POPULATION DYNAMICS AND THE NEXUS BETWEEN HUMAN CAPITAL AND ECONOMIC GROWTH IN MALAYSIA

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ABSTRACT

Changes in population dynamics due to lower fertility and mortality rates, and longer life expectancy have contributed to an ageing population across the world. Initially experienced in developed countries, population ageing is now becoming more apparent in developing countries as well. This thesis investigates the implications of population dynamics, in particular population ageing on Malaysia's economic growth and its goal of becoming a high-income and advanced nation by 2020. Although the effect of ageing on economic growth takes several paths, the impact on human capital is critical as the latter has been seen as the 'engine of economic growth'.

This study investigates two important links: the nexus between human capital, technology diffusion and total factor productivity growth; and the relationship between human capital and economic growth. These baseline models are further extended to estimate the interactions of working-age population structure and education level on total factor productivity and economic growth. In this context, the Benhabib and Spiegel (2005) model of logistic diffusion and the Aghion, Howitt and Murtin (2010) model of human capital and economic growth are re-examined to test their capacity to explain economic growth in Malaysia and investigate the role of human capital on total factor productivity growth. The study covers the period from 1990 to 2010 and for all 13 states of Malaysia. The study also goes beyond standard measures of human capital to consider the quality of higher education.

Empirical analysis confirms the existence of economic convergence among the states where human capital contributes to technology absorption, adoption and economic growth. Athough the young and older workers make a positive contribution to economic growth, the empirical evidence does not fully support the theoretical models examined with respect to ageing effects on economic growth. Future research ought to pay more attention to the measurement of total factor productivity and the quality of education, as well as to alternative demography-based models of economic growth. The study concludes with a discussion on policy implications towards sustainable economic growth and higher living standards for Malaysian people.

DECLARATION

'I, Suhana Md. Saleh, declare that the PhD thesis entitled Population Dynamics and the Nexus between Human Capital and Economic Growth in Malaysia is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work'.

Signature	**Date**
[redacted]	
SUHANA MD. SALEH	**31 AUGUST 2016**

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DEDICATION

To my loving husband and son:

MOHD ZAINAL & MUHAMMAD ZARIF

AND

To my loving parents:

MD. SALEH ADIS & TIMAH OSMAN

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CHAPTER 1
INTRODUCTION AND BACKGROUND

1.1 Introduction

Malaysia aims to become a high-income and advanced nation by the year 2020, with higher quality of life and income per capita rising above US$15,000. Concurrently, Malaysia is also projected to become an ageing nation by 2035. Although it is expected that Malaysia will become a developed nation before the onset of population ageing, the implications of population ageing on economic growth still remain a matter of interest and concern. Given this inevitable demographic shift, empirical research is needed to provide evidence based insights on the implications of population dynamics, in particular population ageing in Malaysia and to propose policies to ensure sustainable economic growth. Issues and implications of population ageing have been widely discussed in the global literature with some analysts viewing them as economically catastrophic, while others focus on the more positive aspects of ageing. The empirical literature indicates that as population ages, the economic growth rate of a country tends to be slower. The slower economic growth has increased the need to support productivity growth, especially through investment in skills and education.

Following the findings of past research and the issues related to effects of demographic change on economic growth, this study aims to advance and fill the gap in the literature of population dynamics, particularly on population ageing and to examine how economic growth in Malaysia can be sustained through human capital development. In this study, two main drivers of economic growth, namely human capital and technology diffusion will be analysed within the endogenous growth model framework. The endogenous growth theory proposes that the introduction of new accumulation factors, mainly knowledge and innovation, will contribute to economic growth. Results from this study will provide better understanding of the challenges and opportunities that will arise from demographic change and ageing population to Malaysia's economic growth.

