between per capita output growth and trade openness, the real exchange rate depreciation and change in the external terms of trade. Meanwhile, inflation and budget deficit do not show any causal effect. The relation between inflation and output growth in particular is consistent with his (the author's) previous study on inflation and growth and finds no causality between them (see: Hossain, 2005).

The importance of openness through trade on economic growth in Indonesia is exclusively investigated by Thangavelu and Rajaguru (2004). For nine rapidly developing countries including Indonesia in the period 1960 to 1996, they decompose trade into export and import and examine their relationship to labor productivity and output growth. In general, it is reported that trade has an important impact on productivity and output growth, and corresponds to Hossain (2006). The specific result for Indonesia suggests that import has a more crucial role to the productivity growth, in the sense that it is import which has a causal effect to productivity growth while export does not. Hence, the premise that import-led productivity growth evidently appears in the case of Indonesia.

Chowdhury and Sugema (2005) specifically investigate the relationship between foreign aid and economic growth in Indonesia. It has been pointed out that Indonesia remains a significant recipient of foreign aid. The authors argue however, that the effectiveness of aid has not been scrutinized. In their exploration, Chowdhury and Sugema (2005) report that even though it is low, the correlation between foreign aid and economic growth is positive.

Another specific study is conducted by Yoo (2006) who examines the relationship between economic growth and electricity consumption for the period 1971 to 2002, among ASEAN countries including Indonesia. The result for Indonesia implies the causality effect running from economic growth to electricity consumption without any effect from electricity consumption to economic growth.

The advance of the causality approach is the ability to explain the relationship between output growth and the factors for a specific country's case. The approach can explicate the relations between the output growth rate and the factors both in bivariate and multivariate form. However, the method is not able to explain in detail how much a certain degree change in explanatory variables affects the dependent variable. Therefore, from the economic decision making point of view, this approach needs further explanation to explore this behavior. Further, in a typical causality test using the Granger approach, the hypothesis of interest is the lags of explanatory power on a dependent variable, and again conditional on lags of the dependent variable. The same opposite direction therefore could happen, in case the dependent variable is interchanged. Durlauf et. at. (2005) point out that this form of test does not explore and discuss the existent interaction among the explanatory variables themselves.

Based on the discussion in this section on empirical studies of economic growth in Indonesia it can be concluded that no studies of economic growth in Indonesia were found that used the three steps procedure. Thus the study of economic growth in Indonesia in this study will be different from those previously done. The investigation of exogenous or endogenous determines the impact of government policy - whether transitory or permanent. The investigation and measurement of the productivity related to growth determines how this is generated and how fast it accelerates growth. The discovery of the determinants and the sources of economic growth using the model identified in the first and second step provides the driving forces of the level, and growth, of real per capita income.

3.4. Chapter conclusion

Indonesia is counted as one of the rapidly growing countries in Asia in the period 1966-2005 (IMF, 2006). During that period, the government implemented policy related to physical and human capital accumulation, openness to trade and investment and macroeconomic stability. The government was also active in response to the development of the world economy. Many studies link the growth rate of Indonesia to these policies. However, the ultimate reason and the proximate causes underlying Indonesia's economic growth are still unclear.

In the literature on economic growth in Indonesia, the studies have not been systematically conducted based on the three steps which subsequently include: (i) Investigating if the long run growth characteristic is exogenous or endogenous; (ii) Investigating and measuring productivity related to growth through testing the catching up hypotheses; and (iii) Discovering the driving forces of the level, and of the growth rate, of real per capita income using the model identified in the first and second steps.

The studies of economic growth in Indonesia related to investigating the characteristic of long run growth have not explicitly and specifically addressed whether it is exogenous or endogenous. The conclusions are mostly revealed from implicit outcomes that intrinsically relate to the exogenous or endogenous growth model. Therefore, it is still unclear whether the government policies have permanent or just a transitory effect on long run growth.

In terms of investigating and measuring productivity related to growth, it is still unclear whether the country is in the process of catching up, both in terms of productivity or technology and income level to the leading economic partner countries. At this point, at least two unsolved questions remain, whether or not the relatively high growth rate achieved by Indonesia in the last decades is accelerated by the diffusion of technology (technology catching up) from the frontier technology country, and whether the growth rate achieved is sufficient for Indonesia to catch up in the long run to the leading economic partner country in terms of income level.

In discovering the driving forces of the real and the growth rate of real per capita GDP, it was found that no studies have been conducted based on the growth model identified from the first step, investigating the characteristic of long run growth and the second step, how productivity is generated.

Based on this discussion, conducting this study based on the three steps is essential in order to provide policy decision makers with a strong theoretical and empirical background for the purpose of preparing an Indonesian development strategy.

This study also fills the existing gaps in the literature of economic growth in Indonesia.

Chapter IV. Economic growth in Indonesia: exogenous or endogenous?

Abstract

The current literature on economic growth has provided two different models with which to characterize economic growth relating to the impact of government policies on long run growth, namely the exogenous and the endogenous growth models. If the growth process is exogenous, government policy can not influence long run growth, as the impact is only temporary. In contrast, if the growth is endogenous, implementing appropriate policies by the government can promote growth and raise the welfare of the people.

Two methods within the time series framework, namely regression equation of time series, and the cointegration and ECM, are used to investigate if economic growth in Indonesia, for the period 1960 to 2006, is characterized as being an exogenous or an endogenous growth model.

The result of the regression equation of time series suggests that investment, trade openness and population growth jointly have a permanent effect on long run growth. The results of the cointegration and ECM, suggest that per capita GDP and per capita investment are cointegrated and that per capita investment has a permanent effect on per capita GDP.

Based on these two results, it is concluded that the characteristic of the long run economic growth in Indonesia is an endogenous growth model. This implies that government policies can influence long run economic growth.

4.1. Introduction

The current literature on economic growth has provided two different models, with which to characterize economic growth, relating to the impact of government policies on long run growth, namely the exogenous and the endogenous growth models. If the growth process is exogenous, government policy can not influence long run growth, as the impact is only temporary. Conversely, if the growth is endogenous, appropriate policies implemented by the government can promote growth.

Investigating the characteristic of the long run economic growth of the Indonesian economy is, therefore, an essential task. More importantly, this work will suggest whether the government, as policy maker, can influence long run economic growth. In essence, the characteristic underlying long run economic growth is a fundamental starting point for the government to formulate its development strategy in order to increase the welfare of the people.

The development of econometric analysis tools, especially in time series, has made it easier to test these two models of growth empirically. There are two time series methods available to investigate the characteristic of long run economic growth, namely: regression equation of time series (see for example: Jones, 1995b; Kocherlakota and Yi, 1996; Karas, 2001) and cointegration and ECM (see for example: Lau, 1994; Lau, 1997; Lau and Sin, 1997; Lau, 1999; Lau, 2008).

Indonesia is dependent on openness to trade to generate export earnings and imports which contribute to national incomes. To a great extent, the performance of the economy is influenced by its major trading partners, and by commodity prices. Thus, some of the main driving forces of the growth lie outside the control of the Indonesian government, which implies an exogenous growth characteristic. Nevertheless, the Indonesian economy can also be linked to its emphasis on human and capital accumulation, foreign direct investment and macroeconomic stability.

This condition is in line with endogenous model that would attempt to explain the influence of government policies. These two different features of the Indonesian economy related to the growth models have generated a query: is the long run economic growth in Indonesia exogenous or endogenous? Is the increase in the living standard of the Indonesian people mostly influenced by government policies? Jones (1995b), Temple (2003) and Dulrauf et. al. (2005) point out that this kind of investigation is not simply to identify the presence of the long run growth effect in the theoretical sense, but it is best seen as indicating whether a government policy change affects growth over a long time.

The purpose of this chapter is to provide empirical answers to those questions. To date there have been debates concerning long run economic growth in Indonesia being exogenous or endogenous, but a study specifically investigating if the characteristic of long run growth is exogenous or endogenous has not been done yet. Therefore, this study fills this knowledge gap and provides an empirical answer.

This study examines Indonesia's long run economic growth by employing both a regression equation of time series and a bivariate cointegration and ECM.

The regression equation of time series uses the following variables: openness, investment and population growth. The result of this approach also provides outcomes concerning the impact of population growth and trade openness on growth. Theoretically, population growth has a negative impact on per capita output growth. Further, the impact of trade openness is also assessed, according to whether it encourages or hurts the economy, by observing its sign and the significance of the coefficient estimate. Rodriquez & Rodrik (2000) specifically point out that the nature of the relationship between openness and growth is still an unresolved issue.

The cointegration and ECM approach uses the per capita investment variable as a counterpart to the per capita output variable, since they are cointegrated. The test is to see whether change in per capita investment impacts permanently on per capita output.

The chapter is organized as follows; the next section examines if the long run growth characteristic in Indonesia is exogenous or endogenous using regression equation of time series and presents the empirical results. Section three examines if the long run growth characteristic in Indonesia is exogenous or endogenous using cointegration and ECM approach and presents the empirical results. Section provides chapter conclusion.

4.2. Regression equation of time series

This section empirically investigates if the characteristic of long run economic growth in Indonesia is exogenous or endogenous using the regression equation formulation of time series model. Methodologically, it applies the set up model of Karas (2001) as a benchmark, but adds openness as one of the policy variables influencing long run economic growth.

4.2.1. Analytical framework and data

Exogenous and endogenous growth model

The analytical framework of the test is derived from the exogenous Solow-Swan model and Rebelo's (1991) endogenous growth model. Following Karas (2001), the analytical framework departs from the household maximizing function. If C is aggregate private consumption, L is the labor force, σ is the inverse of the elasticity of inter-temporal substitution (σ > 0), and ρ is the rate of time preference ($\rho > 0$), each household is infinitely-lived and wishes to maximize utility function:[25]

$$\int_0^\infty \left[(C/L)_t^{1-\sigma}/(1-\sigma\right]e^{-\rho t}dt, \tag{4.1}$$

subject to budget constraint (in per capita terms)

[25] See also Barro and Sala-I-Martin (2004, p. 54-56).

$$\Delta k_t \equiv (1-T) * y_t - c_t - (l+\delta) * k_t \tag{4.2}$$

where Δ denotes differentiation with respect to time. k is the per capita capital stock, T is the productivity factor, y is per capita output, l is exogenous population growth rate, δ is the depreciation rate, and c is per capita private consumption. The exogenous model based on the Cobb-Douglas production function has the following form:

$$Y_t = T * K_t^{\beta *} (e^{\alpha t} L_t)^{1-\beta}, \tag{4.3}$$

where Y is aggregate output, T detains the effect of the productivity factor, K is aggregate capital, α is the growth rate of labor augmenting technological progress ($\hat{L}_t \equiv e^{\alpha t} L_t$ is effective labor force), and $0 < \beta < 1$. In the case that the productivity factor can increase the output, then $T' > 0$. If the constant steady state growth rate of per capita output $(y = Y / \hat{L})$, per capita capital $(k = K / \hat{L})$ and per capita private consumption $(c = C / \hat{L})$ is z, the first order condition implies

$$y_t = \beta(1-T) * T * k_t^{\beta-1} = \rho + l + \delta + \sigma z \tag{4.4}$$

Equation (4.4) depends mostly only on k, where negatively relates to ρ. If saving rate were zero, per capita capital would decline partly due to the depreciation of capital (δ) and the increase in population growth (l). The steady state of per capita output positively relates to per capita capital, and negatively relates to population, while the productivity factor is ambiguous. Differentiating equation (4.4) with respect to time, and taking logarithms form, provides:

$$\Delta y / y = z \quad = \alpha \tag{4.5}$$

where α is the growth rate of labor augmenting technological progress. Since the constant steady state growth depends only on labor augmenting technological progress, the change in per capita capital, population growth and productivity factors do not have impact on the change on the steady state growth ($\partial z / \partial k = \partial z / \partial l = \partial z / \partial T = 0$). Hence, changes in per capita capital, population growth and productivity factors do not have effect on this steady state growth.

For the endogenous growth model, the simple Rebelo (1991) endogenous growth model has the following form:

$$Y_t = T * K_t \quad (4.6)$$

where Y is total output, T is a positive constant that reflects the level of the technology (productivity factor) and K is total capital. Capital has a broad concept which includes human capital. This model has the steady state growth (z) from its first order condition as follows:

$$(1-T)*T = \rho + l + \delta + \sigma z \text{ , \textbf{or}}$$

$$z = \left[(1-T)*T - \rho - l - \delta\right] / \sigma \quad (4.7)$$

Equation (4.7) defines that in the endogenous growth model, steady state growth (z) depends on per capita capital, population growth and productivity factors, whose sign of $\partial z / \partial k$ is positive, $\partial z / \partial l$ is negative, but $\partial z / \partial T$ is ambiguous, whether it is positive because productivity factor generates economic growth or is negative because it discourages economic growth.

Data

In order to empirically test the above exogenous and endogenous framework, this study utilizes the real per capita GDP growth as the output growth (*YG*). On the other hand, investment rate (*IN*) stands to perform capital which accumulate and depreciate as time progresses. The productivity factor T is represented by trade openness (OP).[26] These two factors together with population growth (PG) are considered to have permanent change, and to influence the steady state output growth. These data are taken from the Penn World Table version 6.2 due to Heston, et. al. (2006) based on the 2000 prices index and spanned from 1960 to 2004. The real per capita GDP growth rate is calculated from the real GDP Laypeyres (RGDPL). The data of investment is its ratio to RGDPL, while the trade openness (openk) is constant export plus constant import divided by RGDPL.

4.2.2. Methodology

Appropriateness of the variables

One important requirement that must be satisfied by the policy variables is that they must have effect on growth rate. Statistically, at least one of them must be statistically non stationary so as to exhibit permanent changes, whilst output growth as the dependent variable can be level stationary (I(0)) or first difference stationary (I(1)). Therefore, the unit root test is imposed to see their permanent changes and order of integration.

Regression equation model

In order to empirically examine whether Indonesia's economic growth is characterized by exogenous or endogenous growth in the formulation of regression equation model, the variables of real per capita GDP growth (YG) stand as dependent variables, while population growth (PG), ratio of real investment to GDP (IN), and trade openness (OP) are the independent or explanatory variables. Following Karas (2001), the expression of the model of interest is established as follows:

$$G_t = \mu + \phi t + \alpha_0 D_{1998} + \alpha_1 PG_t + \alpha_2 IN_t + \alpha_3 OP_t + \sum_{j=-n}^{n} \beta_{1j} \Delta PG_{t-j} + \sum_{j=-n}^{n} \beta_{2j} \Delta IN_{t-j} + \sum_{j=-n}^{n} \beta_{3j} \Delta OP_{t-j} + u_t \tag{4.8}$$

[26] Specific discussion on the impact of international trade on economic growth is an old topic, but the debate of whether international trade boost or hurt growth is still on going debate, theoretically and empirically (see for example: Frankel and Romer, 1999; Rodriquez and Rodrik, 2000; Blalock and Veloso, 2007, for detail discussion and example).

where μ is a constant and u is a white noise error term. The presence of time trend (t) in the model is to take into account any unobserved factors that are systematically growing or shrinking over time (Wooldridge, 2008). In effect, if unobserved trending factors are ignored, it may have correlation with explanatory variables. If this is the case, then the regression could possibly be spurious. Hence, the presence of the time trend is nothing but methodologically to eliminate this problem. D_{1998} is the pulse dummy variable to capture the impact of the 1998 economic crisis. It takes the value of 1 for year 1998, and 0 otherwise.

The estimates of $\alpha_1, \alpha_2, \alpha_3$ are coefficients of interest to be tested for an exogenous or endogenous model, and $\beta_{1j}, \beta_{2j}, \beta_{3j}$ are parameters. The inclusion of n leads and lags of the policy variables differenced in the right hand side ($\Delta PG_{t\pm n}, \Delta IN_{t\pm n}, \Delta OP_{t\pm n}$) are to solve any endogenity and super consistency problems in the model (Wooldridge, 2008, p. 642). This is due to the fact that, if all variables are non stationary and integrated of order one (I(1)), the OLS estimator of the parameters ($\alpha_1, \alpha_2, \alpha_3$) are super consistent. Consequently, inference based on their standard error will be generally invalid (Enders, 2004, p. 378-380). Further, n should be large enough for correlation between u_t and ($\Delta PG_{t\pm s}$ $\Delta IN_{t\pm s}$ $\Delta OP_{t\pm s}$) to be zero for $s > n \geq 0$.

In order to interpret the outcome of the estimate, t-ratio should be adjusted so that it has asymptotically normal distribution and is consistent. For this purpose, the residual $\hat{u}$ of equation (4.8), is estimated for an auxiliary (AR(p)) process (see also: Karas, 2001; Enders, 2004, p. 379-380),

$$\hat{u}_t = \sum_{j=1}^{p} \pi_j \hat{u}_{t-j} + \varepsilon_t \qquad (4.9)$$

The estimate π_j is used to compute the asymptotically consistent *t*-ratios. The adjustment of the *t*-ratio for their asymptotic distribution of standard normal takes the following form:

$$adjusted\ t - ratio \equiv (OLS\ t - ratio)\left(\frac{\hat{\sigma}_u}{\hat{\sigma}_\varepsilon}\right)\left(1 - \sum_{j=1}^{p} \hat{\pi}_j\right) \xrightarrow{d} N(0,1) \qquad (4.10)$$

where $\hat{\sigma}_u$ and $\hat{\sigma}_\varepsilon$ denote for the standard deviation estimates of equation (4.8) and (4.9), respectively. Considering the analytical framework of equation (4.5) of the exogenous growth model, and equation (4.7) of the endogenous growth model, the null hypothesis of the test is performed as follows:

$Ho: \alpha_1 = \alpha_2 = \alpha_3 = 0$ for exogenous growth model

$H_1: \alpha_1 < 0, \alpha_2 > 0, \alpha_3 \neq 0$ for endogenous growth model

In principle, the model simply explains the growth rate of outout (*G*) in term of trade openness (*OP*), population growth (*PG*) and investment to GDP ratio (*IN*). The output growth (*G*) can be stationary in level (I(0)) or stationary in difference (I(1)). Therefore, it is not performed with the dynamic relationship in the error correction model.

Empirical procedures

The first step of the empirical procedure is to test the variables for unit root. This test is to see appropriateness of the variables. The test is conducted by DF and ADF, which have the following forms:

$$\Delta y_t = a_0 + a_1 t + \gamma y_{t-1} + \varepsilon_t \qquad (4.11a)$$

$$\Delta y_t = a_0 + a_1 t + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t \qquad (4.11b)$$

Equation (4.11a) and (4.11b) are the DF and ADF tests, respectively. The difference between them is the presence of lag variable differenced in the ADF test. Δ is the lag operator of first difference, y_t is the variable at time t. t is the deterministic time trend, p is the order of the autoregressive process, and Δy_{t-1} is to accommodate an autoregressive process in the errors. γ is the coefficient of interest where its t-statistic is to be compared to the DF unit root test critical values. Each DF and ADF has three testing models, that is: model 1: without intercept and no trend; model 2: with intercept and no trend; and model 3: with intercept and trend.

The procedure of the test is started by observing the data generating process in the time plot of the variables, whether or not it necessitates including an intercept in the model (DF model 1 or 2). Initially, the DF test is employed without incorporating the time trend, as DF test model 1 or 2. If the stationary condition has been found, the test is stopped and the result is reported. If it has not, the test is continued by fitting the time trend in the model, as DF test model 3. Again, if the result has shown the stationarity, the test is stopped and the result is reported. If it has not, the ADF model is then employed, starting from the model 1 or 2, and so forth. If the ADF test should be conducted, the lag length of the variables differenced is determined based on the minimum value among AIC, BIC and MAIC. As the small size sample of the data, calculation of each of the AIC, BIC and MAIC is limited to a maximum four lags. If the variables should be tested using ADF, but the criterion shows the minimum criterion value in the lag of zero, then the model is reported as the ADF with lags zero.[27] In the case that the stationary condition has not been shown by the ADF model 3, the result is reported as the outcome of ADF model 3.

In order to find the order of integration (I(d)), further unit root test is conducted to the variables that do not show stationarity condition in level. It is done by differencing them d times until they get to the stationarity condition. As methodologically

[27] As the different between the DF and ADF unit root test lies on the presence of the variables differenced in the right hand side, the ADF test with lag 0 (zero) is the same as the DF test.

required, at least one of the policy variables should be non stationary, and they all are preferably I(1).

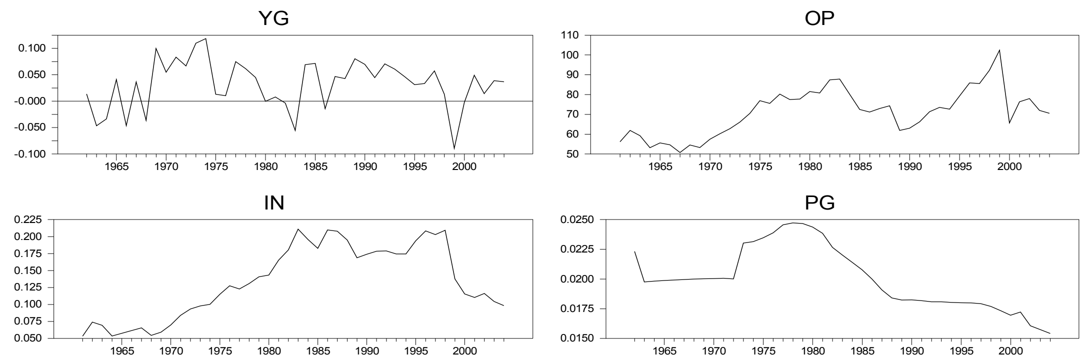
Given that the appropriateness of the variables is obtained, the second step is to determine the leads and lags (*n*) in the variables differenced of equation (4.8). It is started by setting *n* equal to 1, and then checking the specification of the model. If there is correlation between the residual and the lead and lags of the variables differenced, *n* is increased to 2, and so on until they have no correlation with the residual and the model is clean from any endogenity problems. The Hausman test is employed to examine this specification.

The third step is to estimate equation (4.8) using *n* determined in the second step. Diagnostic tests are then conducted to ensure that the model is adequately specified, has no serial correlation and homoscedastic in the residual. The result of the *t*-ratio is then adjusted using the AR(*p*) procedure of equation (4.9) and (4.10). The AIC is utilized to determine *p* in the AR(*p*). And the last step is to analyze the outcome.

4.2.3. Empirical result

The unit root test is conducted for all of the variables. Figure 4.1 displays the time plot of the variables. It is obvious that all variables exhibit intercept except for YG. Hence the unit root test is conducted by incorporating intercept in the model to all of the variables, except for YG. Table 4.1 reports the result of the test.

Figure 4.1
The time plot of the variables: YG, OP, IN, PG



The outcome of the test apparently indicates that all variables are non stationary in level except for YG. A further test is conducted to those variables that are non stationary by differencing *d* times to get the stationary condition. The results indicate that all of the policy variables are stationary in their first difference (I(1)). It can be concluded therefore, that they are appropriate for this empirical examination.

Table 4.1
Unit root test: YG, IN, OP, PG

Variables	The test model* (5% critical value)	Lags	Test statistic value	Conclusion
In level				
YG	DF 1 (-1.95)	-	-3.60	Stationary
IN	ADF 3 (-3.53)	0	-0.27	Nonstationary
OP	ADF 3 (-3.53)	0	-2.60	Nonstationary
PG	ADF 3 (-3.53)	1	-1.63	Nonstationary
In first difference				
DIN	DF 2 (-2.94)	-	-5.30	Stationary
DOP	DF 2 (-2.94)	-	-8.18	Stationary
DPG	DF 2 (-2.94)	-	-5.97	Stationary

Notes: * Refers to the three models of DF and ADF: 1 – no intercept and no trend; 2 – with intercept and no trend; 3 – with intercept and trend. The parentheses are the 5 per cent critical value of the respective model.
Testing to the variables in difference is only conducted to the variables that are not stationary in level.

The outcome of the unit root test also gives some concerns to formulating the model and its consistency. Provided all policy variables are I(1), the formulation of the model therefore necessitates the presence of leads and lags of the policy variables differenced. The Housman test is conducted, and reported in Table 4.2. It suggests that setting *n* equal to 1 has been able to specify the model, providing the Housman test statistic 10.32 with the *p* value 0.41, indicating no correlation between the residual and the lead and lag variables differenced. Hence, the model is clean from any endogenity problem.

Equation (4.8) is estimated using *n* equal to 1 and the result is reported in Table 4.2. The time trend (*t*) has been omitted from the model, since it has a statistically insignificant *t*-ratio. The Ramsay's (1969) regression specification error test (RESET) gives the statistic value 2.03 with *p*-value 0.41, indicating the model is correctly specified. In order to detect any serial correlation problem, the Breusch (1978) and Godfrey (1978) test of serial correlation is implemented. The result suggests that the residual is serially uncorrelated. Furthermore, the Breush and Pagan (1979) test indicates the residual is homoscedastic. Therefore, empirical interpretation based on this model is valid.

Correction procedure is conducted to obtain normal *t*-distribution. The auxiliary AR(*p*) process of the residual of equation (4.8) is estimated using equation (4.9), for *p* is set to 6, provided by the minimum value of the AIC. The sum of the coefficient (π_j) is then calculated utilizing the formulae of equation (4.10). The adjusted *t*-statistic is reported in Table 4.2.

Table 4.2
Estimates of the long run effect on growth
Dependent variable: *YG*

Variables	**Coefficient**	**Adjusted *t*-statistic**
μ (*Constant*)	0.11	3.38*
α_1 (*PG*)	-2.10	-1.38
α_2 (*IN*)	0.37	4.54*
α_3 (*OP*)	-0.10	-2.46**
D_{1998}	-0.15	-4.50*
Hausman test (*p – value*)	10.32 (0.41)	
Ho: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ *F-test stat value*[1]*;* 3, 40 *df*	4.23**	
DW	2.15	
R^2	0.75	
RESET χ^2	2.03 (0.36)	
Serial correlation χ^2	0.71 (0.40)	
Heteroscedasticity χ^2	0.70 (0.87)	

Notes: * and ** significant at 1% and 5% significant level, respectively.
[1] calculated using the same formula as *adjusted t-ratio*

The parameter sign of the estimates are as expected, that is positive for IN and negative for PG, while OP can be positive or negative. The dummy (D_{1998}) variables present its negative sign, implying that the 1998 economic crisis has significant negative impact on growth. The joint test by restricting $\alpha_1 = \alpha_2 = \alpha_3 = 0$, gives the *F*-statistic value 4.23, sufficient to reject the null hypothesis at 5 per cent critical value. At this point, permanent changes in those variables indicate a permanent effect on the steady state growth. This depiction characterizes in favor of the endogenous growth model.

Based on the results from this section on the characteristic of long run economic growth in Indonesia using regression equation of time series, it can be concluded that the Indonesian government, through appropriate policy, can influence long run economic growth.

- One of the channels through which the government can influence the long run growth rate is by encouraging investment, given the positive sign of the parameter estimate, and that it is individually statistically significant.
- In terms of population growth, it has a statistically insignificant negative impact on output growth.
- The government should also carefully conduct its policy in terms of trade openness. The parameter of the openness coefficient estimate is negative and statistically significant. The most possible reason of this negative relationship is that Indonesia is not well prepared before liberalizing international trade (see for example: Simorangkir, 2006). The result of trade openness is robust since lack of preparation to foresee trade openness lead to weaken competitiveness of Indonesian product and finally lower output. [28]

4.3. Cointegration and ECM approach

The second part of empirical work in this chapter investigates if the characteristic of long run economic growth in Indonesia is exogenous or endogenous using a cointegration and ECM approach. The parts of this section are: analytical framework and data, methodology and empirical results.

4.3.1. Analytical framework and data

The analytical framework of investigation is derived from the difference between exogenous and the endogenous growth model related to the impact of government policy on the long run growth. In economic growth study, government policy commonly aims at accumulating capital which is mainly achieved through generating investment.

[28] Simorangkir (2006) empirically studies the impact of the openness to the Indonesian economy. The author finds negative significant relationship between openness (which constructed by export plus import divided by GDP) and output. The study also reviews critically on the trade policies conducted by the Indonesian government since about the last 50 years.

In the exogenous growth model, the long run steady state growth is achieved through the condition that each variable of the model is growing at a constant rate of time. Investment is made to offset the rate of depreciation and population growth which hamper per capita capital. As the characteristic of diminishing marginal productivity, the increase in per capita capital will increase output, but with a decreasing amount. On the other hand, this increase is also eventually seized by the rate of capital depreciation and population growth. The only factor that induces growth is the growth of productivity that is determined exogenously by technology progress. Therefore, any policy to generate investment in order to accumulate capital will only have a transitory effect in the long run growth.

In the endogenous growth model, the long run steady state growth is achieved by the increase of capital productivity. This model applies a broader concept of capital to include inputs such as human and physical capital, knowledge and public infrastructure. Capital productivity can be increased by investment and development in those factors, such as development in education, infrastructure, investment in research and development, and so on. This conception is to eliminate the notion of capital diminishing return in the long run. Therefore, investment can be paid to keep productivity constant or increase, in order to accelerate growth. Any government policy to generate investment, in order to accumulate physical and human capital, and hence increase productivity, could have a permanent effect on the long run growth.

Lau (2008, p. 60) points out that if the n variables are cointegrated with the r cointegrating vector(s), the long run multiplier matrix for structural moving average (MA) representation is of reduced rank of $n-r$. This structural MA exhibits empirical shock, which can be used to examine the long run effect of the structural shocks on the level of observed variables. Juselius (2006, p. 277) underlines that the empirical shocks of the structural MA can be transitory and permanent. The transitory shock has, by construction, no long run impact on the variables in the system, while permanent shock must have significant long run impact on at least one of the variables in the system.