1.2 Research Background

Geographically, Malaysia is situated in Southeast Asia region and consists of 13 states and 3 federal territories, covering an area of about 329,750 square kilometres (see Figure 1.1). Malaysia is separated by South China Sea into two regions, that is Peninsular Malaysia (West Malaysia) and the states of Sabah, Sarawak and Labuan Federal Territory (East Malaysia) on the island of Borneo. Malaysia shares its border with Thailand in Peninsular Malaysia and Brunei in West Malaysia, and is separated from Indonesia and Singapore by the Straits of Malacca. The states in Peninsular Malaysia comprises Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Penang, Sabah, Sarawak, Selangor and Terengganu; and the three Federal Territories (FT), namely the FT of Kuala Lumpur, Putrajaya, and Labuan.

Figure 1.1 Map of Malaysia

Politically, Malaysia is a federation and practises a system of parliamentary democracy with constitutional monarchy, where the King is the head of state and the Prime Minister is the head of government. Malaysia (formerly known as Malaya) gained independence from the British in 1957. Until 1963, Singapore was part of Malaysia, when political conflicts that strained the relationships resulted in the separation of Singapore from the federation. Malaysia is a multiracial and multicultural country, with a mix of three major ethnic groups, namely Malays, Chinese and Indians. The total population is estimated to be 30.5 million in 2015, with the Malays constituting about 55.1% of the population, Chinese 23.7% and Indians about 7.2%. The continuous economic growth has improved the quality of life among the people, with poverty rate reducing to 0.6% in 2014 and overall income distribution improving, with Gini Coefficient[1] of 0.401 in 2014. However, the socio-economic development in Malaysia is still crucial to overcome the challenges in ensuring that all Malaysians benefit from growth and development, by maintaining social cohesion (H.M.Zin 2008; Menon 2008) and enhancing inclusive society, in line with the nation's development strategy of balanced growth and equitable opportunities for all Malaysians (Economic Planning Unit 2015).

During the British colonial rule in Malaya, the country's economy was mainly based on tin mining and rubber. Before independence as well as in the early years of independence, the Malaysian economy was based on the laissez-faire or open market system. During this commodity-driven phase, poverty rate among the population in Peninsular Malaysia was quite high, at about 49.3% in 1970. Rapid population growth that occurred in the early period of post-independence has not only increased the supply of labour force but created the need for diversification in the country's economic base, diversifying from agriculture sector to manufacturing sector. High dependency on export earnings from tin and rubber posed constraints due to the price fluctuations in the commodities market. Therefore, in expanding the economic base, the Malaysian government has to embark on an industrialisation strategy (Fong 1989).

The establishment of the Malaysian Industrial Development Authority (MIDA) in 1967 further streamlined the industrial development in Malaysia and contributed towards the structural shift in the country's output production. The shift has

[1] Gini coefficient refers to the income distribution of a country's residents, with 0 represents perfect equality and 1 represents perfect inequality. A higher Gini coefficient reflects higher income inequality.

transformed the country’s economy from agriculture and primary commodities towards manufacturing of goods and services. These developments have also contributed in increasing the income levels of the people and further enhanced their standard of living. The economic progress has also improved the quality of life for Malaysians, reduced income disparities and supported widespread advances in education, health, infrastructure, housing and public amenities.

Malaysia has experienced high economic growth over the last few decades, despite facing various economic challenges and shocks. The economy has transformed from an agricultural and commodity-based economy in the 1970s to manufacturing in the mid-1980s and to services-based upper middle-income economy in the 1990s (Economic Planning Unit 2015). Malaysia’s real Gross Domestic Product (GDP) has grown by an average of 5.8% per annum from 1991 to 2010, and 6.2% per annum since 1970. The mean monthly household income has increased from RM264 in 1970 to RM6,141 in 2014 (Economic Planning Unit 2010, 2015) and is targeted to reach RM10,540 in 2020.

Improvements in the quality of life and rapid economic growth in Malaysia also resulted in longer life expectancy as well as declining fertility rates (Economic Planning Unit 2010; National Economic Advisory Council 2010). Life expectancy increased from 61.6 years for males and 65.6 years for females in 1970, to 71.9 years for males and 77.0 years for females in 2010. During the same period, the annual (crude) birth rate decreased from 32.4% to 17.5%. In 2010, infant mortality remained low at 6.8%, while adult mortality decreased to 4.8%, thus contributing to increase in longevity. As a result, the total population of those aged above 60 years increased from 1.4 million in 2000 to 2.1 million in 2010. People are also better educated with about 24.2% of the population having tertiary level education and the adult literacy rate of 93.6% in 2010 (Economic Planning Unit 2012).

Declining fertility rate becomes a matter of concern as lower proportion of younger cohorts in the population will result in lower labour supply, which may affect output production, long-run economic development, as well as ageing of the population (Prettner, Bloom & Strulik 2012; Productivity Commission

Australia 2005). However, there are studies that explore the possibilities and discuss the mechanisms on averting the negative economic impact of decreasing fertility. The main argument is that the size of the labour force does not matter for economic growth but rather the quality of the labour force, in terms of the average level of education and higher female labour force participation, which will contribute in enhancing future growth. Higher education level will promote technology development and innovation, thus contributes towards greater economic growth (Dowrick 2003; Romer 1990).

Currently, Malaysia has a fairly young population and workforce[2] (World Bank 2013), with those above 65 years representing less than 10% of the total population. However, with the continuing trend of lower fertility and mortality rate, as well as longer life expectancy, the demographic structure of the population will shift towards increasing proportion of older people. Given this, Malaysia is expected to become an ageing nation by the year 2035, whereby 15% of its population are 60 years and above (Economic Planning Unit 2010).

1.3 Research Problem

The relationship between population dynamics and economic growth remains a subject of debate, with the discussion focusing on whether population dynamics will restrict or promote economic growth. Although most studies in the past have focused on the link between population size and economic growth, recent researchers have focussed on the effects of changes in the age structure or the age composition on long-term economic growth. The implications of population ageing include, among others, increase in the old-age dependency ratio[3], higher fiscal expenditures and a lower support ratio[4], all of which will eventually lead to slower economic growth. Population ageing could also affect the national output per capita, through labour productivity and employment to population ratio (Guest 2005). Labour force participation tends to decrease as population ages and this may contribute to slower economic growth in the future

[2] Working-age population refers to those who are between 15 to 64 years age group.
[3] The ratio of population aged above 65 to those aged 15 to 64 years.
[4] The number of persons aged 15-64 for each person aged 65 or older.

(Bloom, Canning & Fink 2011). In addition, lower fertility rates will reduce the numbers of potential workers which will, in turn, affect output production. Therefore, it is important to determine the effects of population ageing because each age group in a population may behave differently and has a different economic impact to the nation.

The proportion of older population in Malaysia is growing, and its labour contributions need to be studied for sustainable growth in the future. Longer life expectancy and better health conditions will contribute to older people willing to work longer and this will have significant effects on labour force participation and human capital accumulation in Malaysia. Therefore, it is important to ascertain the effect of an ageing population on economic growth in Malaysia by studying the labour contributions of the elderly for sustainable growth in the future. According to Hamid (2015 p.2), the 'nascent knowledge on old age and ageing remains fragmented and unconsolidated', thus there is a need for more empirical evidence to support policies related to ageing in Malaysia. Furthermore, higher fiscal expenditure is predicted to result from higher costs in healthcare and support systems for older persons, as well as longer pension payments and income support.

Gomez and De Cos (2008) propose that there is a positive and significant relationship between population ageing and cross-country economic performance. Meanwhile, Tang and MacLeod (2006) found that labour force ageing has a modest negative direct impact on productivity growth in Canada, based on findings of their study in 10 Canadian provinces over the period of 1981 to 2001. Cuaresma, Lutz and Sanderson (2009) also point out that education as well as age structure affect economic growth. However, Bloom, Canning and Fink (2011) suggest that ageing population will not significantly impede the pace of economic growth in developing countries, claiming that although the share of young people is shrinking, the share is still large enough to offset the share of adults entering into older age[5].