Lau (2008) utilizes this property to test the existence of the endogenous growth model in the economy when the real per capita GDP is cointegrated with real per capita investment. If the growth of the economy is characterized by the exogenous growth model, the structural MA of real per capita investment on real per capita GDP exhibits transitory shock, while in the endogenous growth model, the structural MA exhibits permanent shock. Following Lau (2008), this study considers the representation of structural MA for the exogenous and endogenous growth models as follows:[29]

$$\begin{pmatrix} \Delta x_{1t} \\ \Delta x_{2t} \end{pmatrix} = a + M(B)\varepsilon_t \equiv a + \begin{pmatrix} M_{11}(B) & M_{12}(B) \\ M_{21}(B) & M_{22}(B) \end{pmatrix} \varepsilon_t \tag{4.12}$$

where a is a vector constant, $\Delta \equiv 1 - B$ is the first-difference operator, where x_1 and x_2 stand for the real per capita output and investment or saving rate, respectively. $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})'$ is a vector of structural disturbance such that its components are serially and mutually uncorrelated. The matrix of lag polynomial $M(B) = \sum_{j=0}^{\infty} M_j B^j$, and the constant vector is non zero, in order for the variables to demonstrate long term growth. It is obvious that in fact, the elements of $M(B)$ are impact multipliers. The information concerning the long run effect is provided in the long run multiplier matrix of structural VMA representation (4.12), which is

$$M(1) = \sum_{j=0}^{\infty} M_j \tag{4.13}$$

[29] See also: Ender (2004, p. 272-277)

If the growth is characterized by the exogenous growth model, the impact multiplier $(M(1))$ of real per capita investment is zero; otherwise, it is the endogenous growth model.

Data

In order to investigate the long run economic growth, exogenous or endogenous, the variables of real per capita output and per capita investment are used. Per capita investment is to indicate the policy variable, which is the variable to reflect the government policy that could influence output. Jones (1995b) argues that a test based on investment data may be regarded as providing evidence with respect to the endogenous versus exogenous growth debate for the whole class of growth models, rather than for specific model.[30]

As required by the analytical framework, the real per capita output and real per capita investment should be integrated and cointegrated of order 1 (I(1)). To meet this purpose, this thesis utilizes GDP as the output level and total gross capital formation as investment level,[31] since they are cointegrated in the preliminary exercise. These data are divided by the population number and then converted into 2000 prices[32] to obtain the real per capita GDP and real per capita investment. All these required data are taken from WBWT (World-Bank, 2008). The real per capita GDP is considered to be the output and the real per capita investment is considered to be endogenous variables or input. For the purpose of the analysis, the data are transformed in natural logarithm (ln).

[30] In empirical applications, it is common to use investment in level, its ratio to GDP and also per capita investment. However, the use of per capita investment here is specifically to capture the growth of population in Indonesia which is relatively high (see Figure 3.1).
[31] The better approximation for investment level is in fact gross fixed capital formation. However, in the case of Indonesia, this data is only available for the period 1979-2006, the period which considered too short and insufficient to analyze in the cointegration and ECM.
[32] GDP deflator and consumer prices index (CPI) from WBWT (World-Bank, 2008) are used to convert per capita GDP and per capita investment, respectively into 2000 prices.

4.3.2. Methodology

Cointegration and ECM

Following Lau (2008), the representation of the structural MA of exogenous and endogenous growth is testable through the estimated coefficients of the reduced form ECM in the following form:

$$\begin{pmatrix} \Delta x_{1t} \\ \Delta x_{2t} \end{pmatrix} \equiv \begin{pmatrix} \alpha_1^R \\ \alpha_2^R \end{pmatrix} + \sum_{j=1}^{p} \begin{pmatrix} \phi_{j,11}^R & \phi_{j,12}^R \\ \phi_{j,21}^R & \phi_{j,22}^R \end{pmatrix} \begin{pmatrix} \Delta x_{1,t-j} \\ \Delta x_{2,t-j} \end{pmatrix} + \begin{pmatrix} \pi_1^R \\ \pi_2^R \end{pmatrix} \left(x_{2,t-1} - x_{1,t-1} \right) + \begin{pmatrix} \varepsilon_{1t}^R \\ \varepsilon_{2t}^R \end{pmatrix} \tag{4.14}$$

where p is the lag length, and $\pi^R = (\pi_1^R, \pi_2^R)'$ is the reduced form adjustment vector. The components of $\varepsilon_t^R = \left(\varepsilon_{1t}^R, \varepsilon_{2t}^R\right)'$ are serially uncorrelated but may be contemporaneously correlated with each other. At this point, whether or not the impact multiplier matrix M(*1*) of real per capita investment is zero or not, it can be examined by testing whether the estimate of π_1^R is zero or not, and the long run response of structural disturbances of x_2 to x_1 is negative or not in equation (4.14) (see also: Juselius, 2006, p. 277-281). Therefore, the construction of the hypothesis of the test is as follows:

$Ho: \pi_1^R = 0, \quad M_{12}(1) = M_{22}(1) = negative$, it favors to the exogenous growth model.

$Hi: \pi_1^R \neq 0, \quad M_{12}(1) = M_{22}(1) = positive$, it favors to the endogenous growth model.

In some circumstances, it is possible that $\pi_1^R \neq 0$, but the estimated long run $M_{12}(1) = M_{22}(1)$ is negative. In that case, the evidence is less favorable to an endogenous growth model. Oppositely, if $\pi_1^R = 0$, and $M_{12}(1)$ is positive, then the evidence is favorable to an endogenous growth model. Hence, it is also essential to observe $M_{12}(1)$ as the impact multiplier long run response of one unit of investment disturbance on per capita output. Under the identifying assumption $m_{0,12} = 0$, the impact multiplier $M_{12}(1)$, can be obtained by the standard method of impulse response function.

A specific formulation of the model is required in order to investigate the long run economic growth in Indonesia using this approach. As the impact of the 1998 economic crisis has severely altered real per capita income and investment, a pulse dummy variable is included in the model. The model of interest is therefore as follows:

$$\begin{pmatrix} DLY_t \\ DLI_t \end{pmatrix} = \begin{pmatrix} \alpha_y \\ \alpha_i \end{pmatrix} + \begin{pmatrix} \delta_y \\ \delta_i \end{pmatrix} D_{1998} + \sum_{j=1}^{p} \begin{pmatrix} \phi_{j,11} & \phi_{j,12} \\ \phi_{j,21} & \phi_{j,22} \end{pmatrix} \begin{pmatrix} DLY_{t-j} \\ DLI_{t-j} \end{pmatrix} + \begin{pmatrix} \pi_y \\ \pi_i \end{pmatrix} \left(LI_{t-1} - LY_{t-1} \right) + \begin{pmatrix} \varepsilon_{yt} \\ \varepsilon_{it} \end{pmatrix} \quad (4.15)$$

where DLY and DLI are the log per capita GDP and the log per capita investment in first difference, respectively. D_{1998} is the dummy variable to capture the impact of the 1998 economic crisis. It takes the value of 1 in 1998 and 0 otherwise. α refers to the vector of constant, while y and i correspond to the ECM model of DLY and DLI, respectively. π is a vector of the speed of adjustment parameter. The components of $\varepsilon_t = \left(\varepsilon_{yt}, \varepsilon_{it}\right)'$ are the error term and serially uncorrelated.

In order to estimate equation (4.15), the Johansen (1991, 1995) maximum likelihood estimation procedure is employed. The implementation of the procedure includes examination of cointegration, estimation of the speed adjustment, and estimation of $M_{12}(1)$.

Empirical procedures

Prior to the employment of Johansen's (1991, 1995) procedure, the first step is to conduct unit root test to the variables. The test is to provide evidence that the variables are integrated of order 1. The DF and ADF test is used to this test with the rules as described in the empirical procedures of subsection 4.2.2.

The second step is to determine the rank of π and the cointegrating vector. When the cointegrating vector is obtained, the third step is to estimate equation (4.15) and check the model for model adequacy. The Schwarz Criterion (SC) and Hannan-Quinn Criterion (HQC) are employed to determine the lags length in the vector autoregresion. The Ljung-Box Q-statistic is conducted to detect any serial correlation in the residual. Given the model is properly specified, the last step is to analyze the outcome.

4.3.3. Empirical result

The empirical exploration provides the results of testing the order of integration and order of cointegration, estimating the error correction model, testing model adequacy, and testing the hypothesis. The result of the test is obtained from the CATS in RATS version 2 due to Dennis et. al. (2005).

The unit root test

The time plot of the variables is presented in Figure 4.2. It is obvious that both log per capita GDP and log per capita investment exhibit intercept in their data generating process. Thus, the intercept is incorporated to the model of the unit root test for both variables. Table 4.3 reports the result of the unit root test. In their level, both variables exhibit nonstationary condition, and reach stationary condition in their first difference. It is concluded therefore that both log per capita GDP (LY) and log per capita investment (LI) are integrated of order 1 (I(1)).

Figure 4.2
The time plot of the variables: LY, LI

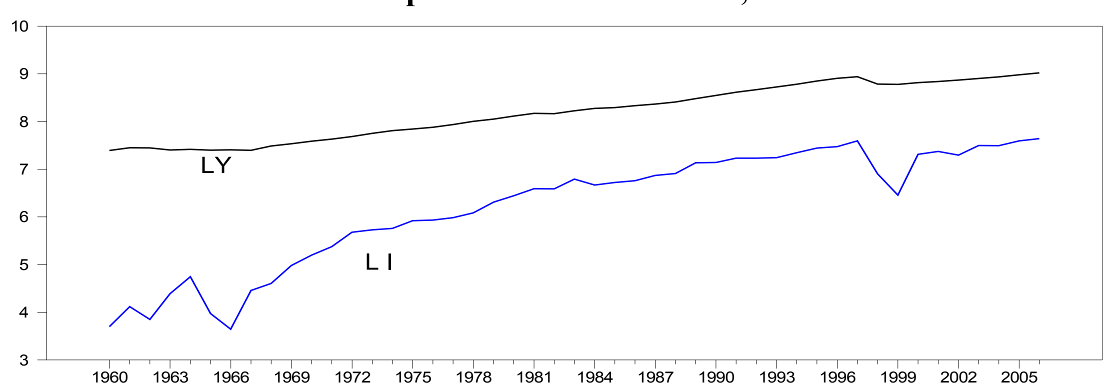


Table 4.3
Unit root test: LY, LI

Variables	The test model* (5% critical value)	Lags	Test statistic value	Conclusion
In level				
LY	ADF 3 (-2.94)	1	-0.10	Nonstationary
LI	ADF 3 (-3.53)	4	-2.56	Nonstationary
In first difference				
DLY	DF 2 (-2.94)	-	-4.79	Stationary
DLI	DF 2 (-2.94)	-	-7.25	Stationary

Notes: * Refers to the three models of DF and ADF: 1 – no intercept and no trend; 2 – with intercept and no trend; 3 – with intercept and trend. The parentheses are the 5 per cent critical value of the respective model.
Testing to the variables in difference is conducted as they are not stationary in level.

The rank of π and *cointegrating vector determination (the cointegration test)*

The cointegration test is conducted using the model with drift. In determining the lags length using the SC and HQC, the maximum lag is set to 5. The outcome shows that the minimum value for SC and HQC is in lag 2. Hence, a lag 2 is used to test the cointegration of the variables. Table 4.4 presents the result of the test.

Table 4.4
The cointegration test: LY, LI

Null hypothesis	Alternative hypothesis	Statistic value	5% critical value*	1% critical value*
λ_{trace} **test:**				
$r = 0$	$r > 0$	21.15	15.41	20.04
$r \leq 1$	$r > 1$	0.06	3.76	6.65
$\lambda_{\max}$ **test:**				
$r = 0$	$r = 1$	23.60	14.07	18.63
$r = 1$	$r = 2$	0.002	3.76	6.65

Notes: * the critical value is from Osterwald-Lenun (1992) which is taken from Enders (2004, p. 443)

The null hypothesis that the variables are not cointegrated, that is $r = 0$ against the alternative of one or more cointegrating vectors, is rejected by the statistic value of the λ_{trace} test at 1 per cent critical value. The case is also true in the $\lambda_{\max}$ test. The null hypothesis of no cointegrating vector $r = 0$ against the alternative that there is 1 cointegrating vector is rejected; given the $\lambda_{\max}$ statistic value is greater than the 1 per cent critical value. It is concluded therefore that both log per capita GDP and log per capita investment are cointegrated. The cointegrating relationship is then given as: $5.62LY - 3.17LI = 0$.

The estimation of the model

The estimates of the regression of ECM (4.15) with the lag length determined by the minimum value of SC and HQC, is reported in Table 4.5. The Ljung-Box Q-statistics indicate that both DLY and DLI model are free from autocorrelation in the residual.[33] Therefore, interpretation based on this estimate is valid.

The *t*-statistic of the error correction term ($(LY\text{-}LI)_{t-1}$) in the model for DLY (π_y) is statistically and significantly different from zero at 5 per cent critical value. This is also supported by the long run impact multiplier matrix as the long run response of a unit of per capita investment disturbance on per capita output value ($M_{12}(1)$) which is positive. This implies a rejection of the null hypothesis and concludes that the long run economic growth is favorable to the endogenous growth model.

Table 4.5
Estimates of the error correction model for LY and LI

Right hand side	Model			
	DLY		***DLI***	
	coeff.	***t*-stat**	**coeff.**	***t*-stat**
Constant	0.25	3.38	-2.53	-3.73
D	-0.20	-9.67	-0.79	-4.14
$(LY\text{-}LI)_{t-1}$	-0.05	-3.01	0.58	3.89
DLY_{t-1}	0.17	1.80	3.30	3.88
DLY_{t-2}	-0.02	-0.20	0.50	0.59
DLI_{t-1}	0.01	1.00	-0.08	-0.74
DLI_{t-2}	-0.01	-1.14	-0.43	-4.05
Ljung-Box Q-Statistic	23.33	* (0.18)	26.203	** (0.24)
$M_{12}(1)$	0.60			

Notes: * Q-statistic up to lags 18; ** Q-statistic up to lags 22
Figure in the parentheses are the *p-value*

[33] This is also supported by the correlograms which is not presented here, that show no evidence of autocorrelation.

The estimation result is quite robust with respect to a number of various lag lengths in the vector ECM (VECM). Table 4.6 reports the estimates of the error correction term (π) and long run responses $M_{12}(1)$ in various lag lengths of VECM. In the lag length of 1 and 2, the coefficient of π_y are statistically significantly different from zero and the impact multiplier is positive. In the lag length of 3 and 4, the coefficient of π_y is not statistically significantly different from zero. However, the impact multiplier, $M_{12}(1)$, is positive. These results indicate that the structural disturbance in the per capita investment has a permanent effect to the per capita GDP.

Table 4.6
The estimates of error correction term and long run responses in various lag length of VECM

Lag length	π_y		π_i		$M_{12}(1)$
	coeff	**t-stat**	**coeff**	**t-stat**	
1	0.06	-3.85	0.45	2.68	0.58
2	-0.05	-3.01	0.58	3.89	0.60
3	-0.01	-0.61	0.57	3.06	0.59
4	0.003	0.30	0.24	2.44	0.74

Notes: π_y and π_i are the estimates of error correction term of ECM model for DLY and DLY, respectively.

Based on the results in this section on the characteristic of long run economic growth using a cointegration and ECM approach, it can be concluded that the cointegration and ECM in testing between the exogenous and endogenous model for the process of economic growth in Indonesia provides further support in favor of the endogenous growth model. The per capita investment is evidently one of the factors that have a positive significant effect on the per capita GDP. Any change in this factor will have a permanent effect on the long run growth rate. Therefore, in order to generate economic growth, the Indonesian government could implement policy to increase investment.

4.4. Chapter conclusion

The current literature on economic growth has provided two different models with which to characterize economic growth, relating to the impact of government policies on long run growth, namely the exogenous and the endogenous growth models. If the growth process is exogenous, government policy can not influence long run growth, as the impact is only temporary. In contrast, if the growth is endogenous, implementing appropriate policies by the government can promote growth.

The development of econometric analysis tools has facilitated the use and testability of these two models of growth. Two methods within the time series framework, namely regression equation of time series, and cointegration and ECM, are used to investigate if economic growth in Indonesia, for the period 1960 to 2006, is characterized as being an endogenous or an exogenous growth model.

The result of the regression equation of time series suggests that investment, trade openness and population growth jointly have a permanent effect on long run growth. Individually, the investment rate has a positive significant effect on growth.

The results of the cointegration and ECM suggest that per capita GDP and per capita investment are cointegrated and that per capita investment has a permanent effect on per capita output. The cointegration and ECM is then used to further investigate the long run growth process of Indonesia using a bivariate model. The strict prerequisite in this model is that both variables are cointegrated is satisfied, given that the log per capita GDP and log per capita investment are cointegrated with the cointegrating vector (1,-1). This outcome indicates that investment has an impact multiplier on per capita income. This is further evidence that the growth in Indonesia is endogenous.

An important implication of this result is that the Indonesian government, through its policies, can influence long run growth. Generating investment is one channel through which the government can spawn long run economic growth, given that both the methods provide evidence of its positive and significant impact. It is also important for the government to manage population growth, since it has a negative correlation to output growth, even though insignificant. Population growth is necessarily best accompanied by development in human capital such as education, in order to increase productivity and final output.[34]

Based on the concurrence of the results from the different methods of testing the exogenous and endogenous growth models, the growth process of Indonesia is endogenous. It is important to underline, however, that both of the methods are in the framework of time series methodology, which is very sensitive to the sample size. The sample size of about forty-five may be too small when analyzing permanent effects on long run growth. Therefore, methodology that can be used to examine differences between the exogenous and endogenous growth models is an area of applied research that can be further explored.

However, based on these two results, it is concluded that the characteristic of the long run economic growth in Indonesia is an endogenous growth model. This implies that government policies can influence long run economic growth.

---

[34] In general, human capital is performed of a person's stock of knowledge and abilities, the increase of which increases the person's productivity. In addition, schooling is the way to acquire the stock of knowledge and the abilities (see for example: Greiner et. al., 2005, p. 62-62). Therefore, the measurement of human capital should cover education, both formal and informal system, such as on the job training, physical and mental fitness, and social services affecting quality of work. However, human capital is not easy to measure. Consequently, proxies for human capital are commonly constructed using the variables such as enrollment rates or average years of schooling.

Chapter V. The Indonesian economy: Does it catch up to the world's leading economies?

Abstract

There are two conceptions of catching up in the growth literature: technology and income level catching up. These are utilized to investigate the Indonesian economy.

A time series equation is performed to examine the process of technology catching up; and the cointegration and ECM, and the polynomial time trend are used to examine income level catching up.

The results of the time series equation suggest that there is a process of adoption of technology (technology catching up) by Indonesia from the frontier technologies of Japan and USA during the period 1960-2005. This technology catching up is empirically deemed to contribute to accelerating productivity and growth on average by about 6 per cent annually.

The results of the cointegration and ECM and the polynomial time trend suggest that there is not any process of income level catching up by Indonesia toward the developed countries of Japan and USA during the same period.

Based on these two results, it is concluded that the process of technology catching up which facilitated Indonesia to accelerate productivity and growth exists. However, the growth acceleration is insufficient for the country to catch up to the leading countries of Japan and USA in terms of per capita income.

5.1. Introduction

There are two conceptions of catching up in the growth literature: technology and income level catching up. These are both utilized to investigate the Indonesian economy catching up to the developed countries. Using both conceptions to investigate the Indonesian economy is new to the literature.

The technology catching up examination is to observe whether there is a process of adoption of technology by Indonesia, a developing country, from the frontier technology countries, which facilitates the acceleration of productivity and growth. On the other hand, income level catching up is to measure empirically whether the growth rate achieved by Indonesia, a developing country, has been able to bring Indonesia to catch up, in terms of income level, to the leading countries.

The technology catching up hypothesis states that the developing country, as the lagging or relatively backward country, can catch up to the frontier technology of the leading country through adoption and implementation of frontier technology in order to accelerate its productivity and growth.[35] It is widely and empirically acknowledged that technology is a crucial element of productivity (see for example: Barro and Sala-I-Martin, 2004; Aghion and Howitt, 2009). The adoption and implementation of frontier technology can even be strategic, because it is not associated with the R&D cost which most developing and laggard countries endure. Barro and Sala-I-Martin (2004, p. 349-350) point out that imitation and implementation have been one of the development strategies chosen by developing countries, since it is cheaper than innovation. There are several channels through which technology catching up takes place, such as foreign direct investment and international trade. However, the process of adoption and implementation of frontier technology itself is not automatic. The backward country needs first to have a certain degree of adoption and implementation capacity.

---

[35] This postulation has the same definition as the adoption of technology and or technology diffusion. In this study, they are used interchangeably.

The income level catching up hypothesis is defined as the process of a developing country to catch up to the developed country in terms of output level, because the developing country, as the poorer country, grows faster than the developed country.[36] If the process exists, the disparities in the income level between the developing (lower income) country and the leading (higher income) country narrows and approaches zero over time. In that case, the growth rate of the developing country has been able to catch up to the income level of the developed country. Many developing countries experience high economic growth for a period of time. However, not all of them are in the process of catching up to the income level of a leading country. Since the process of income level catching up is empirically testable, it is conceptually a good measurement with which to assess the development process of a developing country.

The two concepts of catching up are important for Indonesia, especially in the formulation and measurement of a development strategy. The technology catching up can be used to accelerate productivity and growth through adoption and implementation of frontier technology, while the income level catching up can be utilized to measure whether the growth rate in the output level achieved by Indonesia has been able to bring the economy into the process of catching up to the leading economy, in terms of income level. Obviously, the latter can be used to measure the success of the former. Dowrick and Rogers (2002) emphasize that technology transfer is an important contributor for the income level catching up process. Durlauf et. al. (2005) further point out that many authors view convergence as the process of laggard countries catching up to the leader countries by adopting leading technologies.

[36] There are two fundamental theories underlying this occurrence (see for example: Scoppa, 2009). The first is from the exogenous growth theory which is diminishing return to capital. It suggests that poorer country which has lower endowment of capital, accumulate greater capital, and in addition, capital tend to flow toward these economies characterized by higher returns. The second is endogenous growth model, which postulates that poorer country grow faster because of technological catching up.

Both conceptions of catching up are used in this study to simultaneously empirically investigate the Indonesian economy. Indonesia has attained economic growth over the last four decades at an annual average of about 6 per cent (World-Bank, 2008). Many argue (see for example: Hill, 2000; Dowling and Chin-Fang, 2008), that this was achieved after the country received international capital inflow, gains from international terms of trade and established the manufacturing and industrial sectors. The rapid and impressive process of the Indonesian economy integrating to the world economy is a frequently cited corollary (see for example: Hill, 2000; James and Ramstetter, 2008). However, the most important evidence is through trade, investment and foreign direct investment. They are widely believed to facilitate the process of adoption of technology. These facts are an essential part in the analysis of economic growth, whether the acceleration of productivity and growth is generated by technology catching up; and whether this productivity and growth is able to bring the country to catch up, in the long run, to the income level of the leading countries.

Employing both catching ups together to analyze the development process and the attainments of a specific country is a new deployment. The purpose of examining the Indonesian economy with regard to the catching up hypotheses is to empirically answer the following two questions. Firstly: is there a process of technology catching up by Indonesia to the leading technology countries which facilitated productivity acceleration during the relatively high economic growth period of 1960-2005? Secondly, has the growth rate achieved by Indonesia, in the same period, been able to bring the economy to catching up (converge), in the long run, to the developed countries in terms of per capita income?

Japan and USA were chosen as the frontier technology and the leading countries. It is based on their economic partnerships with Indonesia and their outstanding per capita output. Firstly, they are the first and second trading partners of Indonesia. They have had significant economic cooperation with Indonesia both historically and presently, in terms of exports, imports and investing in FDI and other forms of investment. Secondly, they are influential in the world economy and have a high per capita income. This study does not take new industrialized country such as South Korea, Taiwan or others as the frontier and leading countries, because they do not have special criteria as mentioned for the process of catching up. As for example Taiwan is not the main economic partner of Indonesia. South Korea is one of the main economic partners, but it is merely started in the late of 1980s. Both countries had almost the same income per capita as Indonesia in 1960s, but they now have high technology and income per capita. This would indicate the process of convergence, or simply no indicator of both technology and income level catching up.

The first part of the study investigates the technology catching up by Indonesia toward the frontier technologies of Japan and USA. A regression equation of time series model is used. This model is simple and is able to accommodate the adoption capacity factors of the laggard country. The economic performance, human capital development and openness to technology are used to represent absorptive capacity. The household consumption expenditure and secondary school enrolments are used to embody economic performance and human capital development, while import growth is used to represent the openness to technology. This study examines the technology catching up by Indonesia for the period 1960 to 2005.

The second part of the study investigates income level catching up by Indonesia towards Japan and USA. Two methodological approaches are employed, namely the cointegration and ECM, and the polynomial time trend. In the cointegration and ECM approach, the prerequisite that the income level of the leading and laggard countries should be cointegrated is satisfied pair wise between Indonesia and Japan, and Indonesia and USA. The study examines the income level catching up for the period 1960 to 2005.

The chapter is organized as follows; the next section examines technology catching up and presents the empirical results. Section three examines the income level catching up and presents the empirical results. Section four provides chapter conclusion.

5.2. Technology catching up (adoption of technology) for Indonesia

The empirical investigation into technology catching up by Indonesia towards the leading partner countries of frontier technology is conducted through the formulation of a time series equation model. The outcome of the model is to provide the empirical answer on whether the process of adoption of technology by Indonesia does actually exist. This section describes the analytical framework, methodology and data, and discusses the empirical results.

5.2.1. Analytical framework and data

Analytical framework

The analytical framework of the analysis departs from the concept that technology is the main factor of productivity and growth. It is logical, therefore, that every effort has been paid to increase the capability of technology. Technological progress occurs by innovation (leading country) and adoption (laggard country). The basic theory of technology catching up (diffusion of technology) states that technology progress of laggard country (*TFPG*) is a function of its relative backwardness (technology gaps (*TG*)) and absorptive capacity (AC) (Gerschenkron, 1962; Nelson and Phelps, 1966; Abramovitz, 1986; Barro and Sala-I-Martin, 1997; Escot, 1998; Kang, 2002; Rogers, 2004).

$$TFPG = f(TG, AC) \qquad (5.1)$$

The objective of the laggard country is to be able to adopt and implement frontier technology of the developed country as much and quickly as possible. In effect, and in some cases, technology progress (growth) in the laggard can be higher than that of the leading country. It is enabled because the laggard country departs from a position of its backwardness. However, the technology level of the laggard country will never be over that of the frontier country. The higher growth of technology enables the laggard to accelerate its productivity and growth. Therefore, as the gap narrows, the space for productivity and growth acceleration reduces as well.

For the purpose of empirical examination, equation (5.1) is translated into statistical function:

$$TFPG = a_0 TG^{\alpha} AC^{\beta} EXP(\varepsilon) \tag{5.2}$$

where *EXP* is the exponentiation, ε is a random variable. α and β are constant elasticity coefficients of *TG* and *AC*, respectively and a_0 is a constant. In order to assure positive effect of the technology gap, it is assumed that $\alpha > 0$. Hence, the rate of technology progress in the laggard country is positively related to the technology gaps as well as the level of absorptive capacity. In term of logarithms, equation (5.2) takes the following form:

$$\ln TFPG_t = c + \alpha \ln TG_t + \beta \ln AC_t + \varepsilon_t \tag{5.3}$$

where $c = \log c^{a_0}$ is a constant term, and ε_t is a white noise error term. Equation (5.3) provides an explicit framework to explore the technology catching up, which can be investigated further by econometric methodology to examine the process of adoption of technology and the role of absorptive capacity in order to generate technology and productivity growth.

Data

In this study, technology is represented and measured by total factor productivity (TFP). TFP is computed based on a standard Cobb-Douglas production function with constant return to scale, using two inputs of capital (K) and labor (L). Following Klenow and Rodrigues-Clare (2005) and Vial (2006), the calculation of TFP takes the following form:[37]

$$\ln TFP_t = \ln Y_t - \alpha_t \ln L_t - (1 - \alpha_t) \ln K_t \tag{5.4}$$

[37] The production function with constant return to scale in logarithms form is as follows: $\ln Y_t = \alpha_t \ln L_t + (1 - \alpha_t) \ln K_t + \ln TFP$

where Y_t is total output which is represented by real GDP. L and K are labor and capital, respectively. α_t and $(1-\alpha_t)$ are the elasticity of total output with respect to labor and capital, respectively, and they vary over time. Capital is measured based on the perpetual investment method (PIM)[38] of investment level (I) data, which evolves according to $K_t = I_t + (1-\delta) * K_{t-1}$. The δ stands for depreciation rate. The initial capital stock is calculated according to $(I_{1960})/(\delta + i + p)$ (Klenow and Rodrigues-Clare, 2005), for i and p represent investment growth rate and population growth rate over the period of study.[39] The I_{1960} is investment level in 1960, since the study starts in 1960 and encompasses the years to 2005.

Attention is paid to the determination of depreciation rate in the capital computation. Many studies have furnished the caveat - assuming equal depreciation rates across countries has provided misleading results, especially between developed and developing countries. The weaknesses of planning, bad corporate governance due to corruption and collusion, and other natures of developing countries such as low maintenance cost, have made the quality of existing capital stock in developing countries downgrade quicker. Hence, it is crucial to appraise the rate of depreciation in Indonesia more rapidly than that of advanced, leading technology countries. For these reasons, it is determined that the depreciation rates for Indonesia and the

---

[38] PIM is a system of inventory calculation and control in which the number of units of any inventory item on any certain of time can be obtained from the stock records. In this method, all additions and reductions are recorded in inventory cards as they occur to provide a running balance of quantity and value of items. In the case of capital stock, addition of capital comes from new investment while reduction comes from depreciation because of usage (Mainen et. al., 1998). PIM is a recommended method in the UN's 1993 System of National Accounts to count for capital stock (Van Der Eng, 2008a).

[39] Some empirical studies do not consider population growth in determining the initial level of capital stock (see for example Kang, 2002). Other study which consider population growth in determining capital stock is for example Gylfason and Zoega (2007). They argue that increased population growth accelerate depreciation, because providing a rapidly growing population with high-quality capital is costly in terms of consumption forgone.

leading country (Japan and USA) as the highest and the lowest rate of the commonly used rates in the literature study, that is 8 per cent and 6 per cent, respectively.

The contribution of labor and capital to total output that explain the elasticity of total output with respect to capital and labor, are embodied by α and $(1-\alpha)$, respectively, which exhibit constant return to scale. Following Timmer (1999), the elasticity of total output with respect to labor (α_t) is determined based on the following calculation:[40]

$$\alpha_t = (v_t + v_{t-1})/2 \tag{5.5}$$

where v_t is the share of labor ($\ln L$) in total output ($\ln Y$) at time *t,* thus α_t is therefore not constant over time. Based on the constant return to scale postulation, the output elasticity with respect to capital is then determined by ($1-\alpha$). Based on this calculation, every country (Indonesia, Japan and USA) has a different elasticity (α_t) to determine their TFP.