[5] Based on their study of non-OECD countries.

Earlier studies on age structure and economic growth imply that population ageing affects national or regional income growth, but the effect of changing age structure on income or productivity was not directly examined (Brunow & Hirte 2009). In recent studies, there has been growing empirical support in the literature on the effect of demographic age structure on economic growth (Kogel 2005; Cuaresma 2012).

The link between age structure and productivity is complex and despite considerable literature on this relationship, the direction and magnitude of this correlation still remain unresolved theoretically and empirically (Guest & Swift 2008; Serban 2012). According to Guest and Swift (2008), changes in productivity and labour force participation will determine the capacity of the population to support population ageing. The prospects of sustainable economic growth in an ageing population will be a matter of interest for Malaysia in moving towards its goal of becoming a high-income and advanced nation by the year 2020.

1.4 Motivation for the Research

The effect of population ageing on economic growth has been extensively researched in developed countries, and Malaysia could benefit and learn from the experiences of these countries. Learning from the experience of developed countries could help in developing best possible solution to an unavoidable situation, ensuring the economic growth sustainability and maintaining the quality of life of the Malaysian population. However, few studies have examined this phenomenon in the Malaysian context. The main motivation of the study is to draw from previous findings in the theoretical and empirical literature, and investigate the implications of population dynamics, in particular population ageing on economic growth in Malaysia, specifically to determine the relationship between age structure, human capital, technology diffusion, total factor productivity (TFP) growth and economic growth.

With demographic transition towards ageing, countries need to revise their education policies to meet labour market needs and promote economic growth

(Population Bulletin 2012). Diversification of the economy will need workers with higher- and multiple-skills. Therefore, in addressing the workers' skills need and demographic shift, policy interventions need to ensure the enhancement of human capital, sustainability of economic growth and maintenance of quality of life. It is crucial for Malaysia to learn and prepare to introduce policies that will better manage the population dynamics, especially on changes of the population age structure. Government policies can play a crucial role in determining the effect of ageing on economic growth (Bloom, Canning & Fink 2011; Hamid 2015). The impact of the transition could be cushioned if policymakers take appropriate and timely actions.

In explaining economic growth, both neoclassical and endogenous growth models central proposition assume that technological progress is crucial to achieve a positive and long-run growth of output per capita (Taylor 2009). Human capital could affect technological progress by influencing both domestic innovation and diffusion of technology (Benhabib & Spiegel 2005; Cuaresma, Lutz & Sanderson 2009). Specifically, in relation to Malaysia, Taylor (2007) found that opening the economy up to the global market can accelerate the country's total factor productivity growth through learning-by-doing activities from new technology embodied in new foreign capital equipment. This finding indicates that a weak research and development (R&D) or knowledge base does not necessarily translate into lower economic growth as postulated by the recent expansion of the endogenous growth paradigm.

Given the growing interest on the link between human capital accumulation and technological progress in endogenous growth theory, this study aims to explore the effect of human capital in enhancing technological progress as well as to increase TFP growth rates and regional income. The findings are important for economic policy planning in Malaysia as the country continuously faces the challenges to remain competitive globally and the need to enhance productivity in a knowledge-based economy, as well as to better equip the country in becoming an ageing nation. The emphasis on shifting towards high-skilled labour to address the challenges of population dynamics also needs to be examined in relation to the rising interest and debates on the costs and benefits of growing investments in education, as well as debates on the role of education, in terms of education quantity or quality.