To assure the comparable of the estimate, the computation of TFP for Indonesia, Japan and USA use the same source of data. All variables are measured in national level data. Total output (*Y*) is represented by real GDP, while real gross capital formation (GCF)[41] is considered as investment to perform capital stock (*K*). Those

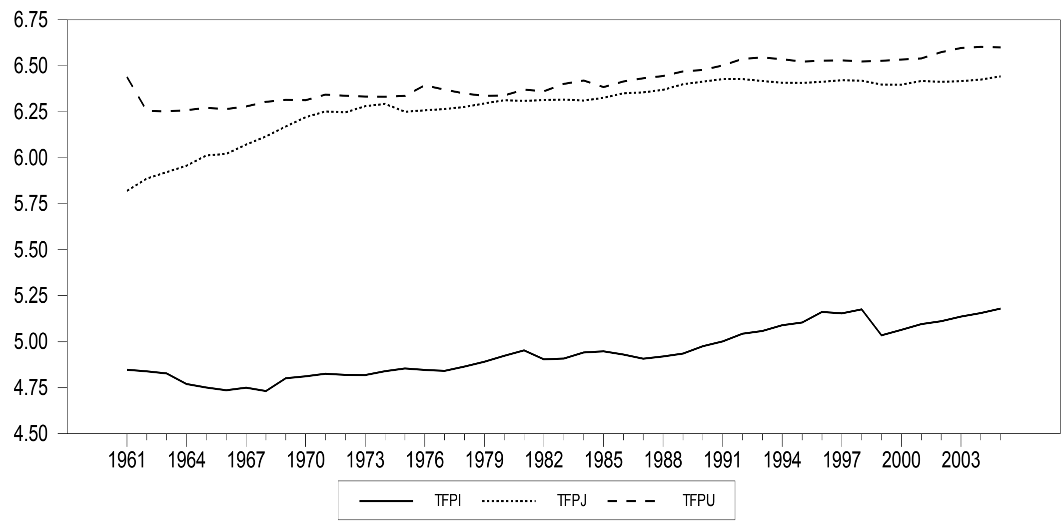
---

[40] There are in fact two ways of determining α_t as the output elasticity to labor (see, for example: Lau and Park, 2003; Hossain, 2006). The first is based on growth accounting method, which is to determine it as labor's share in output. The second is to estimate by econometric method, where TFP usually takes the form of exponential time trend. TFP change can then be viewed as a shift of the production function at reasonably smooth rate over time. This second method however, can not show the level of TFP itself, since it just indicates the change. To get the estimate figure of TFP therefore, the first method is used here.

[41] Gross fixed capital formation (GFCF) is in fact better approximation of investment. However, this data is only available from 1979-2006 for the case of Indonesia. Therefore it uses GCF to perform capital, since it is available in the same period for Indonesia and its leading countries counterpart. GFCF is by far the largest component of total (GCF). Fixed assets are goods that are used repeatedly, or continuously, for at least a year in the process of producing other goods or services.

data are taken from WBWT (World-Bank, 2008), and based on 2000 prices. Furthermore, the employment which is the number of person employed stands for the level of labor (*L*). This data is drawn from Total Economy Database (GGDCCB: The Groningen Growth and Development Centre and the Conference Board, 2008). Having the data of total output, investment and number of people in employment, the averages of α_t for Indonesia, Japan and USA during the period of study are found to be 0.719, 0.625, and 0.629, respectively. The TFP of Indonesia and TFP growth for Indonesia (*TFPIG*),[42] and the TFP of leading country's counterpart are then derived. All of the TFP results are plotted in Figure 5.1.

Figure 5.1
Technology level of Indonesia (TFPI), Japan (TFPJ), and USA (TFPU)
(in log values)



Source: calculation based on the data of real GDP and investment (World-Bank, 2008) and labor (employment) (GGDCCB, 2008).

It is obvious that the level of productivity indicated by the level of technology for Japan (TFPJ) and USA (TFPU) are far above Indonesia (TFPI). The technology gap (*TG*) between Indonesia and leading countries is measured based on the formulation

[42] Since the output of the TFP from equation (5.4) is in log values, the formulation for TFP growth (TFPG) is defined as: $\ln TFP_t - \ln TFP_{t-1}$.

$(TFP_{it} - TFP_{Lt}) / TFP_{Lt}$ (Rogers, 2004),[43] where TFP_{it} and TFP_{Lt} indicate the level of technology in frontier country and the laggard at time *t*, respectively. The technology gap between Japan and Indonesia, and USA and Indonesia are denoted as TGJ and TGU, respectively.

In empirical studies, some factors have been proposed to stand for the adoption capacity variables of the laggard country, such as, financial development, institution, equality, openness, investment rate and human capital. In this study, it is presumed that, economic performance, human capital and import growth are representative for absorptive capacity. The output level (real GDP) and investment rate are good proxies and usually used to measure economic performance. However, because they have been used to compute TFP as the level of technology, this study applies the rate of household consumption expenditure (*HE*), to reflect the national economic performance. It is arguable, because as the low or middle income country, the higher proportion of income is spent for consumption. *HE* is then the share of household consumption expenditure to GDP, and taken from WBWT (World-Bank, 2008).

Human capital (*HC*) is considered crucial in the process of technology transfer. Frontier technology requires qualified human capital to adopt and implement it. Benhabib and Spiegel (2005) point out that a good deal of recent literature focuses on the aptitude of education to speed up technology diffusion to accelerate productivity and growth. In this study, *HC* is then represented by the number of secondary school enrolments which is transformed into natural logarithm (ln). This data is taken from Van der Eng (2008b).[44]

One important and direct channel through which technology can be adopted is from import. The laggard country can directly import machinery and other advanced technology in order to support the production process. This study employs import

[43] The technology gaps is then performed as: $\ln TFP_{it} - \ln TFP_{lt}$

[44] The author gets the data through personal contact.

growth (*MG*) as one absorptive capacity. This data is taken from WBWT (World-Bank, 2008). Provided that all of the data for variables are all set, equation (5.3) is then estimated using the methodology that is discussed in detail in the following subsection.

5.2.2. Methodology

Methodology

In order to estimate equation (5.3) using the variables mentioned in the previous subsection, the time series regression model is performed. This model has the same formulation as equation (4.8) in section 4.2.2. The reason to use this formulation is the flexibility and capability of the model to estimate where the dependent and independent variables are uncertain whether I(0) or I(1) (see: Karas , 2001). Equation (5.3) is then formulated further to meet the properties of time series method. For that purpose, the specification of empirical model is as follows:

$$TFPIG_t = \eta + \delta t + \alpha_0 D_{1998} + \alpha_1 TG_{it} + \alpha_2 HE_t + \alpha_3 HC_t + \alpha_4 MG + \sum_{j=-n}^{n} \varsigma_j \Delta TG_{it-j} + \sum_{j=-n}^{n} \zeta_j \Delta HE_{t-j} + \sum_{j=-n}^{n} \xi_j \Delta HC_{t-j} + \sum_{j=-n}^{n} \vartheta_j \Delta MG_{t-j} + e_t \quad (5.6)$$

where $TFPIG_t$ is the growth rate of Indonesia's technology at time *t*, and η is a constant. The presence of time trend (*t*) in the model is to take into account any unobserved factors that are systematically growing or shrinking over time (Wooldridge, 2008). In effect, if they are ignored, they may have correlation with explanatory variables, which possibly create the regression to be spurious. Hence, the presence of the time trend is nothing but methodologically to eliminate this problem. D_{1998} is the pulse dummy variable to capture the impact of the 1998 economic crisis in Indonesia.

The coefficient of technology gap (*TG*), α_1, is the coefficient of interest to indicate whether there is a process of adoption of technology by Indonesia as the laggard country from the frontier technology, which implies technological catching up by

Indonesia to the leading country. The significance of the parameter estimate of $\alpha_2, \alpha_3, \alpha_3$ is seen as the role of *HE, HC*, and *MG* in order to catch up to the frontier technology as absorptive capacity and to generate technological growth.

The inclusion of the leads and lags of the explanatory variables differenced $(\Delta TG_{t\pm n}, \Delta HE_{t\pm n}, \Delta HC_{t\pm n}, \Delta MG_{t\pm n})$ in the right hand side is to, firstly solve any contemporaneous endogenity between the residuals and the explanatory variables (*TG, HE, HC* and *MG*), if they are I(1) (Karas, 2001; Wooldridge, 2008, p. 642). Bearing in mind that the explanatory variables are at most I(1), the correct conception of the strict exogenity is that there is no correlation between the residuals (e_t) and the variables differenced $(\Delta TG_{t\pm n}, \Delta HE_{t\pm n}, \Delta HC_{t\pm n}, \Delta MG_{t\pm n})$, for all *t* and *n.* Technically, *n* should be large enough for correlation between the residual, e_e, and $(\Delta TG_{t\pm n}, \Delta HE_{t\pm n}, \Delta HC_{t\pm n}, \Delta MG_{t\pm n})$ to be zero for $s > n \geq 0$. Secondly, solve the problem of consistency. It is due to the fact that, if all independent variables are non stationary and integrated of order one (I(1)), the OLS estimate of the parameters $(\alpha_1, \alpha_2, \alpha_3, \alpha_3)$ are super consistent. Consequently, inference based on their standard error will be generally invalid (Enders, 2004, p. 378-380; Wooldridge, 2008, p. 651-652).

In order to obtain an asymptotic normal *t* distribution, the OLS *t-statistic* then needs to be corrected. Following Karas (2001) and Enders (2004, Apendix 6.1, p. 378-380), the AR(*p*) correction procedure is performed. This has a two steps procedure. First, estimating an auxiliary (AR(*p*)) process of the residual of equation (5.6), $(\hat{e}_t = \sum_{j=1}^{p} \pi_j \hat{e}_{t-j} + \varepsilon_t)$. Second, obtaining the corrected *t–statistic* using the formulae: $(OLS \quad t-ratio)(\hat{\sigma}_e / \hat{\sigma}_\varepsilon)(1 - \sum_{j=1}^{p} \hat{\pi}_j)$. This corrected *t-statistic* is asymptotically normally distributed and valid for empirical interpretation.

In general, estimating equation (5.6) with its correction procedure provides consistency and efficiency of the coefficient with standard error and normally distributed t-statistic, and clear away any problem of endogenity. The model of equation (5.6) describes that the technology progress of Indonesia ($TFPIG_t$) is dependent on its relative backwardness (TG_t) and the adoption capacity. Moreover, the degree of adoption and implementation capacity (*HE*, *HC* and *MG*) makes the process of technology catch up possible in order for the laggard to accelerate productivity and growth. In terms of outcome, it produces some important measures: firstly, whether there is a process of technology adoption in Indonesia economic from the frontier technology, that accelerating productivity and growth; and secondly, whether the adoption capacity factors contribute and facilitate to the process of technology adoption.

Methodological procedures

The first step in analyzing technological catch up is to test the variables for unit root and the order of integration. The test is conducted by DF and ADF with the rules as described in the empirical procedures of subsection 4.2.2.

The second step is to specify the leads and lags of the explanatory variables in differenced. Principally, the smallest n which produces uncorrelated variables differenced with the residual is selected. The Hausman test is conducted to observe specification and efficiency of the model with regard to the presence of the leads and lags.

The third step is to estimate the model, to correct the *t-statistic* and to test the hypotheses. Equation (5.6) is estimated for the entire model of Indonesia-Japan and Indonesia-USA, based on the specification of the leads and lags from the second step. It is then followed by the AR(p) correction procedure to obtain an asymptotically normal t-distribution. The technology catching up hypothesis test is conducted as:

$Ho : \alpha_1 \leq 0$,   for technology catching up process does not exist,

$H_1 : \alpha_1 > 0$,   for technology catching up process to exist.

The hypothesis is also implemented to the role of adoption capacity, that is:

$Ho: \alpha_2 = \alpha_3 = \alpha_4 = 0$, for the adoption capacity factors do not have significant contribution to technology catching up,

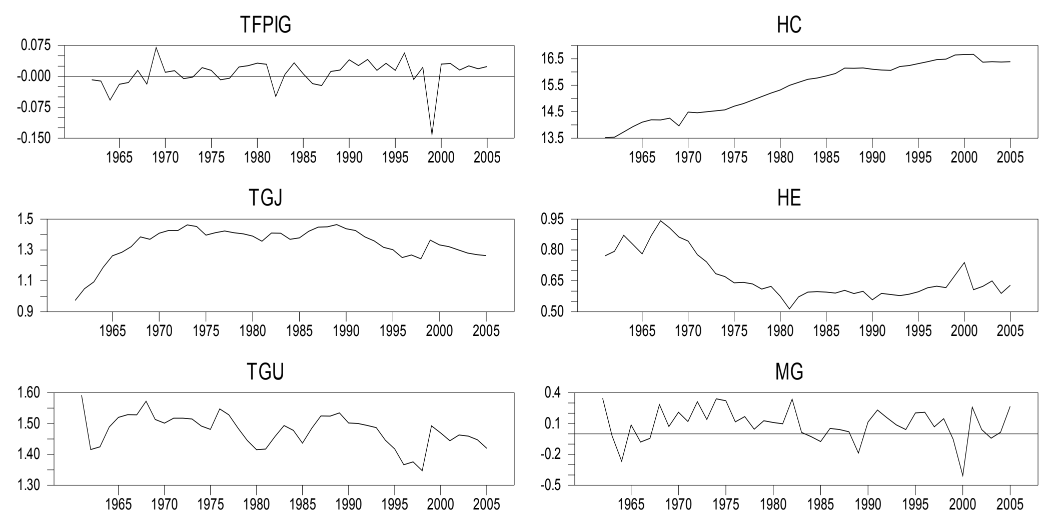
$H_1: \alpha_2 > 0, \alpha_3 > 0, \alpha_4 \neq 0$, for the adoption capacity factors have significant contribution to technology catching up.

5.2.3. Empirical result

Unit root test and order of integration

The time plot of the variables is presented in Figure 5.2, and the unit root test is reported in Table 5.1. It is apparent that all of the variables have intercept, except for TFPIG and MG. Therefore, the unit root test for *TFPIG* and *MG* is started by DF model 1, which does not include intercept term, while the others are started with DF model 2.

Figure 5.2
The time plot of the variables: TFPIG, TGJ, TGU, HC, HE, MG



The results indicate that all variables are stationary in level, except for *HE* and *HC.* Further testing is conducted against those variables that are not stationary by taking their first difference. The statistic values support to reject the null hypothesis, implying that their first difference is stationary. Given the explanatory variables consist of non stationary variables with order of integration is mostly I(1), the specification of the model of equation (5.6) requires the presence of the leads and lags of the explanatory variables differenced.

Table 5.1
Unit root test: TFPIG, TGJ, TGU, HC, HE, MG

Variables	The test model* (5 % critical value)	Lags	Test statistic value	Conclusion
In level				
TGPIG	DF 2 (-2.93)	-	-6.39	Stationary
TGJ	DF 2 (-2.93)	-	-4.20	Stationary
TGU	DF 2 (-2.93)	-	-3.62	Stationary
HC	ADF 3 (-3.51)	1	-0.33	Nonstationary
HE	ADF 3 (-3.51)	3	-1.51	Nonstationary
MG	DF 2 (-2.93)	-	-2.93	Stationary
In first difference				
DHC	DF 2 (-2.94)	-	-7.37	Stationary
DHE	DF 2 (-2.94)	-	-6.67	Stationary

Notes: * Refers to the three model of DF and ADF: model 1 – no intercept and no trend; model 2 – with intercept and no trend; model 3 – with intercept and trend. The parentheses are the 5 per cent critical value of the respective model.
Testing to the variables in difference is only conducted to the variables that are not stationary in level.

Identification of the leads and lags of the differenced variables

The Hausman test is conducted to all of the two empirical models of Indonesia and Japan and Indonesia and USA, to identify how many leads and lags perform the specified and efficient model. The results are reported in Table 5.2. It shows that taking one lead and one lag provides the Hausman test (*p-values*) of 2.95 (0.998) and 7.12 (0.896) for the empirical model of Indonesia – Japan ($I-J$) and Indonesia – USA ($I-U$), correspondingly. These results apparently imply that there is no correlation between $\Delta TG_{t\pm n}, \Delta HE_{t\pm n}, \Delta HC_{t\pm n}, \Delta MG_{t\pm n}$ for $n=1$, and the residual in both $I-J$ and $I-U$ models. This is evidence that taking one lead and one lag in the variables differenced has been able to solve any endogenity problem.

Estimation of the models and correction of the estimates

Model (5.6) which uses *n* equal to one is estimated to analyze technology catching up in a pair wise between Indonesia - Japan and Indonesia - USA. Before reporting the more complete estimation of equation (5.6), it is a worth noting that regressions have been made to the models without incorporating the adoption capacity variables. Given all the requirements of time series have met the goodness fit and model appropriateness, the results indicate that the parameter estimates of TG are statistically insignificant. We presume for this case that the catching up process is not automatic because of the country is backward, but rather, adoption capacity factors are important to hold the process up.

The estimations which incorporate the adoption capacity factors are reported in Table 5.2, for all of the two empirical models of $I-J$ and $I-U$. The time trend has been omitted from the model since it does not have any significant influence. The reported table does not display the parameters estimate of the contemporaneous change $(\Delta TG_t, \Delta HE_t, \Delta HC_t, \Delta MG_t)$ and the leads and lags of the explanatory variables differenced $(\Delta TG_{t\pm n}, \Delta HE_{t\pm n}, \Delta HC_{t\pm n}, \Delta MG_{t\pm n})$, since the analysis is not withdrawn from them. All of the Durbin Watson statistics are close to two, that is 2.01 and 2.36 for $I-J$ and $I-U$, respectively. It signifies that the models are not spurious, but meaningful. Further, the conventional indicator of R^2 is going along in good level, that is 0.94 and 0.89 for $I-J$ and $I-U$, correspondingly. For all of these evidences, it is concluded that the models have convinced for empirical analysis purposes.

In order to obtain an asymptotically normal *t*-distribution with consistent estimates, an AR(*p*) correction procedure is performed to all of the estimated models. The lag length (*p*) is determined based on the minimum of AIC. The adjusted *t*-ratios are then reported accordingly.

All of the parameter estimates signs are as expected, both for $I-J$ and $I-U$, that is positive for $\alpha_1, \alpha_2, \alpha_3$ and positive or negative for α_4. The 1998 economic crisis has a significantly negative impact to technology growth in both $I-J$ and $I-U$ models. In $I-J$, the parameter estimate of α_1 is statistically significantly greater than zero at 1 per cent critical value. It obviously indicates technology catching up by Indonesia toward Japan, which implies the adoption of technology exists. The same case also occurs in the $I-U$ model. The parameter estimate of α_1 is statistically significantly greater than zero, but this is at 5 per cent critical value. The same implication can therefore be extracted from this outcome; the adoption of technology also takes place by Indonesia from USA. The *F*-statistic from restricting $\alpha_2 = \alpha_3 = \alpha_4 = 0$ in $I-J$ gives the statistic value 5.36, which is sufficient to reject the null hypothesis, at 1 per cent critical value indicating that the adoption capacity factors jointly have a significant effect to the adoption of technology. The development of human capital has positive and significant impact on the process of adoption of technology from Japan. It is also the case that economic performance is crucial on the process technology adoption from Japan. The parameter estimate of import growth also has a positive sign and is statistically and significantly different from zero. This indicates that the technology catching up is also individually supported by the growth of imports, which are possibly dominated by machinery and equipment for production and manufacturing from Japan. This point also lends support to Blalock and Veloso (2007) who empirically show that firms and industries supplying an increasingly import intensive sector in Indonesia have higher productivity growth than others. They argue that importing is a source of technology transfer.

Table 5.2
Estimation results of technology catching up
Dependent variable: *TFPIG*

Variables		Indonesia - Japan $I-J$		Indonesia - USA $I-U$	
		Coeff.	*t - stat*[1]	*Coeff.*	*t - stat*[1]
Constant	(η)	-0.36	-3.01*	-0.43	-2.58 **
TG_t	(α_1)	0.09	3.04*	0.14	2.39 **
HC_t	(α_2)	0.01	2.00**	0.01	2.52 **
HE_t	(α_3)	0.17	4.13*	0.04	1.19
MG_t	(α_4)	-0.06	-2.24**	0.04	1.88
D_{1998}		-0.07	-5.15*	-0.07	4.55 *
$\alpha_2 = \alpha_3 = \alpha_4 = 0$ *F-Stat value*[2]:		5.36*		2.17	
R^2		0.94		0.89	
DW		2.01		2.36	
Housman test stat. (*p–value*) - χ^2		2.95 (0.998)		7.12 (0.896)	

Notes: [1] – It has been adjusted through AR(*p*) correction procedure
[2] – Adjusted using the same method of t-statistic
* and ** - indicate significant at 1% and 5% critical value, respectively.

In $I-U$ model, the *F*-statistic from restricting $\alpha_2 = \alpha_3 = \alpha_4 = 0$, provide the statistical value 2.17, which is insufficient to reject the null at any conventional level. It is indicated that the absorptive capacity has not functioned to support the process of adoption of technology. Even though, the human capital development which is long way conducted through education and training program is able to provide high skill labor, to support the process of technology adoption from USA, however, it is individually insufficient to hold up the process of technology adoption from USA. As the parameter estimate of household consumption expenditure and import growth are statistically insignificant, implying that economic performance and import growth individually do not hold up the process of technology adoption.

Based on the results from this section on technology catching up by Indonesia it can be concluded that technology catching up is accelerating productivity and growth. However, can this technology catching up bring Indonesian income to catch up to

Japan and USA in terms of income level in the future? This will be investigated in the next section.

5.3. Income level catching up (convergence) for Indonesia

One stream within the economic growth literature is the process of adoption of technology which is the force behind the process of income level catching up (Dowrick and Rogers, 2002; Desdoigts, 2004). The main purpose of the investigation of income level catching up is to see whether the acceleration of productivity and growth, provided by the empirical outcome of technology catching up in the previous section, has been able to bring Indonesia to catch up in terms of income level to Japan and USA in the long run. The empirical investigation into income level catching up by Indonesia toward Japan and USA employs two approaches, namely the cointegration and ECM approach, and the polynomial time trend approach. This section provides the implementation of those two approaches using Indonesian data.

5.3.1. The cointegration and ECM approach.

Analytical framework and data

As the result of the ability to adopt and implement frontier technology from the developed country, the developing country tends to grow more rapidly than that of the developed country (Scoppa, 2009). Consequently, the income level of the developing country may attain to the level of income of the developed country in the long run. If this process exists, the disparities of income level between developing (lower income) country and leading (higher income) country narrows and gets close to zero.[45] In that case, the growth rate of the developing country has been able to catch up to the output level of the developed country. Bernard and Durlauf (1995) point out that catching up as convergence implies that countries i and j converge between dates t and $t+T$ if the per capita income disparity at time t is expected to decrease in value (if $y_{i,t} > y_{j,t}$). In econometric time series methodology, this notion is predictable, which considers that income differences between high and low income

[45] Barro and Sala-i-Martin (2004, p. 462-465) discuss it deeply in the concept of convergence.

levels cannot contain unit roots or time trend, and the income level difference of the countries must be cointegrated (see for example: Giles, 2005).

For empirical investigation, therefore, the data of income level from 1960 to 2006 is the real per capita GDP of Indonesia and leading countries. These data are further transformed into logarithm values: log real per capita GDP for Indonesia (LI), log per capita GDP for Japan (LJ) and log per capita GDP for USA (LU). These data are from WBWT (World-Bank, 2008).

Methodology

The above analytical framework provides an explicit thought that two output levels should be proportional and cointegrated. Apparently, among the output levels studied, there should be a cointegrating relationship that does not contain an intercept and a trend. This fundamental concept is testable using the cointegration and ECM. Furthermore, since the empirical examination is conducted to the income level catching up of Indonesia towards leading countries of Japan and USA in a pair wise, a two-steps Angle-Granger procedure of cointegration and ECM is preferred.

The product of the two steps Angle Granger methodological procedures provides an ECM which has the following form:[46]

$$\Delta LI = \alpha_0 + \alpha_1 t + \alpha_2 ect_{t-1} + \sum_{j=1}^{p} \beta_{1j} \Delta LI_{t-1} + \sum_{j=1}^{p} \beta_{2j} \Delta LL_{t-1} + \varepsilon_t \tag{5.7}$$

where Δ is the first difference operator; α_0 and t are constant and time trend, respectively. The *ect* is the error correction term. LI and LL are the income levels of Indonesia and leading country, respectively, for LL is either: LJ or LU. ε_t is the

[46] Since the study is to examine the catching up process by Indonesia toward leading country, the presented model is only when the dependent variable is the output level of Indonesia (LI).

white noise error term. The hypothesis of the income level catching up is derived from the parameter estimates of ECM, that is:

$Ho: \alpha_0 = \alpha_1 = 0$ for income level catching up to holds, and

$H_1: \alpha_0 \neq 0;\ \ \alpha_1 \neq 0$ for income level catching up does not hold.

In order to implement the Engle and Granger cointegration and ECM, the first step is to examine the variables for the order of integration. The DF and ADF unit root test is conducted with the rules as described in empirical procedures within subsection 4.2.2. Given the order of integration is satisfied, that is all of the per capita GDP of Indonesia, Japan and USA are I(1), the second step is to test the variables for cointegration in a pair wise of Indonesia–Japan and Indonesia–USA. This test is performed by testing the stationarity of the residual of the long run relationship for Indonesia–Japan and Indonesia–USA. The statistical values are then compared to the Engle Granger cointegration critical values. If the absolute statistic value is greater than the absolute critical value, it implies that the variables are cointegrated, otherwise not.

The stationarity test of the residual for cointegration has the same formulae and procedure to that of DF and ADF unit root test without intercept and trend, which is:

$$\Delta y_t = \gamma y_{t-1} + \varepsilon_t \tag{5.8.a}$$

$$\Delta y_t = \gamma y_{t-1} + \sum\nolimits_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t . \tag{5.8.b}$$

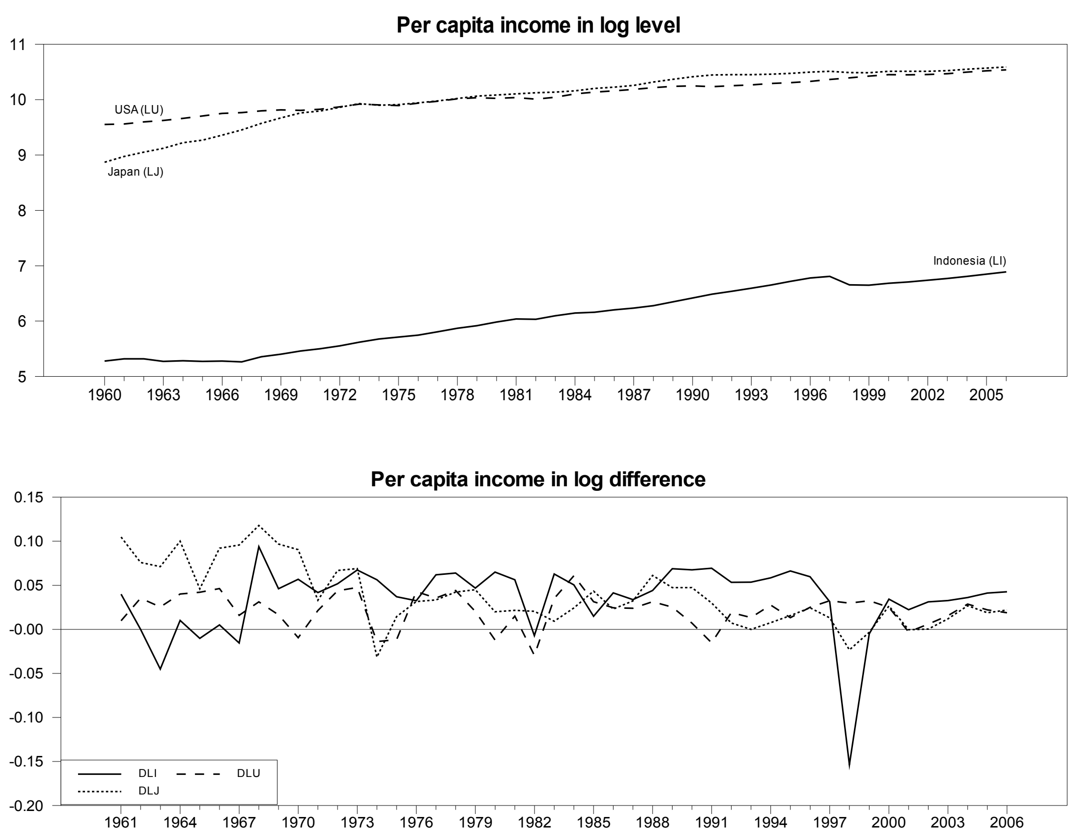
The critical value is provided as the Engle-Granger cointegration test critical value. Equation (5.8.b) is implemented when the outcome of equation (5.8.a) does not indicate cointegration. When the outcome of equation (5.8.b) does not indicate cointegration as well, then it is concluded that the variables are not cointegrated.

Assuming that the contegration is obtained, the third step is to estimate equation (5.7), and to test the hypothesis. The *ect* is taken from the residual of the long run relationship.[47]

Empirical result.

The series of real per capita GDP of Indonesia and leading countries are plotted in figure 5.3. It is obvious that the level of per capita GDP of Indonesia is far below the leading countries. The graph shows that all of the variables in level have intercept in their data generating process. Hence, the unit root test is performed by incorporating intercept to all of the variables.

Figure 5.3
The time plot of the variables: per capita income of Japan, USA and Indonesia



Notes: DLI, DLJ and DLU are the first difference of LI, LJ and LU, respectively.

[47] *ect* is either from $\hat{e}_1 = LI - \alpha LL$ or $\hat{e}_2 = LL - \beta LI$

The result of the unit root test is reported in Table 5.3. All of the absolute statistic values of the variables in level are smaller than the absolute critical values. It indicates that the variables are non stationary in level. Further testing is then conducted to those variables by taking their first difference. The results suggest that all of the absolute statistical values are now greater than the absolute critical value. This outcome is also able to be seen from the plot of the variables in differenced which exhibit their stationarity. It suggests that the variables are stationary in their first difference (I(1)). These results conform to the Engle Granger method of cointegration procedure.