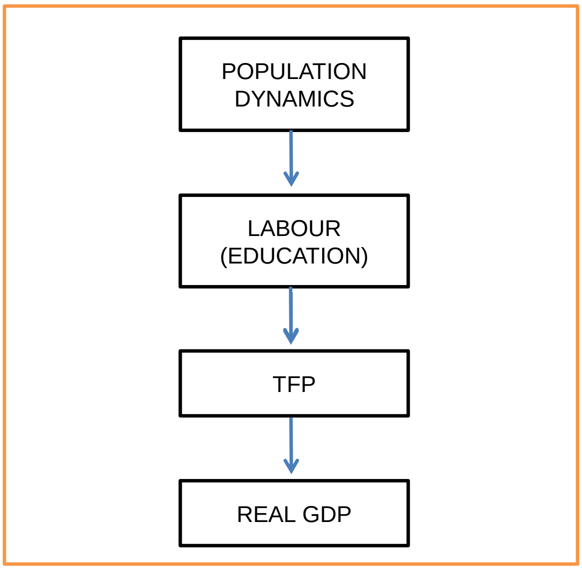
1.5 Conceptual Framework of the Study

This study aims to investigate how human capital development can sustain economic growth in the context of demographic change towards an ageing population and within the theoretical framework of endogenous growth model. Although the neoclassical growth model regards human capital as an exogenous efficiency or technology parameter, Dowrick (2003) claims that technological advances depend on the workforce's level of education and investment in human capital, rather than physical capital for rapid economic growth. In addition, Benhabib and Spiegel (2005) state that increases in stock of basic knowledge will enhance productivity, facilitate innovations and promote scale effects.

This study will employ an endogenous growth model that identifies both human capital and technological progress as endogenous factors that contribute to economic growth. This model contrasts with the neoclassical growth model that regards human capital as an exogenous factor. Human capital which represents the education levels is integrated with technology diffusion and labour participation to examine their impact on economic growth. The empirical models will also include estimation on the interactions of working-age population structure and education on total factor productivity (TFP) and economic growth.

Figure 1.2 depicts the conceptual framework for this study. One of the main drivers of economic growth is labour and labour with education will contribute to total factor productivity and enhance economic growth. In analysing the implications of population ageing, for economic growth in Malaysia, the model considers two of its main effects in the labour force: education and participation rate. Changes in demographics will affect the labour supply in terms of labour force participation and level of education, which will subsequently affect the growth of total factor productivity and real output. In this study, labour is assumed as homogenous.

Figure 1.2 Conceptual framework



Two empirical models were developed in this study to investigate, (i) the nexus between human capital, technology diffusion and total factor productivity growth; and (ii) the nexus between human capital and economic growth. In examining these two relationships, previous econometric models in the literature are reviewed to determine the links between the dependent and independent variables. Nelson and Phelps (1966), among the pioneers in the research on the effects of human capital and technology diffusion on economic growth have proposed two models. The first model suggests that increase in total factor productivity depends on the stock of human capital and varies positively in terms of distance from the technology frontier. The second model proposes that the level of human capital will determine the gap between the technology frontier and the current level of productivity. The two models thus directly indicate human capital as an input into the production process and suggest that the level of human capital is important for economic growth. In general, countries with greater human capital will further enhance TFP growth.

Building on the model proposed by Nelson and Phelps (1966), Benhabib and Spiegel (2005) proposed a logistic model of diffusion which allows for a greater role of human capital in domestic innovation and acknowledges the potential for poverty traps due to barriers to assimilation of foreign technology. The logistic model of diffusion emphasises the interaction of human capital and the technology gap by the distance to the frontier, in this case, the USA as the technology leader. Their model suggests that nations closer to the technology frontier have higher human capital accumulation that could support innovation, while countries far from the frontier benefits from technology diffusion. The gaps of technological diffusion will contribute to divergence in world income.

Therefore, in line with aims of the study, the Benhabib and Speigel (2005) model will be adapted to explain the relationship between human capital, technology diffusion and TFP growth in Malaysia. In this study, education represents the human capital component in the states in Malaysia. Since the economic growth literature also deliberates on whether it is the level of human capital or growth in human capital that promotes growth, this study will also estimate the relationship between human capital and economic growth by adapting the Aghion, Howitt and Murtin (2010) model, hereafter AHM model. The level effect suggests that the level or stock of human capital will enhance economic growth, but the growth effect suggests that it is the accumulation of human capital that affects the economic growth.