Table 5.3
Unit root test: LI, LJ, LU

Variables	**The test model* (5% critical value)**	**Lags**	**Test statistic value**	**Conclusion**
In level				
LI	ADF 3 (-3.52)	0	-1.70	Nonstationary
LJ	ADF 3 (-3.52)	1	-2.28	Nonstationary
LU	ADF 3 (-3.52)	0	-2.90	Nonstationary
In first difference				
DLI	DF 2 (-2.93)	0	-4.75	Stationary
DLJ	DF 2 (-2.93)	0	-3.20	Stationary
DLU	DF 2 (-2.93)	1	-5.29	Stationary

Notes: * Refers to the three model of ADF: model 1 – no intercept and no trend; model 2 – with intercept and no trend; model 3 – with intercept and trend. The parentheses are the 5% critical value of the respective model.

Cointegration and ECM

The cointegration test and ECM analysis is done in a pair wise between Indonesia-Japan, and Indonesia-USA. Table 5.4a and 5.4b report the cointegration and ECM estimates of Indonesia – Japan and Indonesia – USA, correspondingly.

The result for Indonesia-Japan cointegration test indicates that the real per capita GDP of Indonesia and Japan are cointegrated with the cointegration statistic value -4.07. The estimates of the ECM suggest that using lags 1 through 3 in the variables differenced do not change much to the estimates of the parameters. The coefficient of the error correction term is statistically significantly different from zero at conventional level. The coefficient of constant and trend individually indicates that they are not statistically significantly different from zero. However, it is surprising that the test of the coefficient of constant and trend jointly equal to zero is rejected, with the *F*-statistic value 7.86, 5.27 and 3.88 in the model with lags 1, 2 and 3, respectively, compared to the 5 per cent critical values 3.32. Therefore, the result indicates no evidence of income level catching up by Indonesia towards Japan.

Table 5.4a
Cointegration test and error correction model estimates: Indonesia–Japan

a. Cointegration test

Residual	**Cointegration statistic value**	**Engle Granger critical value: 5%**	**- 10%**	**Conclusion**
e1	-2.31	-3.46	-3.13	Cointegrated
e2	-4.07			

b. ECM estimates — **Dependent variable: ΔLI**

		Lags 1	**Lags 2**	**Lags3**
Constant	α_0	0.008 (0.36)	0.005 (0.18)	0.02 (0.56)
Trend	α_1	0.0005 (0.95)	0.001 (1.07)	0.0004 (0.49)
ECT	α_2	-0.14 (-3.67)	-0.17 (-3.62)	-0.16 (-2.71)
DLI_{t-1}	β_{11}	0.12 (0.75)	0.09 (0.60)	0.09 (0.57)
DLI_{t-2}	β_{12}		-0.09 (-0.59)	-0.09 (-0.57)
DLI_{t-3}	β_{13}			0.04 (0.27)
DLJ_{t-1}	β_{21}	0.20 (0.92)	0.15 (0.60)	0.17 (0.63)
DLJ_{t-2}	β_{22}		0.06 (0.24)	0.15 (0.56)
DLJ_{t-3}	β_{23}			-0.24 (-0.94)
DW stat		2.0	1.96	1.90
F-stat: $\alpha_0 = \alpha_1 = 0$ (*p-value*)		7.86 (0.01)	5.27 (0.009)	3.88 (0.030)

Notes: - The figures in the parenthesis of the parameter estimates are the *t*-statistic value, while in the *F*-statistic are the *p*-value.

The outcome for the Indonesia and USA model shows a more steady result. The cointegration test indicates that the real per capita GDP of Indonesia and USA are cointegrated. The estimates of the ECM suggest that using lags 1 through 3 in the variables differenced do not change much to the estimates of the parameters. The coefficient of the error correction term is statistically significantly different from zero at conventional level. It is different with the model for Indonesia–Japan, the coefficient of constant is statistically significantly different from zero for the lags 1 through 3, at conventional level. While the coefficient of trend shows negative insignificant. From this individual test of constant and trend, it has been suggested that Indonesia does not catch up toward the leading country of USA in terms of per capita GDP. This test is supported by the rejection that constant and trend jointly equal to zero in all of the estimated models. The results provide evidence that the country does not catch up to the USA in terms of income level in the long run.

Table 5.4b
Cointegration test and error correction model estimates:
Indonesia–USA

a. Cointegration test

Residual	Cointegration statistic value	Engle Granger critical value: 5%	- 10%	Conclusion
e1 e2	-3.72 -4.00	-3.46	-3.13	Cointegrated

b. ECM estimates **Dependent variable: ΔLI**

		Lags 1	Lags 2	Lags3
Constant	α_0	0.04 (2.47)	0.04 (1.92)	0.05 (2.07)
Trend	α_1	-0.0000 (-0.12	0.0001 (-0.14)	-0.0002 (-0.56)
ECT	α_2	-0.27 (-2.87)	-0.28 (2.40)	-0.31 (-2.30)
DLI_{t-1}	β_{11}	0.31 (2.31)	0.29 (1.96)	0.30 (1.98)
DLI_{t-2}	β_{12}		0.05 (0.30)	-0.04 (-0.23)
DLI_{t-3}	β_{13}			0.14 (0.85)
DLU_{t-1}	β_{21}	-0.52 (-1.83)	-0.50 (-1.59)	-0.59 (-1.72)
DLU_{t-2}	β_{22}		-0.04 (-0.12)	0.08 (0.23)
DLU_{t-3}	β_{23}			0.45 (-1.36)
DW Stat		2.0	2.0	2.1
F-stat: $\alpha_0 = \alpha_1 = 0$ (*p-value*)		6.76 (0.003)	3.42 (0.043)	2.8 (0.07)

Notes: - The figures in the parenthesis of the parameter estimates are the *t*-statistic value, while in the *F-s*tatistic are the *p*-value.

Based on these empirical results of the cointegration approach, the acceleration of productivity and growth achieved by Indonesia during the period of study is insufficient to catch up to the leading partner country in terms of income level in the long run. The result suggests that more acceleration of productivity is required to increase the growth rate, so that Indonesia can attain to the income level of the leading country in the long run.

5.3.2. The polynomial time trend approach

The polynomial time trend approach advocated by Nahar and Inder (2002) is implemented to examine the income level catching up by Indonesia toward leading partner countries of Japan and USA. The approach assesses the trend of the income level gaps which is moving towards zero if the catching up holds. This model can be used to test the income level catching up in the context of convergence, without considering the stationarity of the income level gaps between targeted and laggard country.

Analytical framework and data

If y_u and y_i are the per capita income levels of the targeted (leading) country and the laggard (developing country) of the study, respectively, then the per capita income gap (d_{it}) between the leading and the developing country at time t is defined as $d_{it} = y_{ut} - y_{it}$, where u is either Japan or USA, and i is Indonesia. Nahar and Inder (2002) argue that d_{it} moves toward zero as time progresses should be considered as evidence of income level catching up or convergence. This study examines a developing country as the laggard, which always has its per capita income level below the developed country as the targeted (leading) country, thus d_{it} will appear to be positive at all times. Therefore, in order for the income level catching up process to hold, it is imperative that the rate of change in d_{it} with respect to time, is negative, $(\partial / \partial t) d_{it} < 0$.

Durlauf, et. al. (2005), underline that to test the income level catching up hypothesis, the test ideally measures the per worker income to reflect productivity in the production function which most growth models rely on. In view of this, this study utilizes per worker income gaps between leading countries, namely: Japan and USA, and the laggard country of Indonesia. Income per worker is calculated by dividing real GDP by the number of people in employment. The income per worker gaps are further transformed into logarithm values, which are then named as log per worker income gaps between Japan and Indonesia (LDJ), and USA and Indonesia (LDU). The data of Real GDP for Indonesia and all leading countries are taken from the WBWT (World-Bank, 2008), which are all in US$ and year 2000 prices. The data of employment is taken from Total Economy Database (GGDCCB, 2008). All of the data span from 1960-2005.

Methodology

In order to test the analytical framework, Nahar and Inder (2002) propose the polynomial time trend model to test the income level catching up hypothesis:

$$d_{it} = f(t) + u_t = \Phi_0 + \Phi_1 t + \Phi_2 t^2 + \cdots + \Phi_{k-1} t^{k-1} + \Phi_k t^k + u_{it} \qquad (5.9)$$

where u_{it} is assumed to be an i.i.d with zero mean and constant variance and $\Phi's$ are parameters, which indicate the slope of change in d_i. The income level catching up process exists if the average slope function $\Phi's$ is negative, which brings d_i toward zero. This can be obtained by,

$$\frac{1}{T}\sum_{t=1}^{T}\frac{\partial}{\partial t}d_{it} = \Phi_1 + \Phi_2 r_2 + \cdots + \Phi_k r_k = r'\Phi \qquad (5.10)$$

where $r_k = \frac{k}{T}\sum_{t=1}^{T} t^{k-1}$; $r = [0 \quad 1 \quad r_2 \cdots r_{k-1} \quad r_k]$; $\Phi = [\Phi_0 \quad \Phi_1 \quad \Phi_2 \cdots \Phi_{k-1} \quad \Phi_k]$.

The construction of the hypothesis is performed as:

$Ho: r'\Phi \geq 0$, to indicate no catching up process

$H_1: r'\Phi < 0,$ to indicate the catching up process exist.

In order to test the hypothesis, Equation (5.9) is estimated. The polynomial order (*k*) is determined by the AIC. The calculation of the AIC is limited to maximum $k = 5$, and individually tested to the model of LDJ, and LDU. The vector of $\Phi -$parameter is then multiplied by the *r*–vector to obtain the estimate of $r'\Phi$. The *r*–vector is computed from the trend values, and Φ's are the parameter estimates of equation (5.9). To find the $r'\Phi,$ then perform a *t*–test. The *t*-statistic is computed using the standard formulae: $t = \frac{r'\Phi}{s.e.(r\Phi)}$, where the standard error (*s.e.*) is calculated from their variance and covariance.

Empirical results

Equation (5.9) is estimated for the model of LDJ and LDU and the results are reported in Table 5.5. The AIC has provided the outcome of *k* equal to 4 for both LDJ and LDU. It is unambiguous that all of the *t*–statistics can not reject the null hypothesis. This implies that the process of per worker income catching up, between Indonesia and leading countries of Japan and USA during the period of study does not exist.

Table 5.5
Estimates of the average slope and *t*-statistic: LDJ, LDU

Model	Polynomial order	Average slope	*t*-statistic
Indonesia – Japan (LDJ)	4	0.038	1.37
Indonesia – USA (LDU)	4	0.016	0.52

Consistent with the cointegration and ECM approach, the polynomial time trend approach provides further evidence that the growth rate achieved by Indonesia during the period of study is not able to catch up to Japan and USA in terms of per worker income. The same implication can be drawn that more acceleration in productivity is required to increase the growth rate.

In terms of methodology, the simplicity of the procedure to measure the output growth rate of the developing country is apparently precise. The absence of conditional requirements in the assessment clearly confirms that it is in fact absolute convergence in the growth literature.

Based on the results from this section on income level catching up by Indonesia, it can be concluded that the income level growth achieved by the Indonesia during the period 1960-2005 is insufficient to bring Indonesia to catch up to the developed countries of Japan and USA in terms of income level in the long run. This result is in line with previous studies by Lee et. al. (2005) and, Lim and McAleer (2004), who find no evidence of convergence of Indonesia to the leading countries of Japan and USA. Nevertheless, the outcome of this study contradicts a previous study by Zhang (2003) who finds that ten East Asian Economies, including Indonesia, are catching up to the leading country of Japan. The outcome of these studies suggests that increasing the rate of growth is essential in order for Indonesia to have any possibility to catch up to the leading country's level of income.

5.4. Chapter conclusion

There are two conceptions of catching up in the growth literature: technology and income level catching up. These are utilized to investigate the Indonesian economy catching up to the developed countries of Japan and USA.

The successful implementation of the technology catching up for a developing country is that it can accelerate its productivity and growth by adoption and implementation of frontier technology. The income level catching up can measure whether the result of technological catch up has been able to bring the economy to catch up to the leading country in terms of income level.

A regression equation of time series is used to examine the process of technology catching up, and the cointegration and ECM, and the polynomial time trend approach are used to examine income level catching up. The results of the time series equation suggest that there is a process of adoption of technology (technology catching up) by Indonesia from the frontier technologies of Japan and USA during the period 1960-2005. This technology catching up is empirically deemed to contribute to accelerating productivity and growth on average by 6 per cent annually. Moreover, the occurrence of the technology catching up process is conditional on the presence of the adoption capacity factors, which were represented by economic performance, human capital and import growth.

The results of the cointegration and ECM, and the polynomial time trend approach suggest that there is not any process of income level catching up by Indonesia toward the developed countries of Japan and USA during the period 1960-2005. Therefore, policy makers should implement more development strategies in order to generate higher growth. Related to the technology catching up, policies have to be directed to building stronger adoption capacity, such as emphasizing more human capital development, managing macroeconomic performance and stability, and opening more to the importing of productive goods such as machinery and equipment and optimizing the benefits of partnerships in trade and investment. These results support the theory of technology catching up as described for example by Nelson and Phelp (1966), by which Indonesia as a developing country which relatively backward in technology can adopt and implement frontier technology from Japan and USA to accelerate Indonesia's productivity and growth. This process is however conditional on Indonesia's adoption capacity.

Based on these results, it is concluded that the process of technology catching up which facilitated Indonesia to accelerate productivity and growth exists. However, the growth acceleration is insufficient for Indonesia to catch up to the leading country in terms of per capita income.

Chapter VI. The driving forces of the level and the growth rate of real per capita income in Indonesia

Abstract

The exploration of the driving forces behind the growth process of the economy has been the main focus of the studies of economic growth in Indonesia in recent years; however the ultimate reasons and the proximate causes underlying Indonesia's economic growth are still unclear.

A two step procedure within the bound testing approach to cointegration is used to investigate the driving forces behind the growth process in Indonesia.

The results of the bounds testing approach to cointegration suggest that during the period 1970 to 2006:

(i) The capital stock, labor, exports, external debt to GDP ratio, the stock of foreign direct investment (FDI) and population are the variables that influence real per capita GDP, and they are cointegrated.

(ii) The capital stock, labor and exports are the variables that have a positive effect on the real per capita GDP, while external public debt to GDP ratio, the stock of FDI and population have a negative effect.

(iii) The change in the capital stock, labor and exports have a positive effect on the real per capita GDP growth, while change in external public debt and population have a negative effect. The change in stock of FDI does not have a significant effect to the output growth.

Based on these results it is concluded that the Indonesian Government should increase physical and human capital accumulation, increase employment, and increase exports. The Indonesian Government should also reduce the external debt to GDP ratio; be selective with foreign direct investment so that it does not crowd-out domestic investment; and lessen population growth.

6.1. Introduction

The exploration of the driving forces behind the growth process of real per capita income has been the main focus of the studies of economic growth in Indonesia in recent years, which favor government intervention in achieving policy objectives and lend support to the new growth theory.

Empirical investigation of the exogenous and endogenous growth models implies that the growth process in the economy is characterized as endogenous.[48] This indicates that the government, as the policy maker, has a significant role in generating sustained growth in Indonesia.

Using the endogenous growth framework, this chapter investigates the driving forces of the level and the growth rate of real per capita GDP in Indonesia. The real per capita GDP is used here to reflect real per capita income, and economic growth is also associated with the growth of real per capita GDP. Six categories of factors, namely: openness, macroeconomic stability, governance and institutional development, government expenditure, population and external factors are considered to influence total factor productivity. These factors, along with capital and labor are formulated in an aggregate production function of the endogenous growth model to produce an estimable equation of the driving forces of economic growth. Those six categories are further divided into 14 specific variables of growth.

The bounds testing approach to cointegration advocated by Pesaran, et. al. (2001) is employed to estimate the driving forces of the level and the growth rate of real per capita GDP. The advantage of this method is that: (i) it is simple and applicable to investigate the existence of both short run and long run relationships between the variables; (ii) it is applicable irrespective of the explanatory variables being purely

[48] See chapter IV.

I(0), purely I(1), or mutually cointegrated; and (iii) it is relatively efficient with a small or finite sample data size, as in the case of this study.

Taking into account the limited size of the sample data available and the many policy variables and external factors considered to influence growth, the study is conducted in a two step procedure within the bounds testing approach to cointegration.

- The first step is to select the policy variables and external factors that are most potentially to be the driving forces of real per capita income based on statistical estimation. The general to specific approach is implemented by estimating the output level (real per capita GDP) against all policy variables and external factors using one of the equations within the bounds testing approach, namely, the long run relationship equation model.
- The second step is to estimate the driving forces of the level and growth rate of real per capita GDP using the selected variables from the first step, and employing the full process of the bound testing approach to cointegration, which includes testing the order of integration, testing for cointegration, estimating the long run and short run relationship model, and checking the specification and appropriateness of the model for empirical interpretation, and finally analyzing the outcome.

Based on the two step procedure within the bounds testing approach to cointegration, the study finds that capital, labor and exports are the variables which have an important role in generating the level and the growth of real per capita GDP. External public debt is the factor that should be managed properly, as the increase of its ratio to GDP can hamper per capita GDP. This is also the case for population, since its growth can empirically reduce per capita GDP. The surprising outcome is shown by the stock of FDI, as it has negative and significant impact on real per capita GDP.

The chapter is organized as follows; the next section provides a brief description of the analytical framework and data sources. The third section discusses methodology and its application procedures. Section four presents empirical results. Section seven provides chapter conclusion.

6.2. Analytical framework and data

This section provides a brief discussion of the analytical framework of an endogenous growth model in an aggregate production function, and the data and sources used.

6.2.1. Aggregate production function

The analytical framework in the formulation of the model departs from the aggregate production function utilized in the growth theories.

$$Y = f(T, K, L) \qquad 6.1$$

where *Y* is the output, *K* is the capital and *L* is the number of people involved in employment. The factor *T* is total factor productivity (TFP) of growth in output which is excluded for increasing factor *K* and *L*. The modern growth theories, the exogenous and endogenous model, posit *T* differently. According to exogenous growth theories (Solow, 1956; Swan, 1956), *T* is exogenously determined in the model, while in the endogenous growth model (see for example: Romer, 1986; Lucas, 1988; Grossman and Helpman, 1991; Aghion and Howitt, 1992), *T* is endogenously determined. Since the empirical investigation on the long run economic growth in Indonesia done in Chapter 4 provides evidence in favor of the endogenous growth model, this study formulates the analytical model for investigation of the determinants of short run and long run economic growth based on the endogenous growth model.

According to endogenous growth theory, *T* is to capture any driving forces of growth embodied in economic variables which are not confined by capital and labor. On the class of this growth theory, they are usually economic factors that can be influenced by government policy, such as export, import, foreign direct investment, interest rate, exchange rate, the level of external public debt, and so on. In order to explore in detail the driving forces of economic growth, this study tries to include all factors that are supposed to have influence to the level and the growth of real per capita income in Indonesia. Those factors are classified into some main categories, namely: openness, macroeconomic stability, governance and institutional development, government expenditure and external factors. Therefore, TFP is a function of the factors that reflect the outcomes of economic policies.

$$T_t = f(OP, MES, GI, GE, EF, POP) = OP_t^{\phi} MES_t^{\varphi} GI_t^{\gamma} EF_t^{\eta} GE_t^{\kappa} POP_t^{\lambda} \tag{6.2}$$

where *T* is TFP, *OP* is international openness, *MES* is macroeconomic stability, *GI* is governance and institutional development, *EF* is external factors and *POP* is the population. Remarkably, the effect of each factor also depends on other factor, for example: the effect of international openness (*OP*) (trade and FDI) also depends on the macro economics stability (*MES*) and external factors (*EF*).

There are some channel through which international openness (*OP*), macroeconomic stability (*MES*), governance and institutional development (*GI*), government expenditure (*GE*), population (*POP*) and external factors (*EF*), influencing productivity and growth.

The international openness is measured by two economic factors, namely: international trade and foreign direct investment (FDI). International trade can raise total factor productivity in the economy through its favorable effect on the efficiency of resource allocation (see for example: Begum and Shamsuddin, 1998). FDI can influence productivity level of a country through diffusion of advanced technology and management skills.

Macroeconomic stability is considered crucial in developing productivity and growth. There are some channels through which macroeconomic stability persuades productivity and growth. The ability of the government to keep inflation rate under control, maintain appropriate interest rate and manage exchange rate to facilitate favorable provision for international trade and investment are essential factors to the growth rate. Further, the caution of the government to deal with the public debt, especially external public debt is another measure to spawn productivity and growth. There are two channels trough which external public debt can influence growth; these are through factor accumulation and total factor productivity (Pattilo, et. al., 2005). External public debt influence total factor productivity for example: external debt which usually come from multilateral development banks usually accompanied with a set of policy conditionality. This conditionality encourages government to undertake necessary policy reform that likely affect the efficiency of investment and productivity. Oppositely, if there is a high level of uncertainties and instabilities related to the debt overhang is likely to obstruct incentives to improve innovation or to allocate resources efficiently.

The mechanisms for governance and institutional to affect productivity and growth are through developing secure property right, judicial process, and regulation (see for example: Bloch and Tang, 2004). The secure property right is central to provoking innovation to productivity. Effective institutions for enforcement of business procedures provide greater room for efficiency in the use of resources and technological progress. In regulation, it impedes entrepreneurship and the emerge of new business.

The government expenditure in the frame of fiscal policy setting has the channel to influence productivity and growth. The tax necessary to finance government expenditure could distort incentives, with negative implications for the efficient allocation of resources and hence productivity or the growth of output (Bassanini and Scarpetta, 2001).

Population and external factor have their mechanism to affect productivity and growth. Population has direct channel through which influence productivity. Population can produce human resources, talented man and generally gifted contributor to new knowledge and productivity (Strulik, 2005). Meanwhile, external factor such as the growth rate of two immense economies of USA and Japan have mechanism to influence domestic economy through international trade and investment.

Combining function (6.1) and (6.2), give the following statistical production function:

$$Y_t = K_t^{\alpha} L_t^{\beta} OP_t^{\phi} MES_t^{\varphi} GI_t^{\gamma} EF_t^{\eta} GE_t^{\kappa} POP_t^{\lambda} EXP(\varepsilon_t + c) \tag{6.3}$$

Equation (6.3) provides explanation that the output (*Y*) is dependent on capital (*K*), employment (*L*), international openness (*OP*), macroeconomic stability (*MES*), governance and international development (*GI*), external factor (*EF*), government expenditure (*GE*), and population (*POP*). The ε and c are a random disturbance and a constant term, respectively, while *EXP* is exponentiation. Taking natural logarithm in both sides of (6.3) gives the following equation:

$$\begin{aligned} \ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \phi \ln OP_t + \varphi \ln MES_t + \\ \gamma \ln GI_t + \eta \ln EF_t + \kappa \ln GE_t + \lambda \ln POP_t + \varepsilon_t \end{aligned} \tag{6.4}$$

The α and β are the output elasticity with respect to capital and employment. The $\phi, \varphi, \gamma, \eta$ and κ are constant elasticity coefficients of international openness, macroeconomic stability, governance and institutional development, external factor and government expenditure, associated with the output (*Y*), while λ is to assess the impact of the population on output. While c is the term to stand as a constant parameter, and ε_t is a white noise error term. It become clear here from equation (6.4), even though the theoretical model is initially presented as a supply-side model of economic growth, the empirical equation incorporates all factors of the determinants of output, which also come from demand side of the economy. Hence the empirical model represents both aggregate demand and supply side factors.

Equation (6.4) provides an explicit framework to explore the determinants of output, which can be investigated further by econometric methodology to observe which determinants have significant influence to the output, in the short run and the long run. The direction of the constant elasticity parameters is expected based on the sense of economic theory, for example capital, employment, macroeconomic stability and governance and institutional development are expected to be positive. Openness, external factor, and government expenditure are ambiguous (positive and negative), while population is expected to be negative.

6.2.2. Data

In order to estimate the determinants of economic growth in Indonesia using equation (6.4), the study utilizes the data from the period 1970 to 2006, the period which the mostly required data is available. The main sources of the data are from Model of Finance (MODFI) (Ministry of Finance, 2007), International Finance Statistic (IFS) (IMF, 2008) and WBWT (World-Bank, 2008), while additional data are from United Nation Conference on Trade and Development (UNCTAD, 2008), Total Economy Database (GGDCCB, 2008) and Timer and Vries (2007). It is observed that some categories of the data from MODFI and IFS have the same figures and seem to complete each other, and include the data of real per capita GDP, total investment,[49] export and import, and total government expenditure. This subsection discusses the data and their sources.

The output, capital and human capital.

With respect to equation (6.4), the output (Y) is the real per capita GDP. This data is in local currency and constant 2000 prices which initially is total GDP divided by total population, taken from the IFS online data (IMF, 2008). The data of capital (K) is constructed using the perpetual inventory method (PIM) of investment level (I) data. According to PIM, capital evolves according to $K_t = I + (1-\delta) * K_{t-1}$, where δ

[49] In the IFS (2008), total investment is named by gross fixed capital formation and spanned from 1978-2007, while in MODFI (2007) spanned from 1970-2007.

stands for depreciation rate. The initial capital stock (K_{1970}) is calculated according to $(I_{1970})/(\delta + i)$ (Hall and Jones, 1999; Kang, 2002), for i represents investment growth rate over the period of study. The I_{1970} is investment level in 1970, since the study is from 1970 to 2006. Consistent to chapter V, the depreciation rate is determined to be 8 per cent. The current price data of investment is taken from MODFI (Ministry of Finance, 2007), and further transformed into constant 2000 prices.

Recent emphasis of endogenous growth literature has been on human capital accumulation, which can have a significant impact on a country's productivity and development in the long run. This notion is articulated by embodied labor (L) as the number of people in employment. Labor force in employment has been the core of any effort in the human capital accumulation, such as schooling and training. It also is directly involved in the process of production. The data of employment is extracted from Total Economy Database (GGDCCB, 2008).

Openness: export, import and FDI.

The role of openness on the growth of Indonesia is represented by 2 economic factors, namely: international trade which consists of import and export, and FDI. The data of import and export are taken from IFS (IMF, 2008) and further deflated to constant prices 2000. This data is in local currency. FDI here is the stock of FDI. This data is taken from MODFI (Ministry of Finance, 2007) (1970-1979) and from UNCTAD (2008) (1980-2006), given those go in continuously order. The data is initially in US$, which is then converted to local currency and further deflated with Indonesia's prices index 2000 from WBWT (World-Bank, 2008).

Macroeconomic stability

Macroeconomic stability which consists of stable low interest rate, managed exchange rate and managed public debt, is assumed to have a significant role on economic growth of Indonesia. The data of interest rate is the three month deposit rate and is taken from IFS (IMF, 2008). Meanwhile, the exchange rate data is taken from the same source, and depreciated with its last year's value to perform exchange rate depreciation. Furthermore, the data of inflation rate and total external public debt are extracted from WBWT (World-Bank, 2008). The external public debt is then performed in the ratio to GDP.

Governance and institutional development

The role of governance and institutional development is emphasized in the current literature of economic growth (see for example: Kong, 2007). However, it is still difficult, so far, to measure the level of governance and institutional development in order to empirically estimate the driving forces of growth, especially in the time series approach. This study intends to observe the role of governance and institutional development by utilizing the sum of value added of government, community and social services including public utilities of the economy as the proxy. This data is in local currency and taken from Timmer and Vries (2007).

Government expenditure and population

The impact of government expenditure on the output is examined. The outcome is to see whether it has a positive effect on growth or a negative effect because of tax distortion. This data is taken from MODFI (Ministry of Finance, 2007). The level of population on the per capita output is also examined which is expected to have a negative impact. This data is taken from WBWT (World-Bank, 2008).

External factors

As the study covers the period when the country is opened to the international economy, the factor outside the control of the policy makers is considered in the estimation. There are two large economies that are very influential to the world economy which affected domestically, namely USA and Japan. Fortunately, those countries also have economic cooperation with Indonesia and are the first two economic partnerships in term of trade and investment. With the intention of observing the influence of the external factor to estimate the economic growth in

Indonesia, the growth rate of the gross national income (GNI) of USA and Japan are included. The data of those variables are taken from WBWT (World-Bank, 2008).

Table 6.1
The variables used to estimate the driving force of the level and the growth rate of real per capita income

Variables	Abbr.	Definition and conversion	Source
Real per capita GDP	LY	Logarithm, in. billion Rupiah	IFS (2008)
Policy variables			
Capital*	LK	Logarithm, in billion Rupiah	MODFI (2008)
Labor	LL	Logarothm, in thousand person	Total Economy Database (2008)
Openness:			
Export	LX	Logarithm, in billion Rupiah	IFS (2008)
Import	LM		
Foreign direct investment	LFDI	Log, in billion Rupiah	MODFI (2007) and UNCTAD (2008)
Macroeconomic stability:			
Inflation rate	IF	-	IFS (2008)
Interest rate	IT	-	IFS (2008)
Exchange rate depreciation	ERD	-	IFS (2008)
External debt	EDR	The ratio of external public debt to GDP	WBWT (2008)
Population	LPOP	In thousand	WBWT (2008)
Governance and institutional development	LID	Logarithm, in billion Rupiah	Timer and Vries (2007)
Government expenditure	LGET	Logarithm, in billion Rupiah	MODFI (2007)
External factors			
GNI growth of USA	USA	-	WBWT (2008)
GNI growth of Japan	JPN	-	WBWT (2008)

Note: * constructed based on the investment data using the perpetual investment method (PIM) with 8% depreciation rate.
- The data of real per capita GDP, total investment, export and import, and government expenditure are the same between the IFS and MODFI.

Table 6.1 provides a summary of the data used to analyze the driving forces of economic growth in Indonesia. Variables which indicate the number in level are converted into natural logarithm (ln), namely: capital, labor, export, import, foreign direct investment, institutional development, total government expenditure and population, while others which indicate the ratio or change are not. There are 12 policy variables and 2 external factors in total.

Based on the results from this section on the analytical framework of an endogenous growth model in an aggregate production function, it can be concluded that using the properties of the endogenous analytical framework and utilizing the variables and external factors represented by current data, the driving forces of the output level and its growth rate can be further explored. The methodology used for this purpose is discussed in the next section.

6.3. Methodology

This section provides a brief description of the procedures and the application of the Bounds testing approach to cointegration that is used to empirically estimate equation (6.4), in order to investigate the driving forces of economic growth in Indonesia.