Educational attainment has been widely used to measure the quantitative aspects of human capital (Barro & Lee 2010, Islam 2010). Hanushek and Wößmann (2012) propose that the level of educational achievement (or cognitive skills) of the population is crucial for long-run economic development, suggesting the important role of acquired skills in enhancing growth. They claim that the use of achievement measures has three advantages: first, it captures variation in the knowledge and ability that schools create; second, it incorporates skills from any source to emphasise total outcomes of education; and third, it allows for differences in performance among students with different quality of schooling. They propose that inputs, such as schooling levels, should be used as proxy for human capital when direct measures are unavailable. Islam (2010) lists four reasons in support of this preference: first, educational attainment data is easily attainable across individuals over time; second, it is easy to calculate the economic returns from education in terms of benefits and costs; third, data to measure education quality are more scarce than education attainment; and fourth, uncertainty may arise in changing educational quality and supporting expenditures (resources alone do not yield any systematic returns in terms of student performance).

1.6 Research Methodology

This section will briefly describe the research methodology used in this study. Two baseline empirical models were constructed to analyse the relationships between age structure, human capital and technology diffusion on TFP and economic growth. The empirical analysis will examine and estimate the relationships between the variables defined using panel datasets covering the period of 21 years (1990 to 2010) and using system Generalised Method of Moments (GMM) in the STATA 13 software. This study will focus on 13 states in Malaysia, excluding the 3 federal territories (Kuala Lumpur, Putrajaya and Labuan).

Panel data have the advantage of having both cross-sectional and time series dimensions and have been extensively used in estimating dynamic econometric models (Bond 2002, Wooldridge 2013). These elements enhance the datasets information for its larger sample size, and its greater variability can contribute to more reliable parameter estimates, as well as control for individual heterogeneity (Hsiao 2003). The use of panel data involving moderate to large dimensions has increased since the 1980s (Eberhardt 2012). However, in contrast to Benhabib & Speigel (2005) who estimated the data on 84 nations from 1960 to 1995, the panel dataset for this study will only focus on data from 13 states in Malaysia for 21 years. Since the time series data estimation needs to range over lengthy periods of time, the use of panel data in this study is appropriate to provide good estimates of the aggregate dynamic behaviour and the economics of scale.

1.7 Research Objectives and Questions

In line with the issues and study aims discussed above, the general objective of this study is to examine the potential implications of population dynamics for economic growth in Malaysia. The specific objectives of this study are to:

i. examine the trends of changing population age structure, labour force participation and education in Malaysia;
ii. investigate the relationship between population age structure, human capital, technology diffusion and TFP growth in Malaysia; and
iii. examine the relationship between population age structure, human capital and economic growth in Malaysia.

In accordance with the issues specified above and to guide the empirical analyses, five research questions are identified as follows:

i. What are the trends of changing population age structure, labour force participation and education level in Malaysia?
ii. What is the relationship between human capital, technology diffusion and TFP growth in Malaysia?
iii. What is the relationship between population age structure, human capital, technology diffusion and TFP growth in Malaysia?
iv. What are the effects of human capital on economic growth in Malaysia?
v. What are the effects of population age structure and human capital on economic growth in Malaysia?

1.8 Significance of Research

Past demographic trends show that age structure will continue to change over time, which will have implications to Malaysia as well as other developing countries. In line, with the goal of becoming a high-income and advanced nation by the year 2020, it is crucial that studies are carried out regarding this important demographic phenomenon. This study also aims to advance and fill the gap in the literature of population dynamics in Malaysia by studying the implications of population ageing for economic growth in Malaysia. Specifically, this research will provide evidence-based analysis on the contributions of human capital and technology diffusion on TFP growth, as well as the effects of human capital on economic growth, within the context of endogenous growth model framework. Furthermore, to the best of our knowledge, there are no known empirical studies on Malaysia using the national labour force survey data to study the relationships specified above.