6.3.1. A Bounds Testing Approach to Cointegration

In order to empirically analyze the driving forces of the level and the growth rate of real per capita income in Indonesia, a bounds testing approach to cointegration developed by Pesaran, et. al. (2001) is employed. The bounds testing approach to cointegration is a method for testing the existence of the level relationship between a dependent variable and a set of regressors based on the use of cointegration techniques. The advantages of employing this method are:[50] (i) it is simple and applicable to investigate the existence of the short run and long run relationship between the variables; (ii) it is applicable irrespective to the model where the regressors are purely I(0), purely I(1), or mutually cointegrated; (iii) it is relatively efficient in a small or finite sample data size, as in the case in this study.[51]

[50] See: Fosu and Magnus (2006), Duasa (2007), Yang and Yi (2008), Brahmasrene and Jiranyakul (2009).

[51] Narayan (2004) strengthens this argument by reformulating the critical values for this Bound Test to cointegration approach for the sample size of 30 to 80, with the regressors (*k*) up to 7.

The difference of the bound testing approach to cointegration of Pesaran, et. al. (2001) with other methods of cointegration is that the underlying regressors in the bounds testing approach can be level stationary (I(0)) or first difference stationary (I(1)) (Pesaran et. al., 2001; Narayan, 2004). The other previous methods of cointegration, such as: two step residual based procedure due to Engle and Granger (1987) and Phillips and Ouliaris (1990), the stochastic common trends approach of Stock and Watson (1988), maximum likelihood estimation of Johansen (1991, 1995), and variable addition approach of Shin (1994) all are considering cases in which the underlying variables are integrated of order one. However, all of the other previous methods have been considered in building the bound testing approach to cointegration, especially, the two principal approaches: the two-step residual based procedure for testing the null of no cointegration (Engle and Granger, 1987; Phillips and Ouliaris, 1990) and maximum likelihood estimation (Johansen, 1991, 1995).

Pesaran, et.al. (2001) formulate the bounds testing procedure by modeling a long run relationship in a general vector autoregressive (VAR) model of order *p,* in z_t:

$$z_t = \alpha_0 + \beta t + \sum_{i=1}^{p} \theta_i z_{t-i} + \varepsilon_t, \quad t = 1,2,3,\cdots,T \tag{6.5}$$

where α_0 corresponds to a $(k+1)$-vector of drift (intercept) and β represents a $(k+1)$–vector of trend coefficients. z_t is a vector of variables that permits its elements to be purely I(1), purely I(0) or mutually cointegrated and $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t} \cdots)'$ is zero mean error vector, which is identically and independently distributed (iid) and a homoscedastic process. In particular, z_t is the vector which consists of both y_t and x_t, for y_t is the dependent variable that must be I(1) and x_t is a set of regressors to perform a vector matrix which can be either trend stationary (I(0)) or stationary in the first difference (I(1)).

In order to test the existence of cointegration among the variables, equation (6.5) is specifically described and further developed to perform a conditional VECM in equation (6.6) as follows:

$$\Delta y_t = \alpha_0 + \beta t + \delta_{yy} y_{t-1} + \delta_{xx} x_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta y_{t-i} + \sum_{i=0}^{q} \ell_i \Delta x_{t-i} + \varepsilon_t, \quad t = 1,2,3,\cdots,T \qquad (6.6)$$

where Δ is the first-difference operator. In this formulation, coefficient δ_{yy} and δ_{xx} contain the long run multiplier, while coefficient λ_i and ℓ_i consist of the short run dynamic of the VECM. Equation (6.6) can also be viewed as an ARDL of order (*p, q*) (Pesaran et. al., 2001; Keong et. al., 2005). Some fragments arise from equation (6.6): firstly, if $\delta_{yy} \neq 0$ and $\delta_{xx} = 0'$ it implies that y_t is trend stationary or $y_t \sim I(0)$. In that case the differenced variables Δy_t depends only on its own lagged level y_{t-1} in the conditional ECM (6.6) and not on lagged levels x_{t-1} of the forcing variables. Secondly, if $\delta_{yy} = 0$ and $\delta_{xx} \neq 0'$, Δy_t depends only on the lagged level x_{t-1} then in that case, $y_t \sim I(1)$. Thirdly, if both $\delta_{yy} = 0$ and $\delta_{xx} = 0'$, the level effects in the ECM (6.6) do not exist, and there is no possibility of any level relationship between y_t and x_t. In that case, y_t is stationary in the first difference or $y_t \sim I(1)$.

Therefore, the nonexistence test of the level effect in the conditional ECM in equation (6.6) and more fatefully, the nonexistence of a level relationship between y_t and x_t is the fundamental bounds testing to cointegration. In order to investigate whether or not the unique long run relationship, that is the cointegration among the variables exists, the hypothesis testing is established using the *F*-statistic test or Wald statistic against the long run multiplier coefficient, in the following form:

$H_0 : \delta_{yy} = \delta_{xx} = 0$ for no cointegration

$H_A : \delta_{yy} \neq \delta_{xx} \neq 0$ for cointegration exists

Pesaran et al (2001) provide two asymptotic critical values bound for this cointegration test, when the explanatory variables are integrated of order *d*, (I(*d*)), where $0 \le d \le 1$. The lower value is designated to the I(0) independent variables and the upper value is to the I(1) independent variables. In the case that the independent variables is a mix of both I(0) and I(1), the null hypothesis of no cointegration can be rejected if the *F*-Statistic is greater than the upper critical value. Conversely, if the *F*-statistic falls between the upper and the lower critical values, the result is inconclusive. And finally, the null hypothesis can not be rejected if the test statistic value falls below the lower critical value.

Assuming that the cointegration among the variables exists, the long run relationship model for y_t is established in the conditional ARDL (p,q) (see also for example: Fosu and Magnus, 2006; Duasa, 2007):

$$y_t = \alpha_0 + \beta t + \sum_{i=1}^{p} \lambda_i y_{t-i} + \sum_{i=0}^{q} \ell_i x_{t-i} + \varepsilon_t, \quad t = 1,2,3,\cdots,T \tag{6.7}$$

And the dynamic parameters for the short run relationship are obtained by establishing an ECM associated with the long run relationship:

$$\Delta y_t = \alpha_0 + \beta t + \upsilon ecm_{t-1} + \sum_{i=1}^{p} \eta_i \Delta y_{t-i} + \sum_{i=0}^{q} \mu_i \Delta x_{t-i} + \varepsilon_t, \quad t = 1,2,3,\cdots,T \tag{6.8}$$

where υ is the parameter of error correction term (*ecm*). In this model, the coefficient of the first-differenced variables (Δx_t) captures the short run effect (Keong et. al., 2005). Pesaran, et. al. (2001) underline that the determination of the dynamic lag structure (*p* and *q*) on $y_{t-i}, i = 1,\cdots,p$ and $x_{t-i}, i = 0,\cdots,q$ in (6.7) and the short run feed back from the dependent variables, $\Delta y_{t-i}, i = 1,\cdots,p$ and $\Delta x_{t-i}, i = 0,\cdots,q$ in (6.6) and (6.8), are the case of flexible choice, meaning that the conventional criterions such as AIC and SBC are applicable. Pesaran et. al. (2001) suggest that for limited annual data, the dynamic lags structure (*p, q*) is duly determined to a maximum of 2. Based on the outcome of equation (6.7) and equation (6.8), the long run and short run driving forces of the output level and its growth rate are respectively derived.

In order to have a comprehensive relationship between y_t and x_t, this study also examines the causal relationship, employing Granger causality test based on the ECM of equation (6.8). The test is conducted jointly by restricting all variables in the vector x_t against y_t, $\upsilon = 0, \mu_i = 0$,[52] and individually by restricting the error correction term and the lag of each of the variables differenced in the vector x_t equal to zero. The test is also conducted when the policy variables stand as dependent variables, to see the direction of causality from real per capita GDP to the policy variables.

6.3.2. Methodological procedures

Testing for the order of integration

Even though the bounds testing procedure does not necessitate that the variables are trend or first difference stationary, testing the variables for unit root is still required, to ensure that the data generating process is not I(*d*) for $d > 1$. Hence, the preliminary step of the methodological procedures is to examine the variables for the order of integration. The DF and ADF unit root test is used to test the order of integration, with the rules as described in the empirical procedures of subsection 4.2.2. For the bounds testing approach to cointegration method, only variables that are integrated of order 1 (I(1)) or stationary in level (I(0)) are included.

Selecting the variables that influence real per capita GDP.

The next step in the ARDL bounds testing approach is to test to the existence of cointegration or long run relationship among the variables by estimating equation

[52] As the Granger causality is to test whether the lags of one variables enter into the equation for another variables, the restriction is imposed to the variable differenced (Δx) with the lags $q \geq 1$.

(6.6) using ordinary least squares (OLS) and restricting $\delta_{yy} = \delta_{xx} = 0$. In addition, *y* is the real per capita GDP, while *x* is the vector consists of the variables listed in Table 6.1 which include policy variables and external factors. Considering the annual data size available to the analysis spans only from 1970 to 2006, and the many policy variables and external factors are considered, testing the existence of cointegration directly against all variables in Table 6.1 using equation (6.6) is not possible due to the degree of freedom problem. For that reason, the first step of the methodological procedure is to trim down the variables by selecting those that most potentially have a statistical significant influence to real per capita GDP.

Since one of the destinations in the bounds testing to cointegration is to estimate equation (6.7) which shows the long run relationship of the variables, this equation is utilized to select the variables that are most potentially the driving force of output growth. Two methods of general to specific approach are followed and conducted in selecting the variables.

Method 1 is to estimate the ARDL (*p, q*) in equation (6.7), which *p* and *q* are determined to 1 and 0, respectively, where *y* is the per capita GDP (LY) and *x* is the vector of the regressors which consists of all policy variables and external factors listed in Table 6.1. The selection is conducted by removing insignificant variables one by one, starting with the most insignificant one as indicated by the *t*-ratios. The variable that statistically exhibits the most insignificant (the minimum *t*-statistic in absolute value) is discarded. Re-estimation of equation (6.7) is further conducted by including the rest of the variables. Again, the variable that has the most insignificant (the minimum in absolute value) *t*-statistic is discarded, and re estimated again; and so on. The estimation is stopped when the parameter estimates of the variables have all significant *t*-statistic at 5 per cent critical value. Those variables (that have significant *t*-statistic) are selected for further analysis using the bounds testing approach to cointegration.

Method 2 is to estimate the ARDL (p,q) in equation (6.7) in the most general model, which is to include all the policy variables and external factors listed in Table 6.1, where p and q are determined to 1 and 0, respectively. From the outcome of the regression, all of the variables that have insignificant t-statistic at 5 per cent critical level are discarded. Those that have significant t-statistic are selected for further analysis of bounds testing to cointegration.

Based on these two methods, the selected variables are determined. Both two methods are expected to provide the same outcome. Using these selected variables, the second step is to employ a full process of a bound testing approach to cointegration in order to find the driving forces of the level and growth rate of real per capita GDP. The process includes the following steps: (i) testing for cointegration, (ii) estimating the long run relation relationship, and (iii) estimating the short run relationship in the ECM. This will subsequently be followed by the causality test

Testing for cointegration

In order to examine the existence of cointegration or long run relationship, equation (6.6) is estimated, where y is the per capita GDP (LY) and x a vector of variables which consists of the selected variables from the previous step. The F-statistic value of the bounds test to cointegration, obtained by restricting $\delta_{yy} = \delta_{xx} = 0$ is then compared to the critical values. If the statistic value is above the upper critical value, the null hypothesis of no cointegration or no long run relationship can be rejected. On the contrary, if the statistic value falls below the lower critical value, the null hypothesis cannot be rejected. Finally, if the statistic value falls between the lower and the upper critical values, the result is inconclusive.

In their paper, Pesaran, et al. (2001) formulate the critical values for this testing based on 1000 observations. Another critical value is provided by Narayan (2004), who reformulates the critical values for the bounds testing to cointegration based on 30 to

80 observations. Narayan (2004) shows that the critical value based on the 1000 observations can be 35.5 per cent higher compared to, say, 31 observations at the 5 per cent significance value in the case of 4 regressors. Accordingly, this study uses both the critical values provided by Pesaran et. al. (2001) and Narayan (2004).

Estimating the long run relationship

Once the cointegration is ascertained, the next step is to estimate the long run relationship model of equation (6.7), as conditional ARDL (p,q). This step involves selecting the orders of p and q in the ARDL (p,q_n) for n=1,2, 3… model. This estimation provides the parameters of the long run relationship between the per capita GDP as the dependent variable and a set of regressors as previously defined.

Estimating the short run relationship (ECM)

The ECM associated with the long run relationship model is then estimated. This step is principally to put into practice equation (6.8), which includes determining of the order of p and q in the variable-differenced. The outcome of this step provides the parameters of the short run dynamic relationship between the per capita GDP growth and change in the explanatory variables.

Examining the causality relationship

In order to examine the causality relationship between y_t and x_t, the Granger causality test is conducted to all of the variables within the vector x_t jointly and individually against y_t. This examination is to provide the direction of the causality relationship between y_t and x_t.

The estimates of the long run and the short run relationship models are used to analyze the driving forces of the level and of the growth rate of real per capita GDP in Indonesia. Meanwhile, the examination of Granger causality is to see the causal relationship between real per capita GDP and the policy variables.

Based on the results in this section on the Bounds testing approach to cointegration, it can be concluded that in general, the methodology used to investigate the driving forces of the level and the growth of real per capita income in Indonesia is in fact simple and flexible yet with a high degree of precision given the available data used and the limited sample size.

6.4. Empirical result

This section reports the outcome and analysis of empirical work in discovering the driving forces of the level and the growth rate of real per capita GDP, using the bounds testing approach to cointegration. It is done by testing for unit root, selecting for the variables, testing for cointegration and estimating the long run and short run relationship.

The unit root test.

Figure 6.1 presents the time plot of the variables. It indicates that all variables have intercept in their data generating process, except for IF, ERD and USA. Therefore, the unit root tests are initially conducted by the model without intercept (DF 1) for those three variables and by incorporating the intercept term in the model (DF 2) for the rest of the variables. The result of the unit root tests is reported in Table 6.2.

The first round of testing against all of the variables in level specifies that 7 of 15 variables are stationary (I(0)), they are LK, LFDI, IF, ERD, LPOP, USA and JPN. The unit root test is further conducted in second round testing against those that are not stationary in level by taking their first difference. The results indicate that they are all stationary in their first difference (I(1)). Given the unit root results, all variables are satisfactory to the analysis of determinant of output growth using the bound testing approach to cointegration. Specifically, the prerequisite that the dependent variable must be I(1) is satisfied, provided the unit root test indicate LY is stationary in its first difference.

Figure 6.1
The time plot of the variables: policy variables and external factors

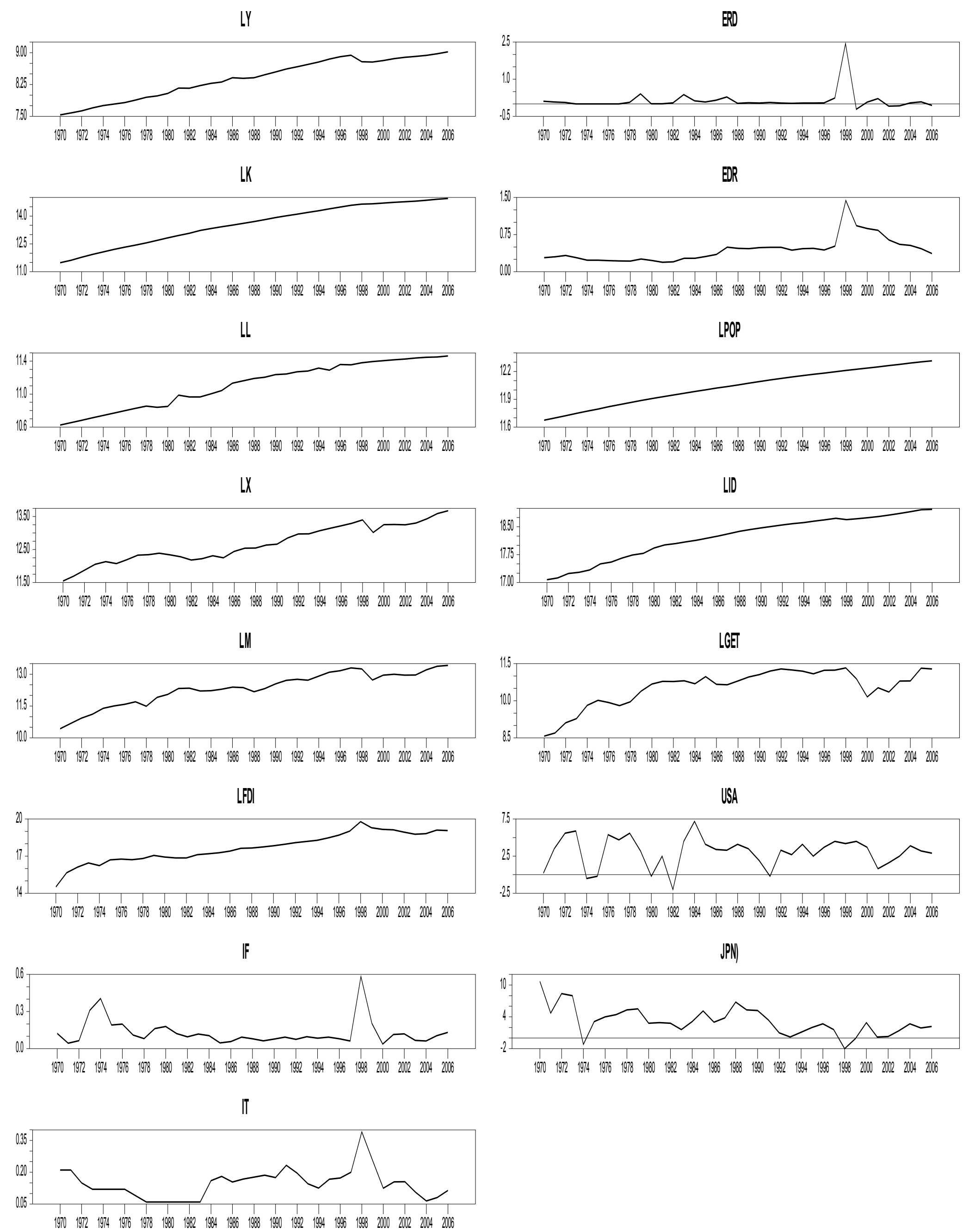


Table 6.2
Unit root test results: Policy variables and external factors

Variables	The test model* (5 % critical value)	Lags	Test statistic value	Conclusion
In level				
LY	ADF 3 (-3.53)	0	-1.11	Nonstationary
LK	ADF 2 (-2.94)	1	-3.21	Stationary
LL	ADF 3 (-3.53)	1	-0.61	Nonstationary
LX	ADF 3 (-3.53)	0	-2.76	Nonstationary
LM	ADF 3 (-3.53)	0	-3.05	Nonstationary
LFDI	DF 2 (-2.94)	-	-3.17	Stationary
IF	DF 2 (-2.94)	-	-4.50	Stationary
IT	ADF 3 (-3.53)	0	-2.65	Nonstationary
ERD	ADF 2 (-2.94)	0	-6.20	Stationary
EDR	ADF 3 (-3.53)	0	-2.35	Nonstationary
LPOP	DF 3 (-3.53)	-	-4.02	Stationary
LID	DF 3 (-3.53)	-	-4.08	Nonstationary
LGED	ADF 3 (-3.55)	0	-2.84	Nonstationary
USA	DF 2 (-2.94)	-	-4.73	Stationary
JPN	DF 2 (-2.94)	-	-4.46	Stationary
In first difference				
DLY	DF 2 (-2.94)	-	-4.79	Stationary
DLL	DF 2 (-2.94)	-	-7.29	Stationary
DLX	DF 2 (-2.94)	-	-6.67	Stationary
DLM	DF 2 (-2.94)	-	-5.68	Stationary
DIT	DF 2 (-2.94)	-	-5.78	Stationary
DEDR	DF 2 (-2.94)	-	-7.56	Stationary
DLID	DF 2 (-2.94)	-	-4.62	Stationary
DLGED	DF 2 (-2.94)	-	-5.50	Stationary

Notes: * Refers to the three models of DF and ADF: model 1 – no intercept and no trend; model 2 – with intercept and no trend; model 3 – with intercept and trend. The parentheses are the 5 per cent critical value of the respective models.
Testing to the variables in difference is only conducted to the variables that are not stationary in level.

Selection of the variable.

The impossibility to test the existence of cointegration among the entire variables simultaneously in one test due to the limited sample size is deciphered to refine the variables that have influence to the long run output and growth in Indonesia. Estimation is conducted to select those variables by utilizing one destination of bounds testing to cointegration approach, namely equation (6.7), in that y is defined as LY, while x consists all policy variables and external factors which include: LK,

LL, LX, LM, LFDI, IF, IT,ERD, EDR, LPOP,LID, LGET, USA and JPN. Considering the size sample of the variable, equation (6.7) is performed in the ARDL (*p*, *q*) where *p* and *q* is set to 1 and 0, respectively. In order to isolate the impact of 1998 economic crisis, the pulse dummy variable (*D*) is included in the estimation, where it takes the value of 1 for the year 1998, and 0 otherwise. The time trend is also included to capture any unobserved factors that are systematically shrinking or growing over time, which may create spurious in the regression.

Method 1 of selecting the variables is conducted by eliminating variables one by one whichever has the most insignificant (the minimum absolute *t*-statistic) parameter estimate in every step of regression. The lag of dependent variable, time trend and the dummy variable of the 1998 economic crisis are always included in every step of regression, even though they possibly have the most minimum absolute *t*-statistic in the previous estimation. The outcome of the first regression give the minimum *t*-statistic on LM, thus it is eliminated at the outset. Continuous regressions results in the elimination are LGET, LINS, USA, IT, ERD, JPN and IF. The final estimation which provides that all policy variables have significant *t*–statistic is reported in Table 6.3.

The variables that all have significant parameters at 5 per cent critical value are LK, LL, LX, LFDI, EDR and LPOP. Observing to the signs of the parameter, LK, LL, and LX are the important factors to generate output level, given their parameter signs are positive and significant, and in line with the theoretical ground. Moreover, EDR and LPOP also stand in formation to the theoretical base, provided their parameters are negative and significant. Surprisingly, the negative sign is found in the parameter estimate of LFDI, which represents the stock of FDI. According to method 1, the selected variables for further analysis of bounds testing to cointegration are therefore LK, LL, LX, LFDI, EDR and LPOP.

Table 6.3
Selection of the variables
Discarding one by one variable (method 1)
ARDL (1,0,0,0,0,0,0) - Dependent variable: LY

Variables	Coefficient	*t*–stat.
Constant	53.95	5.11 *
LY_{t-1}	0.22	1.81
LK	1.00	5.98 *
LL	0.29	2.30 **
LX	0.17	4.65 *
LFDI	-0.09	-3.25 *
EDR	-0.15	-3.25 *
LPOP	-5.42	-5.37 *
Trend	0.02	3.70 *
D	0.01	0.19
R2	0.99	
DW	1.98	

Notes: * and ** indicate significant at 1% and 5% critical value

Method 2 of selecting variables is also conducted by regressing LY against all of the variables listed in Table 6.1. Diagnostic tests have been carried out to specify the outcome estimates. The Lagrange Multiplier serial correlation test for dynamic model advocated by Breusch (1978) and Godfrey (1978) is implemented. The result suggests no evidence of serial correlation in the model, given the statistic value 1.50 with *p*-value 0.22. Breusch and Pagan's (1979) type test of heteroscedasticity reports the chi square 1.49 with the *p* value 0.68, evidence of the homoscedastic in the model. Table 6.4 reports the outcome of the parameter estimates,

The estimates of the regression indicate that among 14 policy variables and external factors as regressors, only 6 have statistically significant effect to the output level, which are LK, LL, LX, LFDI, EDR and LPOP. It is observed therefore that they are exactly the same as the outcome of method 1.

Table 6.4
Selection of the variables
Regressing all variables simultaneously (method 2)
ARDL (1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0) - Dependant variable: LY

Variables	Coefficient	*t*–stat.
Constant	60.84	3.50 *
LY_{t-1}	0.10	0.66
LK	1.06	5.08 *
LL	0.33	2.06 **
LX	0.17	4.15 *
LM	0.002	0.05
LFDI	-0.07	-2.22 **
IF	-0.09	-1.02
IT	0.06	0.59
ERD	0.03	0.85
EDR	-0.18	-2.44 **
LPOP	-6.10	-3.58 *
LID	0.07	0.29
LGET	-0.01	-0.16
USA	-0.08	-0.35
JPN	-0.19	-0.81
Trend	0.03	2.37 **
D	-0.03	-0.22
R2	0.99	
Serial correlation[1] χ^2	1.50 (0.22)	
Heteroscedasticity[2] χ^2	1.49 (0.68)	

Notes: * and ** indicate significant at 1% and 5% critical value
[1] Breusch (1978)and Godfrey (1978) serial correlation test
[2] Breusch – Pagan (1979) heteroscedasticity test

Based on methods 1 and 2, it is easy and confident to determine the variables to include in the bounds testing approach to cointegration, since both methods provide exactly the same outcome, namely: LK, LL, LX, LFDI, EDR and LPOP. Therefore, those variables are selected for further analysis of the driving forces of the level and the growth of real per capita income in Indonesia.

Testing for cointegration

Given the selected variables of the driving force of growth are LK, LL, LX, LFDI, EDR and LPOP, and on the basis of equation (6.6), the conditional VECM of interest now becomes:

$$\Delta LY_t = \alpha_0 + \beta t + \delta_1 LY_{t-1} + \delta_2 LK_{t-1} + \delta_3 LL_{t-1} + \delta_4 LX_{t-1} + \delta_5 LFDI_{t-1} + \delta_6 EDR_{t-1} + \delta_7 LPOP_{t-1} + \sum_{i=1}^{p} \phi_i \Delta LY_{t-i} + \sum_{j=0}^{q} \varphi_j \Delta LK_{t-j} + \sum_{k=0}^{q} \gamma_k \Delta LL_{t-k} + \sum_{l=0}^{q} \eta_l \Delta LX_{t-l} + \sum_{m=0}^{q} \mu_m \Delta LFDI_{t-m} + \sum_{n=0}^{q} \theta_n \Delta EDR_{t-n} + \sum_{r=0}^{q} \vartheta_r \Delta LPOP_{t-r} + D_t + \varepsilon_t \quad (6.9)$$

Equation (6.9) is estimated to examine the cointegration relationship among the variables. Provided the limited annual time series data available, the essential counsel of Pesaran, et. al (2001, p. 308, para. 2) is paid carefully to determine *p* and *q* as the lag length of the variables differenced. The main purpose is to achieve a frail balance between determining *p* and *q* small such that the conditional ECM (6.9) is not unduly over-parameterized and choosing them large to ensure the residual is serially uncorrelated. For that reason, equation (6.9) is initially estimated using *p*=1 and *q*=1, as the ARDL (1,1,1,1,1,1,1) model. The outcome indicates that none of the independent variables differenced with lag length equal to one $(\Delta LK_{t-i}, \Delta LL_{t-i}, \Delta LX_{t-i}, \Delta LFDI_{t-i}, \Delta EDR_{t-i}, \Delta LPOP_{t-i}; i = 1)$ are significant. Therefore, equation (6.9) is re estimated by excluding them (lagged change of independent variables) in a more parsimonious specification, as the ARDL (1,0,0,0,0,0,0) model. Lagrange Multiplier (LM) statistic for testing the hypothesis of no residual serial correlation advocated by Breusch (1978) and Godfrey (1978) is conducted. The result provides LM statistic 3.57, less than the 5 per cent critical value. Therefore, the null hypothesis of the existence of serial correlation is rejected and evidently shows no serial correlation in the residual. This estimation is therefore undertaken for cointegration testing. The result of the cointegration test is reported in Table 6.5.

The calculated *F*-statistic from restricting $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$ in equation (6.9) is 5.45. This value is greater than the upper bounds critical value provided by Pesaran et. al. (2001) at 1 per cent significant level, and by Narayan (2004) at 5 per cent significant level. This implies that the null hypothesis of no cointegration can be rejected, and therefore, there is a cointegration relationship among the variables.

Table 6.5
***F*-Statistic of cointegration relationship test**

	Stat. value	Sign't. level	Bounds critical values Pesaran et al (2001)*		Bounds critical values Narayan (2004)**	
			I(0)	**I(1)**	**I(0)**	**I(1)**
		1%	3.60	4.90	4.02	5.80
***F*-statistic**	**5.45**	5%	2.87	4.00	2.86	4.32
		10%	2.53	3.59	2.39	3.67

Notes: * Unrestricted intercept and unrestricted trend, k=6
** Restricted intercept and trend, k=6 and n=35

Estimating the long run and the short run relationship

Given cointegration among variables exists; the long run relationship model of equation (6.7) is estimated, where y is LY and x a vector of variables which consists of LK, LL, LX, LFDI, EDR and LPOP. Since the dummy variable of the 1998 economic crisis does not have a significant impact on previous estimation (equation (6.9)), it is not included in the long run model. Hence, the specification of the long run relationship model of interest is performed as follows:

$$LY_t = \alpha_0 + \beta t + \sum_{i=1}^{p} \phi_i LY_{t-i} + \sum_{j=0}^{q} \varphi_j LK_{t-j} + \sum_{k=0}^{q} \gamma_k LL_{t-k} + \sum_{l=0}^{q} \eta_l LX_{t-l} + \sum_{m=0}^{q} \mu_m LFDI_{t-m} + \sum_{n=0}^{q} \theta_n EDR_{t-n} + \sum_{r=0}^{q} \vartheta_r LPOP_{t-r} + \varepsilon_t \quad (6.10)$$

Equation (6.10) is estimated and reported in Table 6.6. The lag length (p and q) is determined by initially applying the minimum value that is 1 and 0 for p and q, respectively, and then checking the model for specification and appropriateness. If it has not satisfied, the lag length is increased to 1 and 1 for *p* and *q*, respectively, and so on. This procedure has provided the appropriate and optimum lag length for *p* and *q* is 1 and 0, respectively. Therefore, equation (6.10) is estimated in the ARDL (1,0,0,0,0,0,0) specification.

The diagnostic tests of the model show no evidence of serial correlation in the residual, and it is homoscedastic. The Jarque-Berra normality test suggests that the residual is normally distributed, given the statistic value 0.30 with *p*–value 0.86, insufficient to reject the null hypothesis of normally distributed. The regression specification error test (RESET) indicates that the model is adequately specified; reportedly the *F*-test implies the predictive power and accuracy of the model. It reveals that the model has desired econometric properties, which is a correct functional form, and the residual are serially uncorrelated, homoscedastic and normally distributed. Therefore, the results are valid for empirical interpretation.

The estimated coefficient of the long run relationship shows that capital has the highest significant impact on the long run GDP per capita. A 1 per cent increase in the capital leads to almost 1 per cent increase in GDP per capita, all things being equal. The number of person in employment is also supportive to the per capita output. Assuming all other things equal, a 0.28 per cent increase in per capita GDP can be achieved by creating new jobs to raise 1 per cent of the number of person in employment. Export is another important variable to generate per capita GDP. The magnitude is able to increase 0.17 per cent of GDP by increasing 1 per cent of exports.

Table 6.6
Estimates of the long run relationship model
ARDL (1,0,0,0,0,0,0) - Dependent variable: LY

Variables	Coefficient	*t*–stat.
Constant	52.88	6.06 *
Trend	0.02	4.50 *
LK	0.99	7.05 *
LL	0.28	2.45 **
LX	0.17	4.76 *
LFDI	-0.09	-3.31 *
EDR	-0.14	-4.77 *
LPOP	-5.31	-4.49 *
DW	2.01	
R^2	0.99	
Serial correlation[1] χ^2	2.63 (0.105)	
Heteroscedasticity[2] χ^2	2.57 (0.46)	
Functional form[3] *F-stat*	2.38 (0.11)	
Normality[4] χ^2	0.30 (0.86)	

Notes: * and ** indicate significant at 1% and 5% critical value
[1] Breusch's (1978) and Godfrey's (1978) serial correlation test
[2] Breusch – Pagan's (1979) heteroscedasticity test
[3] Ramsay's (1969) Regression specification error test (RESET)
[4] Jarque Bera (1987) normality test

The outcome gives a cautious however, given the sign of the parameter coefficient of the stock of FDI is negative and significant. This is indicative that the country has not been selective and unable to optimize the role of foreign investment to generate output level. This outcome is in line with the study by Wie (2001). Different clear depictions are given by the outcome of the estimate of external public debt and the number of population, as their signs are negative and significant. The theoretical and empirical position of the role of external public debt is still vague, whether it is able to generate output level, discourages it, or is insignificant (see for example: Schclarek, 2004; Pattillo et. al., 2005; Paudel and Shrestha, 2006; Seetanah et. al., 2007). However, the regression estimate provides an empirical outcome that external public debt has a negative and significant impact on per capita GDP in Indonesia. A 1 per cent increase in the ratio of external public debt to GDP downgrades the per capita GDP by 0.17 per cent. Moreover, as is theoretically inspired, the parameter estimate confirms that the number of population is negatively related to per capita income (see: Karas, 2001). It is extremely vigilant that, if everything is constant, the growth of population by 1 per cent will deteriorate per capita GDP by 5 per cent. The most possible reason behind this is likely that the ratio between employment and the number of population is very low.

The short run relationship between the real per capita GDP and factor variables is estimated utilizing equation (6.8). The factor variables are associated with the long run model, which include: LK, LL, LX, LFDI, EDR and LPOP. Therefore, the specification of the ECM of interest for the short run relationship is performed as follows:

$$\begin{aligned}\Delta LY_t = \alpha_0 + \beta t + \sum_{i=1}^{p} \varpi_i \Delta LY_{t-i} + \sum_{j=0}^{q} \omega_j \Delta LK_{t-j} + \sum_{k=0}^{q} \varsigma_k \Delta LL_{t-k} + \sum_{l=0}^{q} \tau_l \Delta LX_{t-l} + \\ \sum_{m=0}^{q} \xi_m \Delta LFDI_{t-m} + \sum_{n=0}^{q} \psi_n \Delta EDR_{t-n} + \sum_{r=0}^{q} \zeta_r \Delta LPOP_{t-r} + \delta ecm_{t-1} + \varepsilon_t\end{aligned} \tag{6.11}$$

The *ecm* is obtained from the long run counterpart of equation (6.10). The same method as in equation (6.9) is implemented to determine the lag length, p and q. It initially applies the minimum value 1 and 0 for p and q, respectively, and then checking the model for specification and appropriateness. If it has not satisfied, the lag length is increased to 1 and 1 for p and q, respectively, and so on. This procedure has provided that the appropriate and optimum lag length for p and q is 1 and 0, respectively. The estimation result is reported in Table 6.7.

The robustness of the model has been validated by several diagnostic tests. The Breusch (1978) and Godfrey (1978) test of serial correlation detect no evidence of serial correlation in the residual, provided the statistic value 0.25 with the p value 0.617. The statistic value of Breusch and Pagan (1979) test which is 0.24 with the p value 0.970 also confirms that no heteroscedasticity problem in the residual. The residual also passes the Jarque-Berra's (1987) normality test. The RESET test for functional form specification indicates that the model is correctly specified. Therefore, the desired econometric properties have been satisfied in this model, which is a correct functional form and the residual are serially uncorrelated, homoscedastic and normally distributed. For that reason, empirical interpretations based on this model are then valid.

Table 6.7
Estimates of the error correction model
ARDL (1,0,0,0,0,0,0) – Dependent variable: DLY

Variables	Coefficient	*t*–stat.
Constant	0.07	0.65
Trend	-0.001	-0.34
DLY_{t-1}	0.08	1.08
DLK	0.90	4.36*
DLL	0.50	5.64*
DLX	0.19	6.41*
DLFDI	-0.02	-0.79
DEDR	-0.18	-7.74*
DLPOP	-7.00	-2.06**
ecm_{t-1}	-0.63	-5.47*
DW	2.07	
R^2	0.96	
Serial correlation[1] χ^2	0.25(0.617)	
Heteroscedasticity[2] χ^2	0.24(0.970)	
Functional form[3] *F-stat*	1.11(0.345)	
Normality[4] χ^2	0.12(0.939)	
AIC:164.30, *SBC*:148.74		

Notes: $ecm = LY - 27.47 - 0.87LK - 0.36LL - 0.25LX + 0.09LFDI + 0.10EDR + 3.02LPOP$
* and ** indicate significant at 1% and 5% critical value
[1] Breusch's (1978) and Godfrey's (1978) serial correlation test
[2] Breusch – Pagan's (1979) heteroscedastiscity test
[3] Ramsay's (1969) Regression specification error test (RESET)
[4] Jarque-Bera (1987) normality test

The signs of the long run relationship are maintained in the dynamic coefficient of the short run relationship. As the short run dynamic, the constant demonstrates an insignificant parameter. However, LFDI is insignificant in this short run. It suggests that the negative impact of the stock of FDI is only harmful in the long run. Population growth and the growth rate of external public debt can deteriorate per capita GDP, given both parameter estimates of DEDR and DLPOP are negative and significant. On the other side, the growth rate of capital (DLK), employment (DLL) and export (DLX) can generate per capita GDP growth, provided their coefficients are positive and significant. The growth of capital again has the most influential impact in the output growth, followed by employment and export.

The equilibrium correction coefficient (ecm_{t-1}), estimated -0.63 is significant at 1 per cent critical value. It has the correct sign which implies very high speed of adjustment to equilibrium after a shock. The disequilibrium from the previous year's shock, about 63 per cent, converges back to the long run equilibrium in the current year.

Examining the causality relationship

In order to examine the causal relationship employing the Granger causality test, equation (6.11) is estimated using the lags length p and q equal to 1. The same lag is also applied when the dependent variable is each of the policy variables. While the signs of the parameters are all maintained the same as the parameters of the short run relationship estimates, the results of the Granger causality test are reported as follows:

- Capital, employment, export, stock of FDI, external public debt to GDP ratio and population number jointly Granger cause real per capita GDP.
- Capital, employment, export, stock of FDI, external public debt to GDP ratio, and population individually Granger cause real per capita GDP.
- Real per capita GDP only Granger causes employment, and does not Granger cause capital, export, stock of FDI, external public debt to GDP ratio, and population individually

These results indicate that there is only one positive bidirectional relationship, which is between real per capita GDP and employment. The increase in employment will cause the increase in employment, and the increase in real per capita GDP will generate employment in the economy. It is no doubt therefore to emphasize policy related to labor market.. In the supply side, upgrading skill and information access of the workforce to the job opportunity is the most important in the context of Indonesia.

In the demand side, providing spacious room for job creation through encouraging investment for example is another policy that should go in line.

Even though capital and export have only one positive directional relationship to real per capita GDP, jointly or individually, policy needs also to be conducted for the purpose of accumulating capital and generating export. The increase of capital and export will cause the increase of real per capita GDP, but it is not vice versa. The increase in real per capita GDP does not cause raising capital and / or export. Specific to the accumulating capital, which is done through spawning investment, this also attempt to generate employment. Providing conducive environment for business and investment is crucial, through: bureaucratic reform in the tax office to combat any bribery practices, investment coordinating board to cut the long process of start to dong business and law enforcement.

The government has also to deal with policy related to external public debt, FDI and population growth, as they have one negative directional relationship. The increase in external public debt to GDP ratio, stock of FDI and population will cause reducing real per capita GDP, and it is not vice versa. The government has to look at other financing, instead of external public debt which usually comes from multilateral development banks and bilateral relation to finance the budget deficit, such as issuing bond. Policy has also to be directed to selectively attract FDI that does not crowd out domestic investment. In order to keep low population growth, government needs to emphasize family planning program, with two children, and providing better education.

Based on the results in this section on discovering the driving forces of the level and the growth rate of real per capita GDP, it can be concluded that capital, employment and exports are the important factors to generate per capita GDP. External public debt and the population number are further factors that should be managed carefully, as they are negatively correlated with the output level. The presence of FDI is another factor that needs more attention, since its accumulation has a negative impact on the output level. One interesting outcome is drawn on the relationship between real per capita GDP and employment as they have bidirectional Granger causality relationship, meaning that creating more jobs will increase real per capita GDP, and further, increasing real per capita GDP will generate more jobs.

6.5. Chapter conclusion

The exploration of the driving forces behind the growth process of the Indonesian economy has been the main focus of the studies of economic growth in Indonesia in recent years. However, the ultimate reason and the proximate causes underlying Indonesia's economic growth are still unclear. A two step procedure within the bounds testing approach to cointegration is used to investigate the driving forces behind the growth process.

This two step process has advantages to be employed in this kind of study which has short data size available and considers many variables. The process also satisfies the methodology because none of all policy variables or external factors is integrated of order *d*, for *d* greater than one, as evidenced from the unit root test.

In the first step, it is found that real per capita GDP in Indonesia can be linked to capital, employment, exports, external debt to GDP ratio, stock of foreign direct investment and population number. Consistent with theory, the outcomes of the long run estimates indicate the expected parameter signs, which are capital, employment and exports are the variables that have a positive effect on real per capita GDP, while external public debt and population have negative signs. The stock of FDI is the only variable that is surprising for having a negative sign. The most possible reason is likely that a crowding-out effect occurs in the Indonesian economy.

In the second step, it is found that during the period 1970 to 2006:

(i) The real per capita GDP and the capital stock, employment, exports, external debt to GDP ratio, the stock of FDI and population are cointegrated. Hence, there is a unique long run relationship between them.

(ii) The capital stock, employment and exports are the variables that have a positive effect on the real per capita GDP, while external debt to GDP ratio, the stock of FDI and population have a negative effect. One reason for the negative effect of the stock of FDI is that it possibly crowded-out domestic investment.

(iii)The change in the capital stock, employment and export have a positive effect on the real per capita GDP growth, while change in external public debt to GDP ratio and population have a negative effect. The change in stock of FDI does not have a significant effect to the output growth.

Based on these empirical results, and bearing in mind to the fact that the Indonesian government can only influence policy variables, the ability to maintain and continue the current growth rate in the long run for Indonesia will depend on the implementation of appropriate policies. Some details about the results are:

- The results suggest that the Indonesian economy is heavily reliant on the accumulation of physical and human capital, thus more emphasis is needed to support an environment that is conducive for domestic investment.
- The results suggest that exports have an important impact on both short run and long run output. Thus the economy will be greatly affected by the contraction in the global market.
- The results suggest that the high level of external public debt will render the economy susceptible to the volatilities of the world financial market, particularly to the foreign exchange rate, as for example in the speculation in the 1998 economic crisis. The direct effect on the economy is that the higher the level of external public debt, the lower the output level and its growth.
- The results suggest that the negative impact of the stock of FDI is an urgent policy task so that Indonesia can be able to benefit from FDI.

Based on these results it is concluded that the Indonesian Government should emphasize increasing physical and human capital accumulation, increasing employment, and increasing exports. The Indonesian Government should also reduce the external debt to GDP ratio, be selective with foreign direct investment so that it does not crowd-out domestic investment; and lessen population growth.

Chapter VII. Conclusion and Policy Implications

Abstract

An important policy goal for many governments is to increase the growth of real income. Real income is important because it represents economic wellbeing. The main objective of policy makers and researchers in studying economic growth is essentially how to attain high economic growth to increase real per capita income.

A three step process has been used to discover the driving forces of the level, and of the growth rate, of real per capita GDP in Indonesia.

The results suggest that:

- First, long run economic growth in Indonesia is endogenous; therefore the government can influence long run growth through appropriate policies.
- Second, the acceleration of productivity and of growth of about 6 per cent annually was contributed by the adoption of technology from Japan and USA. However, this growth is insufficient to catch up to the leading countries of Japan and USA in terms of per capita GDP in the long run.
- Third, the real per capita GDP is:
    - Related positively to capital, employment and export;
    - Related negatively to external debt to GDP ratio, stock of FDI and population.

Based on these results, the Indonesian government should formulate an active development strategy:

- That increases investment to generate physical and human capital accumulation;
- That increases exports;
- That reduces the external debt to GDP ratio;
- That reduces FDI which crowds-out domestic investment; and
- That reduces the growth of population.

7.1. Introduction

An important goal of policy for many governments is to increase the growth of real income. Real income is important because it represents economic wellbeing. The main objective of policy makers and researchers in studying economic growth is essentially how to attain high economic growth to increase real per capita income.

The chapter is organized as follows: the next section provides a brief description of the background to this study. The third section outlines the empirical analysis and the policy implications. Section four outlines the contributions that this study makes to knowledge. Section five outlines the limitations to this study. Section six outlines suggestions for further research. Section seven provides concluding remarks.

7.2. Background

This section provides a brief outline of the background to this study. Indonesia is one of the rapidly growing countries in Asia (IMF, 2006). During the period 1960-2006, the average economic growth is about 6 per cent per annum. Economic policies and institutional changes related to economic growth have been the focus of many studies on Indonesia's economic development (see for example: Woo et. al., 1994; Hill, 2000; Wie, 2006). However, the ultimate reasons and the proximate causes underlying the driving forces of economic growth are still unclear.

Even though real per capita income has increased more than fivefold (in constant prices) during the period of 1960-2006, the current level of per capita income of Indonesia is still far below that of the leading countries, such as Japan and USA. Thus, the importance of this research is to discover how to increase the growth rate of real per capita income for Indonesia.

The development of economic growth theory, from the classical to the modern, has helped researchers and policy makers investigate the driving forces of the level, and of the growth, of real per capita income. In the current economic growth literature, most empirical studies are based on the two competing growth models, namely the exogenous and the endogenous growth models.

Fundamentally, the main difference between exogenous and endogenous models lies on the impact of government policy on long run economic growth. In the exogenous growth model, any change in the factors or in the policy variables made by government has only a transitory effect on long run growth. In the endogenous growth model any changes in policy variables have a permanent effect. If the characteristic of an economy is exogenous, then diminishing returns to reproducible factors. Saving rates, population growth and technological progress determine exogenously to growth and that policies do not have a role in stimulating long run growth. In contrast, endogenous growth attempts to change the diminishing returns to reproducible factors into constant or increasing returns. This process is characterized by adding the concept of human and physical capital and introducing externalities, so that the long run growth rate is determined endogenously, in the sense that it depends on the investment decisions that in turn could be influenced by appropriate government policy. Therefore, in terms of setting up a development strategy for a given country, like Indonesia, it is helpful to know if economic growth is characterized as exogenous or endogenous.

In terms of the source of productivity related to growth, the exogenous and endogenous models have the same objective but have a different departure point.

- In the exogenous model, a poorer country tends to grow faster than a richer country because of the underlying proposition of diminishing returns to capital. The poorer country which has lower capital endowment, lower accumulated physical and human capital, and in addition, capital tending to flow toward those economies characterized by higher returns. As a result, a poorer country tends to grow faster. This concept leads to the notion of income level catching up, which in turn can be understood in two different ways.

- First, convergence in terms of income level. The steady state income level of the countries will be the same, and with time they will all tend to reach the same level of per capita income, if they have similarities in terms of preferences and technological progress.
- Second, convergence in terms of the growth rate. All countries will eventually attain the same steady state growth rate, given that technological progress, which is exogenously determining growth, is available to be shared equally. Clearly, if both countries have the same preferences, a poorer country tends to grow more rapidly than a richer country in terms of per capita income.

- In the endogenous growth model, a poorer country tends to grow faster than a richer country because of technological catching up. The more backward a country is in technology and productivity, the greater the scope for catching up. Consequently, because of a more rapid shift of resources from the low productivity to the high productivity sectors, the backward country would grow faster than a rich, developed country (Thirwall, 2002). Because productivity is identical to the level of technology, this kind of notion becomes commonly called technology catching up.

Given these two competing models, this study advocates that, in order to identify the driving forces of the level, and of the growth, of real income in Indonesia, the study of economic growth has to be conducted in the following three step process:

1. Investigate if the characteristic of long run economic growth in Indonesia is exogenous or endogenous.
2. Investigate the process of productivity related to growth. In practice, this productivity has to be examined for the presence of technology catching up, and measured by income level catching up.
3. Identify the driving forces of the level and of the growth rate of real per capita income level in Indonesia.

This study uses this three step procedure to obtain empirical results for economic growth in Indonesia.

Based on the results from this section on the background to this study, it can be concluded that this background provides a strong basis upon which to build the empirical analysis. The empirical analysis and the policy implications are discussed in the next section.

7.3. Empirical analysis and policy implications

This section provides an outline of the three sets of empirical results and the related policy implications that were obtained in Chapters IV, V and VI; they are:

- Investigating if growth is exogenous or endogenous.
- Investigating catching up hypotheses.
- Discovering the driving forces of the level and of the growth rate of real per capita GDP.

7.3.1. Investigating if growth is exogenous or endogenous

This first set of empirical results determines if the characteristic of long run economic growth in Indonesia is exogenous or endogenous.

Two methods within the time series framework, namely regression equation of time series, and cointegration and ECM, are used to investigate if economic growth in Indonesia, for the period 1960 to 2006, is characterized as being an exogenous or an endogenous growth model.

The result of the regression equation of time series suggests that investment, trade openness and population growth jointly have a permanent effect on long run growth. Individually, the investment rate has a positive significant effect on growth.

The results of the cointegration and ECM method suggest that per capita GDP and per capita investment are cointegrated and that per capita investment has a permanent effect on per capita output. The cointegration and ECM is then used to further investigate the long run growth process of Indonesia using a bivariate model. In this model the strict requirement that both variables are cointegrated is satisfied, given that the log per capita GDP and log per capita investment are cointegrated with the cointegrating vector (1,-1).

This outcome indicates that investment has a long run multiplier effect on per capita income. This is further evidence that the growth in Indonesia is endogenous.

An important implication of this result is that the Indonesian government, through its policies, can influence long run growth in order to increase the welfare of the people. Generating investment is one channel through which the government can increase long run economic growth, given that both the methods provide evidence of its positive and significant impact. It is also important for the government to manage population growth, since it has a negative correlation to output growth, even though insignificant. Population growth is necessarily best accompanied by development in human capital such as education, in order to increase productivity and final output.

Based on the concurrence of the results from the different methods of testing the exogenous and endogenous growth models, the growth process of Indonesia is endogenous. It is important to underline, however, that both of the methods are in the framework of time series methodology, which is very sensitive to the sample size. The sample size of about forty-five may be too small when analyzing permanent effects on long run growth. Therefore, the methodology that can be used to examine differences between exogenous and endogenous growth models is an area of applied research that could be further explored.

Thus, based on these two results, and in answering this first set of empirical results, it is concluded that the characteristic of the long run economic growth in Indonesia is an endogenous growth model. This implies that government policies can influence long run economic growth in order to increase the welfare of the people.

7.3.2. Investigating the catching up hypotheses

The second set of empirical results determines if there is a process of catching up for Indonesia. A time series equation is used to examine the process of technology catching up, and the cointegration and ECM, and the polynomial time trend approach are used to examine income level catching up.

The results of the time series equation suggest that there is a process of adoption of technology (technology catching up) by Indonesia from the frontier technology of Japan and USA during the period 1960-2005. This technology catching up is empirically deemed to contribute to accelerating productivity and growth, on average by 6 per cent annually. Moreover, the occurrence of the technology catching up process is conditional on the presence of the adoption capacity factors, which were represented by economic performance, human capital and import growth.

The results of the cointegration and ECM, and the polynomial time trend approach suggest that there is not any process of income level catching up by Indonesia toward the developed countries of Japan and USA during the same period.

Policy makers should implement more development strategies in order to generate higher growth. Related to the technology catching up, policies have to be directed to build stronger adoption capacity factors, such as emphasizing more human capital development, managing macroeconomic performance and stability, and opening more to the importing of productive goods such as machinery and equipment and optimizing the benefits of partnerships in trade and investment.

These results support the theory of technology catching up as described for example by Nelson and Phelp (1966), by which Indonesia, as a developing country which is relatively backward in technology, can adopt and implement frontier technology from Japan and USA to accelerate Indonesia's productivity and growth. This process is however conditional on Indonesia's adoption capacity.

Based on these two results, and in answering this second set of empirical results it is concluded that the process of technology catching up which facilitated Indonesia to accelerate productivity and growth exists. However, the growth acceleration is insufficient for the country to catch up to the leading countries in terms of per capita income.

7.3.3. Discovering the driving forces of the level and the growth rate of real per capita income

This third set of empirical results determines the driving forces of the level and of the growth rate of real per capita income in Indonesia over the period 1970–2006. The real per capita GDP is used to reflect real per capita income. A two step procedure within the bounds testing approach to cointegration is utilized to discover the driving forces of the level and the growth rate of real per capita GDP.

In the first step, it is found that real per capita GDP in Indonesia can be linked to capital, employment, exports, external debt to GDP ratio, stock of FDI and population number. Consistent with theory, the outcomes of the long run estimates indicate the expected parameter signs, which are capital, employment and export are the variables that have a positive effect on real per capita GDP, while external public debt and population have negative signs. The stock of FDI is the only variable that is surprising for having a negative sign. The most possible reason is likely that a crowding-out effect occurs in the Indonesian economy.

In the second step, it is found that during the period 1970 to 2006:

(i) The real per capita GDP and the capital stock, employment, exports, external debt to GDP ratio, the stock of FDI and population are cointegrated. Hence, there is a unique long run relationship between them.

(ii) The capital stock, employment and exports are the variables that have a positive effect on the real per capita GDP, while external debt to GDP ratio, the stock of FDI and population have a negative effect. One reason for the negative effect of the stock of FDI is that it possibly crowds-out domestic investment.

(iii) The change in the capital stock, employment and exports have a positive effect on the real per capita GDP growth, while change in external debt and population have a negative effect on the real per capita GDP growth. The change in stock of FDI does not have a significant effect to the output growth.

Based on these empirical results, and bearing in mind to the fact that the Indonesian government can only influence policy variables, the ability to maintain and continue the current growth rate in the long run for Indonesia will depend on the implementation of appropriate policies. Some details about the results are:

- The results suggest that the Indonesian economy is heavily reliant on the accumulation of physical and human capital, thus more emphasis is needed to support an environment that is conducive for domestic investment.
- The results suggest that exports have an important impact on both short run and long run output. Thus the economy will be greatly affected by the contraction in the global market, as for example in the current global financial crisis.
- The results suggest that the high level of external public debt will render the economy susceptible to the volatilities of the world financial market, particularly to the foreign exchange rate, as for example in the speculation in the 1998 economic crisis. The direct effect on the economy is that the higher the level of external public debt, the lower the output level and its growth.
- The results suggest that the negative impact of the stock of FDI is an urgent policy task so that Indonesia can be able to benefit from FDI.

Thus, it is concluded that the Indonesian Government should increase physical and human capital accumulation, increase employment, and increase exports. The Indonesian government should also reduce the external debt to GDP ratio; be selective with foreign direct investment so that it does not crowd-out domestic investment; and lessen population growth.

Based on the results from this section on empirical analysis and policy implications, it can be concluded that this thesis has been successful.

7.4. Contribution of this thesis to knowledge

This section highlights the two main contributions of this study to the economic literature; that is a contribution of substance and a contribution of methodology.

In terms of substance, this study makes three contributions: The characteristic of growth; the source and the rapidity of national productivity; and the driving forces of per capita income.

The characteristic of growth. This study is the first to analyze Indonesia's economic growth process starting from determining if the characteristic of long run growth is exogenous or endogenous. This starting point provides a strong fundamental growth theory background to the analysis of Indonesia's growth. Further, this study makes a significant empirical contribution to the ongoing debate on whether or not long run growth in Indonesia can be influenced by government policy.

The sources of national productivity. This study is the first to empirically investigate how national productivity has been generated, and how rapidly this productivity growth to catch up to Japan and USA is. Utilizing the two concepts of technology and income level catching up from the economic growth literature, this study provides empirical evidence to suggest that technology adoption has contributed, during the period 1960-2006, to productivity growth. However, this study also finds that the productivity and the growth of real per capita income achieved by Indonesia are insufficient to catch up to the world leading countries of Japan and USA in terms of per capita income.

The driving forces of per capita income. This study is the first to empirically determine that in the long run, the level of real per capita income is related positively to capital, employment and exports, and is negatively related to external public debt, the population and the stock of FDI. In the short run, the growth rate of real per capita income is positively related to the growth of capital, employment and exports, and negatively related to the growth of external public debt to GDP ratio and population growth.

These three contributions are original and a new addition to the literature of economic growth in Indonesia.

In terms of methodology, this study is the first to employ the bounds testing approach to cointegration as a two step procedure to investigate the driving forces of the level and the growth rate of real per capita income in Indonesia. The first step is to define the factors that can be linked to real per capita income; the second step is to identify how those factors are integrated in determining the level and the growth rate of real per capita income in Indonesia.

Based on the results from this section on the contributions of this study, it can be concluded that this has been successful thesis.

7.5. Limitations to this thesis

This section outlines the limitations to this study. There are a number of limitations arising from this empirical study of economic growth in Indonesia.

- *Limited data*. The first limitation is the availability of the data used in the analysis, which are beyond the scope of this study. To obtain reliable results from any empirical analysis, longer sample size and accurate data are needed. However, achieving this is not an easy task. This thesis uses the data which is subject to some limitations due to sample size and readability.

- *Exogenous or endogenous*. The second limitation is that in the time series regression model to test exogenous and endogenous growth, the methodology requires that the leads and lags of the variables be differenced if the explanatory variables is I(1). This process will always be constrained by the degrees of freedom. Given the policy implications regarding the potential role of government in promoting growth, the testing between exogenous and endogenous growth using this time series equation should ideally incorporate all the policy variables. However, this is impossible with the limited size sample.

- *Technology catching up*. The third limitation is that in the test for technology catching up, the model is only able to incorporate very few adoption capacity factors, as the sample size is small. In fact, using only three factors to represent all of the factors of adoption capacity is likely to be insufficient. Therefore, the policy related to building adoption capacity is limited to that of the factors that were actually investigated. A further issue in this analysis is associated to the leading country taken as the frontier technology. Examining only two leading partner countries, Japan and USA, is likely to be insufficient to represent all leading countries who are significant trading partners with Indonesia.

- *Income level catching up*. The fourth limitation is with the income level catching up, in that the study is not able to show the minimum growth rate that would be required so that Indonesia would catch up to the developed countries of Japan and USA in terms of income level, and how long this would take.

- *Income distribution*. The fifth limitation is income distribution, which is beyond the scope of this study. The study investigated the driving forces of the (average) level and the (average) growth rate of real per capita income; it does not address the problem of income distribution.

- *Domestic catching up*. The sixth limitation is catching up within Indonesia, which is beyond the scope of this study. The study investigated catching up between Indonesia and Japan and USA, but it did not empirically investigate the catching up hypotheses within the country.

Based on the results in this section on the limitations to this study, it can be concluded that while this study has made a significant contribution, there are still many limitations to be improved.

7.6. Suggestions for future research

The limitations of this study suggest some avenues for further research to deepen the understanding of economic growth in Indonesia. First, in relation to investigating the characteristic of long run economic growth; the available method is constrained by the consideration of the degrees of freedom; given the small sample size. Therefore, developing a methodology that would incorporate more policy variables is an area for future research.

Second, in relation to technology catching up; to develop a methodology that is able to incorporate more adoption capacity factors. The purpose would be so that policy related to the development of adoption capacity factors can be derived in detail from investigating these factors. Further, to investigate the process of technology catching to all of the developed countries that have economic cooperation with Indonesia. This would investigate the importance of each trading partner in relation to adoption of technology.

Third, in relation to income level catching up; to develop a methodology that is able to identify the minimum threshold rate and the length of time for Indonesia to catch up to the level of per capita income of the leading countries of Japan and USA is an area for future research.

Fourth, in relation to the problem of growth and inequality; to investigate the catching up hypotheses within Indonesia is an area for future research.

Based on the results in this section on suggestions for future research, it can be concluded that while this study has made a significant contribution, there are still many topics to be researched.

7.7. Concluding remarks

Despite the limitations, this study has been able to achieve its major objective of analyzing the economic growth in Indonesia for the period 1960-2005. This study is the first to use the fundamental properties of economic growth theories together with current econometric methodology in order to analyze a specific developing country, Indonesia. The main contribution of this study is to offer a three step framework for the empirical and theoretical analysis of economic growth in a specific country, that is (i) determining if the characteristic of long run economic growth is exogenous or endogenous, (ii) investigating how productivity related to growth is generated and measuring the growth rate achieved in comparison to the growth rate of two leading economies, and (iii) discovering the driving forces of the level, and of the growth rate, of real per capita income, based on the model resulting from the first two steps.