Better understanding of the relationships between population dynamics and drivers of growth, namely human capital and technology diffusion, is important to help sustain Malaysia's economic growth in the long run. In addition, it is important for Malaysia to learn and formulate policies that will better manage the changes of the population age structure. As Bloom, Canning and Fink (2011) state, government policies play a crucial role in determining the effect of demographic change, in particular population ageing on economic growth and with appropriate policies, the impact of the transition could be moderated. Learning from the experience of developed countries could help in developing best possible solution to an unavoidable situation, ensuring the economic growth sustainability and maintaining the quality of life of the Malaysian people.

The stakeholders of this research are academics, professional researchers, economists, politicians and policy makers in Malaysia. The outcomes of this study will enhance the understanding of state governments regarding population dynamics, particularly on the changes of population age structure and important growth determinants. The findings could contribute in providing additional inputs in policy planning, specifically related to human capital, technology development and population ageing. In addition, dialogues could be promoted between stakeholders on issues related to population dynamics and economic growth at the state level, which will help in future planning and promotion of pro-growth initiatives in the states. This will provide the basis for the state planning agencies to allocate funding for infrastructures, provide support for industrial growth as well as skills training and up-skilling, with the aim of achieving sustainable economic growth. In addition, one of the significance of this study is that it employs an estimator that controls for the potential endogeneity problem of the explanatory variables in particular the Generalised Method of Moments (GMM) technique introduced by Blundell and Bond (1998).

In summary, the findings from this study may contribute in enhancing the current knowledge and understanding of population dynamics in Malaysia, which also able to provide better insights toward the preparation of becoming an ageing nation. The results could also provide better understanding of the vital role of human capital and technological progress as to sustain TFP growth. Specifically, this study will contribute to knowledge as follows:

i. This study will contribute in terms of empirical analysis on the relationships between age structure, human capital, technology diffusion and TFP or economic growth, using the endogenous economic growth model to provide better understanding of the changes in population age structure and contributions of the factors of production.

ii. In this process, the study will also provide better understanding of the contributions of the factors of production, specifically the TFP and human capital towards enhancing economic growth.

iii. This study will also enhance the understanding of economic growth in an economy with an ageing population and thus, to the existing body of knowledge in terms of literature and empirical work related to population ageing, human capital accumulation, technology diffusion and labour force participation, not only in Malaysia but for other developing countries as well.

1.9 Organisation of the Thesis

This thesis consists of eight chapters and is organised as follows. Chapter 1 highlights the focus for this research on the implications of population dynamics for economic growth and the role of human capital development in sustaining economic growth in an ageing nation. The chapter also outlines the research problem and motivation by identifying existing gaps in the empirical literature on Malaysia and described the framework, methodology and objectives that will guide this study. In addition, five research questions were identified to guide the empirical analyses. The significance of research was also explained to provide insights on the related stakeholders involves in population ageing in Malaysia.

Chapter 2 elaborates the population dynamics, population ageing and labour force participation in Malaysia. The chapter begins with the description on population dynamics and trends in terms of changes in age structure, fertility and mortality, life expectancy and dependency ratios, and the link with population ageing. The chapter also highlights the demographic transitions and indicators that characterise population ageing, as well as the effects of population ageing on economic growth. In addition, trend analyses on labour force participation in the states were also discussed.

Chapter 3 gives an overview of the Malaysian economy and reviews the literature related to human capital for economic growth. The chapter traces the trajectory of major economic policies and identifies the challenges for sustaining economic growth in Malaysia, in particular the challenges of being in the middle-income trap. The role of human capital as a catalyst for economic growth and the link between population age structure and human capital accumulation was explored.