The results of this study make a significant contribution for researchers, for policy makers and for the Indonesian government. For researchers, this study offers a new direction for discovering the driving forces of the level, and of the growth rate, of real per capita income, in the sense that to define the driving forces of the level, and of the growth rate, of output, one should first define which economic growth model should be used by testing the characteristic of long run growth; and identifying the process of raising national productivity. This study shows that employing the bounds testing approach to cointegration in a two step procedure provides an expedient way to analyze the driving forces of the level, and of the growth rate, of output by examining almost all the factors that potentially influence growth; and doing so while using a time series framework with limited sample size.

For policy makers and for government, the outcome of this thesis may serve as guidance for development planning, budgeting and policy formulation. The endogenous growth characteristic found in this empirical study suggests an active development strategy, since governments can influence long run economic growth. The study provides suggestions on how Indonesia can accelerate its productivity growth by increasing adoption capacity that in turn should increase adoption of technology. Increasing the acceleration of productivity growth is a must for Indonesia if the country is eager to achieve the position of a developed country in terms of per capita income, since the empirical study shows that the growth rate achieved during the last for decades is insufficient to catch up to a developed country in terms of real per capita income. The study further provides a clear depiction of the driving forces of the level, and the growth rate of real per capita income. These are the economic variables that should be addressed by government in order to increase the real per capita income growth rate.

In practical terms, the results of this study will be sent to the Ministry of Finance through the Fiscal Policy Office. The author, as a staff of this Office, will firstly present the results of this study. The author will also submit the results to the Head of the Fiscal Policy Office for policy consideration.

Bibliography

Abramovitz, M. (1986). Catching up; forging a head, and falling behind. *Journal of Economic History, 46*(2), 385-406.

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica, 60*(2), 323-351.

Aghion, P., & Howitt, P. (1998). *Endogenous growth theory*. Cambridge, Massachusetts: The MIT Press.

Aghion, P., & Howitt, P. (2005). Growth with quality-improving innovations: an integrated framework. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (First ed.). North Holland: Elsevier B. V.

Aghion, P., & Howitt, P. (2006). Joseph Schumpeter Lecture - Appropriate growth policy: A unifying framework. *Journal of the European Economic Association, 4*(2-3), 269-314.

Aghion, P., & Howitt, P. (2009). *The economics of growth*. Cambridge, Massachusetts: The MIT Press.

Arrow, K. J. (1962). The economic implication of learning by doing. *Review of Economies Studies, 29*, 155-173.

Athukorala, P.-C. (2006). Post-crisis export performance: the Indonesian experience in regional perspective. *Bulletin of Indonesian Economic Studies, 42*(2), 177-211.

Awokuse, T. O. (2008). Trade openness and economic growth: is growth export-led or import-led. *Applied Economics, 40*, 161-173.

Baak, S. (2008). The bilateral real exchange rates and trade between China and U.S. *China Economic Review, 19*(2), 117-127.

Baier, S. L., Dwyer, G. P., & Tamura, R. (2006). How important are capital and total factor productivity for economic growth. *Economic Inquiry, 44*(1), 23-49.

Barosi-Filho, M., Silva, R. G., & Diniz, E. M. (2005). The empirics of the Solow growth model: long term evidence. *Journal of Applied Economics, VIII*(1), 31-51.

Barro, R. J. (1990). Government spending in a simple model of endogenous growth. *Journal of Political Economy, 98*, S103-S125.

Barro, R. J., & Lee, J. W. (1993). International comparisons of educational attainment. *Journal of Monetary Economics, 32*, 263-394.

Barro, R. J., & Sala-I-Martin, X. (1997). Technological diffusion, convergence and growth. *Journal of Economic Growth, 2*(1), 1-26.

Barro, R. J., & Sala-i-Martin, X. (2004). *Economic Growth* (Second ed.). Massachusetts: The MIT Press, Cambridge

Bassanini, A., & Scarpetta, S. (2001). The driving forces of economic growth: panel data evidence for the OECD countries. *OECD Economic Studies, 33*.

Batra, R., & Beladi, H. (1996). Gains from trade in a deficit-ridden economy. *Journal of Institutional and Theoretical Economics, 152*, 540-554.

Baumol, W. (1986). Productivity growth, convergence and welfare: what the long run data show. *American Economic Review, 76*(5), 1072 - 1085.

Beck, T., Demirguc-Kunt, T., & Levine, R. (1999). A new database on financial development and structure. *World Bank.*

Becker, G. S., & Mulligan, c. B. (1997). The endogenous determination of time preference. *Quarterly Journal of Economic, 112*, 729-758.

Begum, S., & Shamsuddin, A. F. M. (1998). Exports and economic growth in Bangladesh. *Journal of Development Studies, 35*(1), 89-114.

Benhabib, J., & Spiegel, M. M. (2005). Human capital and technology diffusion. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (First ed.). Amsterdam, the Netherlands: Elsevier, B.V. .

Bentzen, J. (2005). Testing for catching-up period in time-series convergence. *Economics Letters, 88*, 323-328.

Bernard, A. B., & Durlauf, S. N. (1995). Convergence in international output. *Journal of Applied Econometrics, 10*(2), 97-108.

Bernard, A. B., & Durlauf, S. N. (1996). Interpreting tests of the convergence hypothesis. *Journal of Econometrics, 71*, 161-173.

Bhatt, V. V. (1966). Balanced and unbalanced growth: a reply. *The Economic Journal, 76*(303), 674 - 675.

Blalock, G., & Veloso, F. M. (2007). Import, productivity growth, and supply chain learning. *World Development, 35*(7), 1134-1151.

Bleaney, M., Gemmell, N., & Kneller, R. (2001). Testing the endogenous growth model: public expenditure, taxation and growth over the long run. *The Canadian Journal of Economics, 34*, 36-57.

Bloch, H. and Tang, S.H.K. (2004). Deep determinant of economic growth: institutions, geography and openness to trade. *Progress in Development Studies, 4(3)*, 245-255.

Boediono. (2005). Managing the Indonesian economy: Some lessons from the past. *Bulletin of Indonesian Economic Studies, 41*(3), 309-324.

Bond, S., Leblebicioglu, A., & Schiantarelli, F. (2004). Capital accumulation and growth; a new look at the empirical evidence. *Economic Papers, 2004-W08*, Economics Group, Nuffield College, University of Oxford.

Booth, A. (1998). *The Indonesian economy in the nineteenth and twentieth centuries: a history of missed opportunities*: MacMilan Press Ltd, London and ST. Martin's press, Inc., New York.

Booth, A., & McCawley, P. (1981). *The Indonesian economy during the Soeharto era*: Oxford University press.

Bosworth, B. P., Collins, S. M., & Chen, Y. C. (1995). Accounting for differences in economic growth. *Brooking Discussion Papers in International Economics, No. 115*, Washington, DC: The Brooking Institution.

Brahmasrene, T., & Jiranyakul, K. (2009). Capital mobility in Asia: evidence from bounds testing of cointegration between saving and investment. *Journal of the Asia Pacific Economy, 14*(3), 262-269.

Breusch, T. S. (1978). Testing for autocorrelation in dynamic linear models. *Australian Economics Papers, 17*, 334-355.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica, 47*, 1287-1294.

Cameron, G. (2005). The sun also rises: productivity convergence between Japan and the USA. *Journal of Economic Growth, 10*, 387-408.

Campos, N. F., & Karanos, M. G. (2008). Growth, volatility and political stability: Non-linear time series evidence for Argentina. *Economics Letters, 100*, 135-137.

Chen, B.-L., Hsu, M., & Lu, C.-H. (2008). Inflation and growth: Impatience and a qualitative equivalence. *Journal of Money, Credit and Banking, 40*(6).

Chen, E. K. Y. (1997). The total factor productivity debate: determinants of economic growth in East Asia. *Asian-Pacific Economic Literature, 11*(1), 18-39.

Cheung, Y., W, & Lai, K. S. (1993). Finite sample sizes of Johansen's likelihood ratio test for cointegration. *Oxford Bulletin of Economics and Statistics, 55*, 313-328.

Chowdhury, A., & Sugema, I. (2005). How significant and effective has foreign aid to Indonesia been? *ASEAN Economic Bulletin, 22*(2), 186-216.

DeLong, J. B. (1988). Productivity growth, convergence and welfare: comment. *American Economic Review, 78*, 445 - 502.

Denison, E. F. (1962). *The sources of economic growth in the United States and the alternative before us*. New York: Committee for Economic Development.

Dennis, J. G., Johansen, S., & Juselius, K. (2005). CATS in RATS, version 2: Estima.

Desdoigts, A. (2004). Neoclassical convergence versus technological catch up: A contribution for reaching a consensus. *Problems and Perspective in Management, 3*.

Dhanani, S., & Hasnain, S. A. (2002). The impact of foreign direct investment on Indonesia's manufacturing sector. *Journal of the Asia Pacific Economy*, 61-94.

Dickey, D., & Fuller, W. A. (1979). Distribution of the estimates for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*, 427-431.

Dijk, M. v., & Szirmai, A. (2006). Industrial policy and technology diffusion: Evidence from paper making machinery in Indonesia. *World Development, 34*(12), 2137-2152.

Dinopoulos, E., & Sener, F. (2007). New directions in Schumpeterian growth theory. In H. Hanusch & A. Pyka (Eds.), *Elgar companion to Neo-Schumpeterian economics*. Cheltenham: Edward Elgar.

Doan, T. A. (2007). RATS version 7. 1560 Sherman Ave., Suite 520, Evanston, Il 60201: Estima.

Dollar, D., & Kraay, A. (2001). Trade, growth, and poverty. *Working Paper, Development Research Group, the World Bank, WPS2615*.

Domar, E. D. (1946). Capital expansion, rate of growth and employment. *Econometrica, 14*, 137 - 147.

Domar, E. D. (1957). *Essay in the theory of economic growth*. London: Macmillan.

Dowling, J. M., & Chin-Fang, Y. (2008). Indonesian economic development: Mirage or miracle. *Journal of Asian Economics, 19*, 474-485.

Dowrick, S., & Rogers, M. (2002). Classical and technological convergence: beyond the Solow-Swan growth model. *Oxford Economic Papers, 54*, 369 - 385.

Drysdale, P., & Yiping, H. (1997). Technology catching up and productivity growth in East Asia. *Economic Record, 73*, 201-211.

Duasa, J. (2007). Determinant of Malaysian trade balance: An ARDL bound testing approach. *Global Economic Review, 36*(1), 89-102.

Duflo, E. (2004). The medium run effects of educational expansion: evidence from a large school construction program in Indonesia. *Journal of Development Economics, 74*, 163-197.

Durlauf, S. N., Johnson, P. A., & Temple, J. R. W. (2005). Growth econometrics. In P. Aghion & S. Durlauf (Eds.), *Handbook of Economic Growth* (Vol. IA). Amsterdam: Elsevier, Chapter 8.

Easterly, W. (1997). The ghost of financing gap: how the Harrod-Domar growth model still haunts development economics. *Policy Research Working Paper, The World Bank, 1807*.

Effendy, N., & Soemantri, F. M. (2003). Foreign direct investment and regional economic growth in Indonesia: a panel data study. *Working Paper in Economics and Development Studies, Department of Economic Padjajaran University*(No. 200305).

Enders, W. (1996). *RATS handbook for econometric time series*: John Wiley & Sons, Inc.

Enders, W. (2003). *RATS programming manual*. Department of Economics, Finance and Legal Studies, Tuscaloosa, AL 35487.

Enders, W. (2004). *Applied econometric time series* (2nd ed.): John Wiley & Sons.

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation and testing. *Econometrica, 55*, 251-276.

Escot, L. (1998). Technological catch up: gradual diffusion of technology and convergence in the neoclassical growth model. *IAER, 4*(1), 24-33.

Fagerberg, J. (1994). Technology and international differences in growth rates. *Journal of Economic Literature, 32*(3), 1147-1175.

Fagerberg, J., & Verspagen, B. (2002). Technology-gaps, innovation-diffusion and transformation, and evolutionary interpretation. *Research Policy*, 1291-1304.

Feng, Y., & Wu, C. (2008). Is Chine's economic growth extraordinary or mediocare? The role of the exchange rate. *China and World Economy, 16*(1), 100-116.

Fosu, O.-A. E., & Magnus, F. J. (2006). Bounds testing approach to cointegration: An examination of foreign direct investment, trade and growth relationship. *American Journal of Applied Sciences, 3*(11), 2079-2085.

Frankel, J. A., & Romer, D. (1999). Does trade cause growth? *The American Economic Review, 83*(3), 379-399.

Frankel, M. (1962). The production function in allocation and growth: a synthesis. *American Economic Review, 23*, 677-693.

Furman, J. L., & Hayes, R. (2004). Catching up or standing still? National innovative productivity among 'follower' countries, 1978-1999. *Research Policy, 33*, 1329-1354.

Gancia, G., & Zilibotti, F. (2005). Horizontal innovation in the theory of growth and development. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of Economic Growth* (Vol. 1A, pp. 111 -166). Amsterdam, North-Holland: Elsevier B.V.

Gerschenkron, A. (1962). *Economic backwardness in historical perspective*. Cambridge, MA: Belknap Press of Harvard University Press.

Giles, D. E. A. (2005). Output convergence and international trade: time series and fuzzy clustering evidence for New Zealand and her trading partners, 1950-1992. *The Journal of International Trade and Economic Development, 14*(1), 93-114.

Godfrey, L. G. (1978). Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econmetrica, 46*, 1293-1302.

Goldsmith, R., W. (1969). *Financial structure and development*. New Haven, CT: Yale University Press.

Gray, M. (2002). Foreign direct investment and recovery in Indonesia: recent events and their impact. *IPA Backgrounder, 14*(2).

Greiner, A., Semmler, W., & Gong, G. (2005). *The forces of economic growth: a time series perspective*. New Jersey: Princeton University Press.

Griliches, Z. (1979). Issues in assessing the contribution of R&D in productivity growth. *Bell Journal of Economics, 10*, 92-116.

Groningen Growth and Development Centre and the Conference Board. (2008). Total economy database. *http://www.conference-board.org/economics/*(January).

Grossman, G. M., & Helpman, E. (1991). *Innovations and growth in the global economy*. Cambridge, Massachusetts: MIT Press.

Guest, R. S., & McDonald, I. M. (2007). Global GDP shares in the 21st century - an equilibrium approach. *Economic Modeling, 24*, 859-877.

Gundlach, E. (2007). The Solow model in the empirics of growth and trade. *Oxford Review of Economic Policy, 23*(1), 25-44.

Gylfason, T., & Zoega, G. (2007). A golden rule of depreciation. *Economic Letters, 96*, 357-362.

Ha, J., & Howitt, P. (2007). Accounting for trends in productivity and R&D: a Schumpeterian critique of semi-endogenous growth theory. *Journal of Money, Credit and Banking, 39*(4), 733-774.

Hall, R. E., & Jones, C. I. (1999). Why do some countries produce so much more output per worker than others. *The Quarterly Journal of Economics, 114*(1), 83-116.

Hamilton, J. D. (1994). *Time series analysis*. Princeton: Princeton University Press.

Han, G., Kalirajan, K., & Singh, N. (2002). Productivity and economic growth in East Asia: innovation, efficiency and accumulation. *Japan and the World Economy, 14*, 401-424.

Hanusek, E. A., & Kimko, D. D. (2000). Schooling, labor force quality, and the growth of nations. *American Economic Review, 90*, 1184-1208.

Harrod, R. F. (1939). An easy in dynamic economic theory. *Economic Journal, 49*, 14 - 33.

Harrod, R. F. (1948). *Toward a dynamic economics*. London: Macmillan.

Heston, A., Summers, R., & Aten, B. (2006). Penn World Table version 6.2, (Publication from Center for International Comparison of Production Income and Prices at the University of Pennsylvania, at: http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php:

Hill, H. (2000). *The Indonesian economy* (2nd ed.): Cambridge University Press.

Hofman, B., Zhao, M., & Ishihara, Y. (2007). Asian development strategies: China and Indonesia compared. *Bulletin of Indonesia Economic Studies, 43*(2), 171-199.

Hossain, A. (2005). The Granger-causality between money growth, inflation, currency devaluation and economic growth in Indonesia: 1954-2002. *International Journal of Applied Econometrics and Quantitative Studies, 2-3*.

Hossain, A. (2006). Sources of economic growth in Indonesia, 1966-2003. *Applied Econometric and International Development, 6*(2).

Howitt, P. (1999). Steady endogenous growth with population and R&D inputs growing. *Journal of Political Economy*(107), 715-730.

Ikhsan, M. (2006). *FDI and tax incentives in Indonesia*. Paper presented at the International Symposium on FDI and Corporate Taxation: Experiences of Asian Countries and Issues in the Global Economy.

International Monetary Fund. (2006). *World economic outlook*. Washington, DC.

International Monetary Fund. (2008). International financial statistic, *DXDATA*: International Monetary Fund.

Irmen, A., & Kuehnel, J. (2008). Productive government expenditure and economic growth. *CESifo Working Paper, No. 2314*.

Ishida, M. (2003). Industrialization in Indonesia since the 1970s. *IDE Research Paper, 5*.

Islam, N. (1995). Growth empirics: a panel data approach. *Quarterly Journal of Economics, 90*, 1127-1170.

Jacob, J., & Meister, C. (2005). Productivity gains, technology spillover and trade: Indonesia manufacturing, 1980-96. *Bulletin of Indonesia Economic Studies, 41*(1), 37-56.

James, W. E., & Ramstetter, E. D. (2008). Trade, foreign firms and economic policy in Indonesian and Thai manufacturing. *Journal of Asian Economics, 19*, 413-424.

Jarque, C. M., & Bera, A. K. (1987). A test for normality of observation and regression residuals. *International Statistical Review, 55*, 163-172.

Jin, J. C. (2006). Openness, growth and inflation: Evidence from South Korea before the economic crisis. *Journal of Asian Economics, 17*, 738-727.

Johansen, S. (1991). Estimation and hypothesis testing of cointegrating vectors in Gaussian vector autoregressive models. *Econometrica, 59*, 1551-1580.

Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford: Oxford University press.

Jones, C. I. (1995a). R&D-based models of economic growth. *Journal of Political Economy*(103), 759-784.

Jones, C. I. (1995b). Time series test of endogenous growth model. *Quarterly Journal of Economics, 110*, 495-525.

Juselius, K. (2006). *The cointegrated VAR model: methodology and application*. New York: Oxford University Press.

Kaldor, N. (1957). A model of economic growth. *Economic Journal, December*.

Kaldor, N. (1961). Capital accumulation and economic growth. In F. A. Lutz & D. C. Hague (Eds.), *The theory of capital: proceeding of a conference held by International Economics Association*. New York: St. Martin's Press.

Kan, E. O., & Omay, T. (2006). Empirical issues and example: Growth theory. *International Business and Economic Research Journal, 5*(8).

Kang, S. J. (2002). Relative backwardness and technology catching up with scale effects. *Journal of Evolutionary Economics, 12*, 425-441.

Karas, G. (2001). Long run economic growth in Europe: is it endogenous or neoclassical? *International Economic Journal, 15*(2), 63-76.

Keong, C. C., Yusop, Z., & Sen, V. L. K. (2005). Export-led growth hypothesis in Malaysia: An investigation using bounds test. *Sunway Academic Journal, 2*, 13-22.

Keynes, J. M. (1936). *The general theory of employment, interest and money*. London: Macmillan.

Kim, J. I., & Lau, L. J. (1994). The sources of economic growth of East Asian newly industrialized countries. *Journal of the Japanese and International Economies, 8*, 235-271.

King, A., & Ramlogan, C. (2008). Is Latin America catching up? A time series approach. *Review of Development Economics, 12*(2), 397-415.

King, R. G., & Levine, R. (1993a). Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics, 108*(3), 717 - 737.

King, R. G., & Levine, R. (1993b). Finance, entrepreneurship and growth. *Journal of Monetary and Economics, 32*, 513-542.

King, R. G., & Rebelo, S. (1990). Public policy and economic growth: developing neoclassical implications. *Journal of Political Economy, 98*, 908-931.

Klenow, P. J., & Rodrigues-Clare, A. (2005). Externalities and growth. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth*. Amsterdam, the Netherland: Elsevier B.V., .

Klenow, P. J., & Rodriques-Clare, A. (1997). The neoclassical revival in growth economics: has it gone too far? *NBER Macroeconomic Annual, 12*, 73-102.

Klump, R., McAdam, P., & Willman, A. (2007). The long-term suCESs of the neoclassical growth model. *Oxford Review of Economic Policy, 23*(1), 94-114.

Kocherlakota, N. R., & Yi, K.-M. (1996). A simple time series test of endogenous vs exogenous growth model: an application to the United States. *The Review of Economic Statistics, 78*(1), 126-134.

Kong, T. (2007). A selective review of recent development in the economic growth literature. *Asian Pacific Economic Literature*, 1-33.

Krugman, P. (1994). The myth of Asia's miracle. *Foreign Affairs, 73*(6), 62-78.

Lau, L. J., & Park, J. (2003). *The sources of East Asian economic growth revisited*. Paper presented at the Conference on International and Development Economics in Honor Henry Y. Wan, Jr.

Lau, S. H. P. (1994). Unit roots and cointegration in endogenous growth model: result and interpretation. *Working Paper, Australia National University, Canberra, No. 268*.

Lau, S. H. P. (1997). Using stochastic growth models to understand unit roots and breaking trends. *Journal of Economic Dynamic and Control, 21*, 1645-1667.

Lau, S. H. P. (1999). *I*(0), integration and cointegration out: time series properties of endogenous growth models. *Journal of Econometrics, 93*, 1 - 24.

Lau, S. H. P. (2008). Using an error-correction model to test whether endogenous long-run growth exists. *Journal of Economic Dynamic and Control, 32*, 648-676.

Lau, S. H. P., & Sin, C.-Y. (1997). Observational equivalence and a stochastic cointegration test of the neoclassical and Romer's increasing return models. *Economic Modeling, 14*, 39-60.

Leamer, E. E. (1995). *A trade economist's view of US wages and globalization.* Paper presented at the Brooking Conference

Lee, H.-A., Lim, K.-P., & Azali, M. (2005). Income disparity between Japan and ASEAN-5 economies: converge, catching up or diverge? *Economics Bulletin, 6*(13), 1-20.

Levine, R. (1997). Financial development and economic growth: Views and agenda. *Journal of Economic Literature, 15*, 688-726.

Levine, R. (2005). Finance and growth: theory and evidence. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (Vol. IA). Amsterdam: Elsevier B.V.

Lim, L.-K. (1999). *Modeling economic growth in South-East Asia.* Unpublished thesis, The University of Western Australia, Perth.

Lim, L. K., & McAleer, M. (2002). Economic growth and technology catching up by Singapore to the USA. *Mathematics and Computers in Simulation, 59*(1-3), 133-141.

Lim, L. K., & McAleer, M. (2004). Convergence and catching up in ASEAN: a comparative analysis. *Applied Economics, 36*, 137-153.

Lipsey, R. E., & Sjoholm, F. (2004). Foreign direct investment, education and wages in Indonesia manufacturing. *Journal of Development Economics*, 415-422.

Liwan, A., & Lau, E. (2007). Managing growth: the role of export, inflation and investment in three ASEAN neighboring countries. *Munich Personal RePec Archive*(No. 3952).

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3-42.

Lucas, R. E., Jr. (2000). Some macroeconomics for the 21st century. *Journal of Economics Perspectives, 14*, 159-168.

MacDonald, R. (2000). The role of the exchange rate in economic growth: A Euro-zone perspective. *NBB Working Paper, 9*.

Mainen, G., Verbiest, P., & Wolf, P.-P. d. (1998). Perpetual inventory method: Service lives, Discard Patterns and depreciation methods. *Statistical Netherlands, Department of National Accounts, July*

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics, 107*(2), 407-437.

Marks, S. V. (2004). Fiscal sustainability and solvency: theory and recent experience in Indonesia. *Bulletin of Indonesian Economic Studies, 40*(2), 227-242.

McQuinn, K., & Whelan, K. (2007). Conditional convergence and the dynamics of the capital-output ratio. *Journal of Economic Growth, 12*, 159-184.

Meeks, R. (2005). *MPhil macroeconomic: economic growth* (Version 4 ed.): Nuffield College.

Miles, W. (2008). Exchange rate, inflation and growth in small, open economies: a difference-in-difference approach. *Applied Economics, 40*, 341-348.

Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy, 66*, 281-302.

Ministry of Finance (2007). Model of Finance - MODFI. Jakarta: Fiscal Policy Office.

Mountford, A. (2006). International trade and growth miracles: the implications of nonhomothetic preferences. *Review of International Economics, 14*(4), 645-657.

Mulligan, C. B., & Sala-I-Martin, X. (1993). Some evidence on the links between aggregate income and human capital. University of Chicago. Mimeograph.

Myrdal, G. (1957). *Economic theory and underdeveloped region*. London: Duckworth.

Nahar, S., & Inder, B. (2002). Testing convergence in economic growth for OECD countries. *Applied Economics, 34*, 2011-2022.

Narayan, P. K. (2004). Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji. *Discussion Papers, Department of Economics, Monash University, ISSN 1441-5429*.

Nedomlelova, I. (2007). Selected models of economic growth versus the theory of regional development. from http://alnus.kin.tul.cz/~vyzkum/wd/download/2007/VybraneModelyEkonomickehoRustu.pdf

Nelson, R. R., & Pack, H. (1996). *Firm competencies, technological catch up, and the Asian miracle*. Paper presented at the Conference in Honour of Gustav Ranis.

Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technology diffusion, and economic growth *American Economic Review, 56*, 69-75.

Ng, S., & Perron, P. (2001). Lag length selection and the construction of unit root test with good size and power. *Econometrica, 69*(6), 1519-1554.

Osterwald-Lenun, M. (1992). A note with quintiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics. *Oxford Bulletin of Economics and Statistics, 54*, 461-471.

Pagano, M. (1993). Financial market, growth: an overview. *European Economic Review, 37*(613-622).

Papageorgiou, C. (2002). Technology adoption, human capital and growth. *Review of Development Economics, 6*(3), 351-368.

Park, D. (2000). Is the Asia-Australasia region a convergence club? *Asian Economic Journal, 14*, 415-419.

Park, D. (2003). An empirical examination of income convergence in the Asia-Pacific region. *Journal of Asian Economies, 14*, 497-502.

Pattillo, C., Poirson, H., & Ricci, L. (2005). What are the channel through which external debt affect growth? *IMF Working Paper, WP/04/15*.

Paudel, R., & Shrestha, M. B. (2006). The role of external debt, total trade and labour force in economic growth: The case of Nepal. *The Business Review, Cambridge, Summer*(5, 2), 130.

Peretto, P. F. (2003). Fiscal policy and long run growth in R&D based models with endogenous market structure. *Journal of Economic Growth, 8*, 325-347.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of the level relationship. *Journal of Applied Econometrics, 16*, 289-326.

Phillips, P., & Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. *Econometrica, 58*, 165-193.

Phillips, P. C. B., & Sul, D. (2007). Transition modeling and econometric convergence tests. *Econometrica, 75*(6), 1771-1855.

Prodromidis, K. P., & Podromidis, p. I. (2008). Return to education: the Greek experience, 1988-1999. *Applied Economics, 40*, 1023-1030.

Psacharopoulos, G. (1994). Returns to investment in education: a global update. *World Development, 22*(9), 1325-1343.

Psacharopoulos, G., & Arrigada, A. M. (1986). The educational composition of the labor force: An international comparison. *International Labour Review, 125*(561-574).

Psacharopoulos, G., & Patrinos, H. A. (2002). Returns to investment in education: a further update. *World Bank Policy Research Working Paper, 2881*.

Ramsay, F. (1928). A mathematical theory of saving. *Economic Journal, December*.

Ramsey, J. B. (1969). Tests for specification errors in classical linear least squares analysis. *Journal of the Royal Statistical Association, Series B*(71), 350-371.

Rebelo, S. (1991). Long run policy analysis and long run growth. *Journal of Political Economy, 99*, 500-521.

Rodrigo, G. C., & Thorbecke, E. (1997). Sources of growth: A reconstruction and general equilibrium application to Indonesia. *World Development, 25*(10), 1609-1625.

Rodriquez, F., & Rodrik, D. (2000). Trade policy and economic growth: a skeptic's guide to cross-national evidence. In B. S. Bernanke & J. J. Rotemberg (Eds.), *NBER Macroeconomic Annual*: Cambridge: MIT Press.

Rogers, M. (2003). A survey of economic growth. *The Economic Record, 79*(244), 112 - 135.

Rogers, M. (2004). Absorptive capability and economic growth: how do countries catch up? *Cambridge Journal of Economics, 28*(4), 577-596.

Romer, P. M. (1986). Increasing returns and long run growth. *Journal of Political Economy, 94*(5), 1002-1037.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*, S71-S102.

Romer, P. M. (1994). The origin of endogenous growth. *The Journal of Economic Perspectives, 8*(1), 3-22.

Sagerstrom, P. S., Anant, T. C. A., & Dinopoulos, E. (1990). A Schumpeterian model of product life circle. *American Economic Review, 80*, 1077-1091.

Sarel, M. (1997). Growth and productivity in ASEAN countries. *IMF Working Paper*(No. WP/97/97).

Sato, R. (1964). The Harrod-Domar model vs Neo-Classical model. *The Economic Journal, 74*(294), 380 - 387.

Schclarek, A. (2004). Debt and economic growth in developing and industrial countries. *Working Paper, Lund University, Department of Economics*(December 15, 2004).

Schumpeter, J. (1934). *The theory of economic development*. Cambridge, MA: Harvard University Press.

Schumpeter, J. (1939). *Business cycles*. Philadelphia, PA: Porcupine Press.

Schumpeter, J. (1942). *Capitalism, socialism, and democracy*. Harper, New York.

Scoppa, V. (2009). Technological catch-up or neoclassical convergence? Identifying the channels of convergence for Italian regions. *Munich Personal RePec*

Archive, 13051, at: http://mpra.ub.uni-muenchen.de/13051/13051/MPRA_paper_13051.pdf.

Sedgley, N. H. (2006). A time series test of innovation-driven endogenous growth. *Economic Inquiry, 44*(2), 318-332.

Seetanah, B., Padachi, K., & Durbary, R. (2007). External debt and economic growth: a vector error correction approach. *International Journal of Business Research*(September).

Shin, Y. (1994). A residual-based test of the null of cointegration against the alternative of no cointegration. *Econometric Theory, 10*, 91-115.

Sidrauski, M. (1967). Inflation and economic growth. *Journal of Political Economy, 75*, 796-810.

Sigit, H. (2004). Indonesia. In N. Oguchi (Ed.), *Total Factor Productivity: Survey Report* (pp. 98-133). Tokyo: Asian Productivity Organization.

Simorangkir, I. (2006). The openness and its impact to Indonesian economy: A SVAR approach. A paper presented at the Graduate program in Economic Development's 50th Anniversary Conference, held at Vanderbilt University, Nashille TN USA, November 9-11, 2006, at:http://www.vanderbilt.edu/econ/conference/gped-conference-06/papers/iskandar.pdf

Singh, T. (2008). Financial development and economic growth nexus: a time series evidence from India. *Applied Economics, 40*, 1615-1627.

Siregar, R., & Rajaguru, G. (2005). Sources of variation between the inflation rates of Korea, Thailand and Indonesia during the post-1997 crisis. *Journal of Policy Modeling, 27*, 867-884.

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations*. New York: Random House, 1937.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 70*(1), 65-94.

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics, 39*(3), 312-320.

Solow, R. M. (2000). *Growth theory: an exposition* (Second ed.): Oxford University Press.

St. Aubyn, M. (1999). Convergence across industrialized countries (1890-1989): New result using time series methods. *Empirical Economics, 24*, 23-44.

Stiglitz, J. (1990). Comments: some retrospective views on the growth theory. In P. Diamond (Ed.), *Growth/productivity/unemployment: essays to celebrate Bob Solow's birthday* (pp. 50-68). Cambridge: MIT Press.

Stock, J. H., & Watson, M. W. (1988). Testing for common trends. *Journal of American Statistical Association, 83*, 1097-1107.

Stokke, H. E. (2004). Technology adoption and multiple growth paths: an intertemporal general equilibrium analysis of the catch up process in Thailand. *Review of World Economics, 140*(1), 80-109.

Strulik, H. (2005). The role of human capital and population growth in R&D-based models of economic growth. *Review of International Economics. 13(1),*129-145.

Swan, T. V. (1956). Economic growth and capital accumulation. *Economic Record, 32*, 334 - 361.

Tanuwidjaja, E., & Choy, K. M. (2006). Central bank credibility and monetary policy in Indonesia. *Journal of Policy Modeling, 28*, 1011-1022.

Taylor, L., & Rada, C. (2007). Can the poor countries catch-up? mixed results from extended source of growth projections from the early 21st century. *Metroeconomica, 58*(1), 127-154.

Temple, J. R. (2003). The long run implication of growth theories. *Journal of Economic Survey, 17*(3 497 - 510).

Thangavelu, S. M., & Rajaguru, G. (2004). Is there an export or import-led productivity growth in rapidly developing Asian countries? a multivariate VAR analysis. *Applied Economics 36*, 1083-1093.

Thirwall, A. P. (2002). *The Nature of Economic Growth: an alternative framework for understanding the performance of nations.* Cheltenham, UK: Edward Elgar Publishing limited.

Timmer, M. P. (1999). Indonesia's ascent on the technology ladder: capital stock and total factor productivity in Indonesia manufacturing, 1975-95. *Bulletin of Indonesia Economic Studies, 35*(1), 75 - 97.

Timmer, M. P., & Vries, G. J. d. (2007). A cross-country database for sectoral employment and productivity in Asia and Latin America, 1950-2005 [Electronic Version], from http://www.eco.rug.nl/ggdc./dseries/10-sector.html

Tobin, J. (1965). Money and economic growth. *Econometrica, 33*, 671-684.

Toda, Y., & Yamamoto, T. (1994). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics, 66*, 225-250.

Tsai, P.-L., & Huang, C.-H. (2007). Openness, growth and poverty: The case of Taiwan. *World Development, 35*(11), 1858-1857.

UNCTAD. (2008). United Nation Conference on Trade and Development: FDI Stat [Electronic Version], from http://stats.unctad.org/FDI/TableViewer/tableView.aspx?ReportId=1254

Uzawa, H. (1965). Optimum change in an aggregative model of economic growth. *International Economic Review, 6*(1), 18-31.

Van der Eng, P. (2006). *Accounting for Indonesia's economic growth: Recent past and near future*. Paper presented at the Seminar on World Economic Performance: Past, Present and Future, Long Term Performance and Prospect of Australia and Major Asian Economies, *on the occasion of Angus Maddison's 80th birthday*.

Van der Eng, P. (2008a). Capital formation and capital stock in Indonesia, 1950-2007. *Working Paper in Trade and Development, No. 2008/24*, The Arndt-Corden Division of Economics Research School of Pacific and Asian Studies, ANU College of Asia and the Pacific.

Van der Eng, P. (2008b). Education data estimates for Indonesia: 1880-2005

van Leeuwen, B. (2007). *Human capital and economic growth in India, Indonesia, and Japan: a quantitative analysis, 1890-2000.* PhD Thesis, Utrecht University, at http://www.basvanleeuwen.net/bestanden/proefschrift/proefschriftbvl.pdf.

Verspagen, B. (1991). A new empirical approach to catching up or falling behind. *Structural Change and Economic Dynamics, 2*, 359-380.

Vial, V. (2006). New estimates of total factor productivity growth in Indonesian manufacturing. *Bulletin of Indonesian Economic Studies, 42*(3), 357-369.

Wang, J.-H. (2007). From technological catch up to innovation-based economic growth: South Korea and Taiwan compared. *Journal of Development Studies, 43*(6), 1084 - 1104.

Weil, D. N. (2005). *Economic growth*: Addison-Wesley.

Whistler, D., White, K. J., Wong, S. D., & Bates, D. (2004). Shazam econometric software version 10.

Wie, T. K. (2001). The role of foreign direct investment in Indonesia's industrial technology development. *International Journal of Technology Management, 22*(5/6), 583-598.

Wie, T. K. (2006). Policies for private sector development in Indonesia. *Asian Development Bank (ADB) Institute Discussion Paper, 46*.

Wolff, E. N., & Gittleman, M. (1993). The role of education in productivity convergence: does higher education matter?,. In A. Szirmai, B. V. Ark & D. Pilat (Eds.), *Explaining economic growth: essays in honour of Angus Maddison* (pp. 147 - 167). Amsterdam: North-Holland.

Woo, W. T., Glassburner, B., & Nasution, A. (1994). *Macroeconomic policies, crises and long term growth in Indonesia, 1965-90*: The World Bank, Washington, D.C.

Wooldridge, J. M. (2008). *Introductory econometrics: a modern approach* (Vol. 4e). Mason, OH: South-Western Cencage Learning.

World Bank. (2008). World Bank World Table: DX Data, James Cook University accessed data.

World Bank. (1993). *The East Asia Miracle*. New York: Oxford University Press.

World Bank. (2007). *Investing in Indonesia's education: allocation, equity and efficiency of public expenditures* (Vol. January): Poverty Reduction and Economic Management Unit, East Asia and Pacific Region.

Yang, Y. Y., & Yi, M. H. (2008). Does financial development cause economic growth? Implication for policy in Korea. *Journal of Policy Modeling, 30*, 827-840.

Yoo, S. H. (2006). The causal relationship between electricity and consumption and economic growth in the ASEAN countries. *Energy Policy, 34*, 3573-3582.

Young, A. (1928). Increasing returns and economic progress. *Economic Journal, December*.

Young, A. (1992). A tale of cities factors accumulation and technical change in Hong Kong and Singapore. In O. J. Blanchard & S. Fischer (Eds.), *NBER Macroeconomic Annual 1992* (pp. 13-52). Cambridge, Massachusetts: MIT Press.

Young, A. (1994). Lessons from the East Asian NICs: a contrarian view. *European Economic Review, 38*, 964-973.

Young, A. (1995). The tyranny of numbers: confronting the statistical realities of the East Asian growth experience. *Quarterly Journal of Economics, 110*, 641 - 680.

Zhang, Z. (2003). Can the rest of East Asia catch up with Japan: some empirical evidence. *Japan and the World Economy, 15*, 91 - 110.

Zhu, S., & Oxley, L. (2001). Testing model of growth - a two sector model of the USA. *Applied Economic Letters, 8*, 325-329.

Zhu, S., & Oxley, L. (2002). New Zealand economic growth-endogenous or exogenous? *Mathematic and Computer in Simulation, 59*, 125-131.

Zivot, E., & Andrews, D. W. K. (1992). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business and Economic Statistic, 10*, 251-270.

Zuleta, H. (2007). Biased innovations in the Harrod-Domar model. *Revista de Economia del Rosario, 10*(2), 153 - 169.

Appendices

Appendix 1

Table A1
Data used for investigating the characteristic of the long run growth using regression equation of time series

Year	RGDPL	OP	IN	PG
1960	1098.52	56.14	5.35	
1961	1113.69	61.87	7.42	2.23
1962	1061.71	59.22	6.94	1.98
1963	1026.09	53.16	5.37	1.98
1964	1068.09	55.6	5.76	1.99
1965	1018.75	54.62	6.17	1.99
1966	1055.97	50.79	6.56	1.99
1967	1017.83	54.53	5.45	2.00
1968	1119.40	53.27	5.92	2.00
1969	1180.77	57.49	6.99	2.00
1970	1279.19	60.18	8.39	2.00
1971	1364.43	62.83	9.35	2.00
1972	1514.28	66.12	9.8	2.30
1973	1693.67	70.57	10.02	2.31
1974	1715.74	76.89	11.52	2.35
1975	1733.78	75.58	12.76	2.39
1976	1863.45	80.25	12.28	2.46
1977	1978.19	77.51	13.09	2.47
1978	2067.06	77.75	14.07	2.47
1979	2066.57	81.56	14.34	2.44
1980	2082.79	80.82	16.52	2.38
1981	2075.14	87.46	18.03	2.27
1982	1960.39	87.87	21.09	2.20
1983	2095.92	80.08	19.57	2.14
1984	2245.64	72.50	18.28	2.08
1985	2213.99	71.18	20.98	2.00
1986	2317.18	72.96	20.79	1.91
1987	2416.49	74.33	19.5	1.84
1988	2610.87	61.89	16.88	1.82
1989	2792.85	63.02	17.4	1.82
1990	2917.42	66.25	17.84	1.82
1991	3123.35	71.32	17.89	1.81
1992	3313.18	73.56	17.45	1.81
1993	3466.98	72.66	17.44	1.80
1994	3575.54	79.31	19.38	1.80
1995	3695.11	85.9	20.83	1.80
1996	3907.01	85.56	20.31	1.79
1997	3958.08	92.32	20.94	1.77
1998	***… continued***			

Table A1
Data used for investigating the characteristic of the long run growth using regression equation of time series
Continued….

Year	RGDPL	OP	IN	PG
1998	3604.03	102.38	13.78	1.73
1999	3595.57	65.71	11.55	1.70
2000	3771.86	76.39	11.03	1.72
2001	3826.47	77.99	11.63	1.60
2002	3975.58	72.03	10.44	1.57
2003	4121.02	70.57	9.83	1.54
2004	4064.21	81.71	10.56	1.25

Notes: RGDPL: Real per capita GDP Laypeyres (in US$),
OP: Openness, PG: Population growth.
Source: Penn World Table (Heston et. al., 2006)

Appendix 2

Table A2
Data used for investigating the characteristic of the long run growth using cointegration and ECM

Year	*y*	*i*
1960	1623.395	40.427
1961	1723.623	61.508
1962	1712.470	46.962
1963	1642.392	80.686
1964	1661.117	114.913
1965	1639.286	53.204
1966	1648.242	38.324
1967	1628.755	86.192
1968	1782.607	100.064
1969	1871.240	145.452
1970	1976.294	181.138
1971	2064.489	216.147
1972	2173.587	292.644
1973	2328.506	307.239
1974	2460.639	317.258
1975	2551.901	372.579
1976	2638.758	377.866
1977	2800.853	396.947
1978	2991.836	438.454
1979	3136.583	549.030
1980	3340.322	629.120
1981	3540.823	727.743
1982	3511.680	727.078
1983	3737.848	892.514
1984	3932.909	787.023
1985	3995.765	829.535
1986	4158.116	861.244
1987	4301.414	961.793
1988	4494.896	1001.937
1989	4817.287	1252.984
1990	5157.556	1262.346
1991	5522.333	1383.250
1992	5824.638	1380.837
1993	6150.068	1399.829
1994	6515.961	1551.844
1995	6963.870	1709.230
1996	***…continued***	

Table A2
Data used for investigating the characteristic of the long run growth using cointegration and ECM
(c*ontinued …*)

Year	*y*	*i*
1996	7392.284	1758.366
1997	7634.024	1990.705
1998	6542.649	997.471
1999	6506.914	636.933
2000	6737.789	1498.868
2001	6891.438	1592.167
2002	7106.212	1475.731
2003	7346.824	1805.872
2004	7613.128	1796.795
2005	7937.403	1991.361
2006	8279.410	2082.181

Notes: ***y*:** Per capita GDP (IDR thousand)
***i*:** Per capita gross capita formation (IDR thousand)
Source: WBWT (World-Bank, 2008)

Table A3
Data used for investigating technology catching up by Indonesia towards Japan and USA

Year	Japan			USA			Indonesia					
	GDP	GCF	Labor	GDP	GCF	Labor	GDP	GCF	Labor	HE	SS	MG
1960	669755	223698.2	44360	2545850	478619.8	68511.88	18449	1697.308	33720.28	77.2	748164	
1961	750417	281406.4	44980	2613656	470458.1	68563.91	19575	2329.425	34327.62	79.4	756557	0.346983
1962	817272	284410.7	45560	2749689	519691.2	69703.64	19949	1296.685	34968.3	87.1	922454	-0.0192
1963	886524	304077.7	45950	2861553	546556.6	70685.27	19500	1852.5	35640.47	82.7	1122991	-0.26591
1964	990041	348494.4	46550	3020446	582946.1	72247.27	20173	2844.393	36342.29	78.1	1329786	0.086667
1965	1047659	339441.5	47300	3189829	650725.1	74023.41	20364	1588.392	37071.95	87	1455272	-0.07975
1966	1159115	382508	48270	3379559	689430	76260.84	20944	1110.032	37830.25	94.2	1453834	-0.04444
1967	1287569	463524.8	49200	3471587	666544.7	78028.97	21180	1969.74	38618	90.7	1547376	0.283721
1968	1453440	543586.6	50020	3617123	698104.7	79632	23728	2420.256	39433.38	86.3	1156214	0.070652
1969	1634799	624493.2	50400	3713653	724162.3	81575.25	25503	3468.408	40274.6	84.3	1951739	0.209814
1970	1809865	718516.4	50940	3721700	669906	82003.52	27582	4357.956	41139.89	77.7	1910380	0.118881
1971	1894910	689747.2	51210	3850500	735445.5	82321.72	29512	5430.208	42350.53	74.2	1980608	0.3125
1972	2054339	741616.4	51260	4065800	809094.2	84760.29	31838	6940.684	43613.12	68.5	2042977	0.14
1973	2219356	858890.8	52590	4304800	891093.6	87559.08	34951	7269.808	44914.28	67.1	2127354	0.340017
1974	2192164	833022.3	52370	4284400	852595.6	89196.13	37836	7378.02	46240.34	64	2435374	0.321696
1975	2259936	754818.6	52230	4276900	744180.6	88197.49	40176	9521.712	47577.37	64.3	2695577	0.116509
1976	2349768	761324.8	52710	4507000	860837	91063.32	42582	10262.26	49006.09	63.5	3070307	0.1673
1977	2452931	770220.3	53420	4717000	971702	94316.41	46259	10824.61	50402.97	61	3500000	0.044517
1978	2582248	813408.1	54080	4981900	1096018	98330.98	50518	12073.8	51780	62.3	4000000	0.126819
1979	2723860	901597.7	54790	5140400	1141169	101077.7	54101	13417.05	51004	57.6	4495026	0.110701
1980	2800607	918599.1	55360	5128000	1040984	101576.1	58821	14175.86	51553	51.4	5367107	0.097453
1981	2882761	913835.2	55810	5257400	1119826	102721.8	63614	16984.94	59123	57.2	6027908	0.338042
1982	2962451	900585.1	56380	5153600	963723.2	101884.3	64316	17879.85	57803	59.5	6730423	0.01414
1983	***….continued***											

Table A3

Data used for investigating technology catching up by Indonesia towards Japan and USA (*continued…*)

Year	Japan			USA			Indonesia					
	GDP	GCF	Labor	GDP	GCF	Labor	GDP	GCF	Labor	HE	HC	MG
1983	3010200	854896.8	57330	5386300	1007238	103208.1	69751	21832.06	57811	59.8	7086448	-0.02714
1984	3104086	875352.3	57660	5774000	1235636	107401.8	74754	20034.07	60084	59.5	7668889	-0.0751
1985	3261848	936150.4	58070	6011000	1220233	109564.2	77353	21658.84	62458	59.1	8363154	0.052893
1986	3358356	957131.5	58530	6217200	1224788	112025.7	81967	24180.27	68338	60.4	10295636	0.041601
1987	3485806	1010884	59110	6425100	1246469	114881.6	86311	26065.92	70403	58.8	10240334	0.019781
1988	3721612	1161143	60110	6690000	1251030	117374.2	91797	26437.54	72518	59.9	10365886	-0.18696
1989	3918520	1265682	61280	6926300	1295218	119740.7	100136	32644.34	73425	55.8	9883371	0.115656
1990	4122341	1364495	62490	7055000	1248735	121135.6	109150	33509.05	75851	58.9	9556682	0.231568
1991	4260468	1393173	63690	7041300	1140691	120137.2	118895	37570.82	76423	58.4	9445498	0.157268
1992	4301879	1333582	64360	7276200	1193297	120898.2	127480	38881.4	78518	57.8	10907290	0.087025
1993	4312530	1276509	64500	7472000	1270240	122667.5	136727	40334.47	79210	58.5	11324697	0.041672
1994	4359909	1238214	64530	7775500	1407366	125538.2	147037	45728.51	82039	59.7	12202854	0.202928
1995	4445371	1262485	64570	7972800	1443077	127453.6	159382	50842.86	80110	61.6	13079115	0.2094
1996	4567445	1319992	64860	8271400	1538480	129349.2	171564	52670.15	85702	62.4	14209974	0.068702
1997	4639177	1317526	65570	8647600	1686282	132319.1	179627	57121.39	85406	61.7	14479800	0.147159
1998	4544104	1195099	65140	9012500	1802500	134356.7	156048	26216.06	87672	67.8	16941778	-0.05293
1999	4537665	1125341	64620	9417100	1911671	136535.4	157282	17930.15	88817	73.9	17217756	-0.40672
2000	4667448	1185532	64460	9764800	2001784	138481.3	165021	36634.66	89838	60.7	17329609	0.259287
2001	4676054	1159661	64120	9838900	1849713	138582.8	171033	38482.43	90807	62.3	12841940	0.0418
2002	4688318	1083001	63300	9997600	1809566	138214.4	178729	38248.01	91647	65	13107485	-0.04252
2003	4754589	1084046	63160	10249800	1855214	139338	187273	47941.89	92811	58.9	12922865	0.015639
2004	4885068	1123566	63290	10651700	2013171	140844	196694	47403.25	93722	62.9	13119769	0.266607
2005	4978244	1164909	63560	10995800	2122189	143280	207872	51136.51	93958	63	13802736	0.170667
2006	5087765		63820	11314678		145951	219271	53940.67	95177	62		0.075756

Notes: GDP: gross national product (US$ Million), GCF: gross capital formation (US$ Million), Labor (Thaousand), HE: Household consumption expenditure (per cent of GDP), HC: Number of secondary school enrolment, MG: Import growth.

Source: GDP, GCF, HC and MG are from WBWT (World-Bank, 2008), Labor is from Total Economy Database (GGDCCB, 2008), HCis from Van der Eng (2008b)

Appendix 4

Table A4
Data used for investigating income level catching up by Indonesia towards Japan and USA

Year	Per capita income			Per worker income		
	Japan	USA	Indonesia	Japan	USA	Indonesia
1960	7118	14091	196	15057.62	37272.28	547.1188
1961	7904	14229	204	16638.53	38162.25	570.2405
1962	8528	14741	204	17890.14	39477.15	570.4881
1963	9157	15121	195	19241.39	40474.94	547.1308
1964	10120	15741	197	21211.24	41810.38	555.0833
1965	10595	16417	195	22089.64	43092.17	549.3102
1966	11616	17194	196	23948.54	44315.78	553.6311
1967	12783	17470	193	26099.7	44491	548.449
1968	14382	18022	212	28979.01	45422.98	601.7237
1969	15845	18323	222	32349.23	45524.26	633.2278
1970	17345	18150	235	35433.77	45384.64	670.4442
1971	17928	18542	245	36903.18	46773.8	696.8508
1972	19166	19371	258	39969.02	47968.22	730.0097
1973	20535	20314	276	42087.56	49164.52	778.1712
1974	19899	20034	292	41746.53	48033.48	818.2465
1975	20189	19803	303	43152.52	48492.31	844.435
1976	20837	20671	313	44459.25	49493.03	868.9124
1977	21543	21418	333	45794.31	50012.51	917.7832
1978	22474	22382	355	47620.21	50664.6	975.6277
1979	23508	22841	372	49580.78	50855.91	1060.721
1980	23981	22568	397	50452.89	50484.34	1140.981
1981	24503	22911	420	51514.17	51180.96	1075.96
1982	25010	22246	417	52403	50582.89	1112.676
1983	25241	23039	444	52365.27	52188.73	1206.535
1984	25864	24484	467	53689.46	53760.74	1244.158
1985	27012	25264	474	56019.86	54862.82	1238.48
1986	27643	25891	494	57224	55497.96	1199.435
1987	28551	26518	511	58812.84	55928.03	1225.956
1988	30353	27362	534	61746.8	56997.21	1265.851
1989	31828	28062	572	63772.49	57844.16	1363.786
1990	33369	28263	612	65790.53	58240.53	1439.005
1991	34381	27833	656	66713.86	58610.5	1555.749
1992	34629	28366	692	66661.05	60184.54	1623.577
1993	34629	28747	730	66681.05	60912.63	1726.133
1994	34890	29550	774	67382.29	61937.34	1792.27
1995	35439	29942	827	68619.11	62554.54	1989.539
1996	36318	30704	878	70068.72	63946.3	2001.855
1997	36792	31716	906	70272.37	65354.14	2103.213
1998	***…continued***					

Table A4
Data used for investigating income level catching up by Indonesia towards Japan and USA
(*continued…*)

Year	Per capita income			Per worker income		
	Japan	USA	Indonesia	Japan	USA	Indonesia
1998	35947	32671	777	69493.94	67078.92	1779.907
1999	35828	33748	773	69898.89	68971.85	1770.855
2000	36789	34600	800	72131.79	70513.47	1836.862
2001	36776	34495	818	72793.29	70996.53	1886.848
2002	36787	34699	844	73834.88	72333.99	1951.357
2003	37227	35247	872	75313.13	73700.64	2017.778
2004	38236	36275	904	76888.7	75998.27	2099.091
2005	38962	37084	942	78552.69	77096.77	2210.988
2006	39824	37791	983			

Notes : Per capita income and per worker income are in US$

Sources : Per capita income is real GDP per capita from WBWT (World-Bank, 2008), per worker income is real GDP per capita (World-Bank, 2008) divided by number of employment (GGDCCB, 2008)

Appendix 5

Table A5

Data used for investigating the driving forces of the level and the growth rate of real per capita income in Indonesia

Year	Y	K	L	FDI	X	M	ITR	IFR	EDR	Pop	JPN	USA	ERD	INS	GET
1970	1872.7	97059.46	41139.89	2012523	103100.2	33961.85	21	12	0.28	117537	0.108	0.002	0.11	26067.38	16066.4
1971	1956.4	110493.5	42350.53	6365902	119914.9	43621.36	21	4.4	0.30	120389	0.048	0.032	0.08	27335	18592.8
1972	2059.8	131063.8	43613.12	9940204	143006.2	56273.3	15	6.5	0.33	123360	0.086	0.059	0.06	30780.03	23733.7
1973	2206.6	152218.3	44914.28	13901848	171203.9	67310.1	12	31	0.28	126410	0.080	0.062	0.00	31768.73	28968.0
1974	2331.8	173510.7	46240.34	11293581	186309.7	89037.24	12	41	0.23	129499	-0.014	-0.004	0.00	33912.62	36708.9
1975	2418.3	199869.3	47577.37	17877597	175452.6	99239.45	12	19	0.23	132589	0.032	-0.008	0.00	39976.5	41866.7
1976	2500.6	225713.7	49006.09	18963674	197625	107291.3	12	20	0.22	135903	0.040	0.052	0.00	41849.1	41460.6
1977	2651.2	252641.3	50402.97	18226336	225976.7	120976.8	9	11	0.22	139096	0.044	0.050	0.00	46590.05	42562.9
1978	2835.2	283220.6	51780	19965556	228822.9	98069.74	6	8.1	0.22	142204	0.054	0.055	0.07	50664.84	50222.9
1979	2924.7	323272.7	51004	25522555	239282.7	149146.2	6	16	0.26	145262	0.056	0.028	0.41	52883.19	69955.1
1980	3103.5	372582.9	51553	22655964	228021.9	171105.9	6	18	0.23	148303	0.027	0.000	0.01	61148.31	87177.8
1981	3523.0	424350.8	59123	20931315	215096.2	225876.5	6	12	0.19	151305	0.028	0.029	0.01	66534.57	97211.7
1982	3502.1	477259.2	57803	20977103	195570.4	229421.1	6	9.5	0.20	154245	0.030	-0.009	0.05	68883.59	92922.9
1983	3737.9	551395.4	57811	27328198	202517.9	201043.6	6	12	0.27	157157	0.017	0.031	0.37	72251.74	108303.2
1984	3932.9	612460.6	60084	29105990	222305.6	204895.2	16	11	0.27	160075	0.032	0.081	0.13	75560.4	92873.9
1985	4053.8	675013.8	62458	31789529	208128.3	219042.6	18	4.7	0.31	163036	0.053	0.038	0.08	79964.72	118430.5
1986	4482.7	737803.8	68338	36250952	253559.5	241887.8	15.4	5.8	0.35	166015	0.029	0.025	0.15	84535.29	107488.1
1987	4432.8	812389.7	70403	45248589	279392.5	236263.5	16.8	9.3	0.50	168990	0.040	0.039	0.28	89917.05	116920.7
1988	4486.7	894303.3	72518	46822047	280492.3	193763	17.7	8	0.47	171994	0.068	0.051	0.03	95956.61	132732.3
1989	4818.0	994026.1	73425	50727888	306336	224731	18.6	6.4	0.47	175063	0.054	0.024	0.05	100703.3	149021.4
1990	5157.5	1108059	75851	55986662	315544.5	280452.9	17.5	7.8	0.49	178232	0.052	0.016	0.04	105450.2	164812.0
1991	5522.3	1222705	76423	63347259	380452.9	331685.9	23.3	9.4	0.49	181320	0.034	-0.004	0.06	109450.1	165757.8
1992	5824.6	1334317	78518	72114805	429722.6	349216.8	19.6	7.5	0.49	184322	0.011	0.029	0.04	113751.4	178944.0
1993	***…continued***														

Table A5

Data used for investigating the driving forces of the level and the growth rate of real per capita income in Indonesia (*continued…*)

Year	Y	K	L	FDI	X	M	ITR	IFR	EDR	Pop	JPN	USA	ERD	INS	GET
1993	6150.1	1461233	79210	78870165	432437.9	335443.4	14.6	9.7	0.44	187232	0.003	0.022	0.03	118065.9	185268.7
1994	6516.0	1606143	82039	87004665	475429.1	403524.1	12.5	8.5	0.47	190043	0.010	0.040	0.04	121740.6	185736.3
1995	6963.9	1771007	80110	1.05E+08	512135.1	488016.4	16.7	9.4	0.47	192750	0.019	0.033	0.04	126310.8	179839.5
1996	7392.3	1960816	85702	1.32E+08	550853.6	521517.2	17.3	8	0.44	195457	0.035	0.039	0.04	131161.6	207138.3
1997	7634.0	2155651	85406	1.82E+08	593820.3	598264.2	20	6.2	0.52	198163	0.018	0.049	0.24	136447	253253.0
1998	6542.6	2286927	87672	3.93E+08	660229.8	566614.4	39.1	58	1.44	200867	-0.020	0.051	2.44	131671.5	253331.5
1999	6506.9	2333680	88817	2.41E+08	450243.6	336142.7	25.7	21	0.93	203568	-0.002	0.048	-0.22	134681.8	215361.7
2000	6737.8	2422867	89838	2.11E+08	569490	423318	12.5	3.7	0.87	206265	0.029	0.047	0.07	138148.1	221466.7
2001	7050.3	2519498	90807	2.04E+08	573164.6	441011.7	15.5	12	0.84	209014	0.006	0.004	0.22	143015.7	306323.2
2002	7267.8	2601682	91647	1.67E+08	566188.8	422271	15.5	12	0.64	211817	0.003	0.008	-0.09	148850.2	262183.3
2003	7429.6	2684014	92811	1.41E+08	599516.9	426113.3	10.6	6.6	0.55	214674	0.015	0.021	-0.08	155454.1	281851.8
2004	7613.1	2818174	93722	1.5E+08	680621.1	543183.7	6.44	6.2	0.53	217587	0.029	0.037	0.04	163027.1	309874.7
2005	7907.0	2977125	93958	2E+08	799749.2	646574.1	8.08	11	0.47	220558	0.023	0.031	0.09	171587.3	362150.0
2006	8282.6	3100553	95177	1.92E+08	869151.6	672674.6	11.4	13	0.37	223042	0.026	0.035	-0.06	173215.1	390701.6

Notes: Y: Real per capita GDP (IDR (Indonesian Rupiah) thousand), K: Capital (constructed based on investment data in IDR Billion), L: Labor (thousand), FDI: Stock of FDI (IDR Million), X: Export (IDR Billion), M: Import (IDR Billion), ITR: Interest rate, IFR: Inflation rate, EDR: External public debt to GDP ratio, Pop: number of population (Thousand), USA: the growth of gross national income of USA, JPN: the growth of gross national income of Japan, ERD: exchange rate depreciation, INS: Government and institutional development (IDR Billion), GET: Government expenditure (IDR Billion)

Source: Y, IFR, EDR, Pop, JPN, USA (World-Bank, 2008), Investment for capital, GET (Ministry of Finance, 2007), Labor (GGDCCB, 2008), FDI (Ministry of Finance, 2007; Unctad, 2008), M, I, ITR, ERD (International-Monetary-Fund, 2008), INS (Timmer and Vries, 2007)