Chapter 4 describes the theoretical framework and empirical models of the relationships between age structure, human capital, technology diffusion and TFP or economic growth. Using the models adapted from Benhabib and Spiegel (2005) and Aghion, Howitt and Murtin (201~~1~~0), two baseline empirical models were identified for this study: a) the human capital, technology diffusion and TFP growth model and b) the human capital and economic growth model. The empirical models will enable a better understanding of the relationships between human capital and economic growth, as well as to ascertain the human capital level and growth effects on economic growth in Malaysia. The chapter includes discussion on the basic principles of neoclassical and endogenous growth models, as well as description of the data and variables used in this study. The last section of this chapter briefly explains the estimation method of this study.

Chapter 5 explains the empirical specifications and discuss the finding of the empirical models on education and economic growth in Malaysia. Applying the endogenous growth model framework, two baseline empirical models were developed to examine the links between human capital, technology diffusion and TFP growth, as well as the relationships between human capital and economic growth. Empirical findings for all empirical models as analysed using system Generalised Method of Moments (GMM) were later discussed.

Chapter 6 further discusses the empirical specifications and findings of the extended interaction models on education levels and education quality. Next, Chapter 7 discusses the empirical results of the links between working-age population, human capital and TFP or economic growth. Chapter 8 summarises the research details, discusses the empirical results and highlights the implications of the study. The chapter also recommends policy options related to population ageing, human capital and economic growth in Malaysia.

CHAPTER 2
POPULATION DYNAMICS AND LABOUR FORCE PARTICIPATION IN MALAYSIA

2.1 Introduction

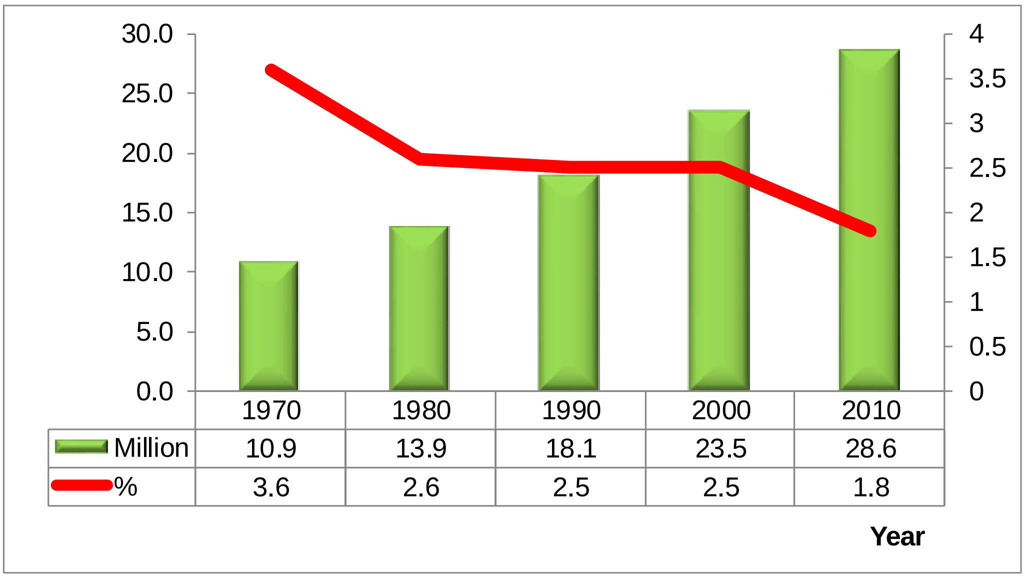
In this chapter, demographic characteristics of the population in Malaysia will be discussed to enhance the understanding of the changes in population age structure and the transition towards population ageing. The chapter begins with descriptions on population dynamics in terms of trends of fertility, mortality, life expectancy, dependency ratios as well as changes in age structure. The following sections will discuss the indicators that characterise population ageing, linking the effects of lower fertility and mortality on population ageing, as well as highlighting the effects of population ageing on economic growth. The last section will analyse the data on labour force participation in the states in Malaysia. The trend analyses in this chapter will mainly base on macro time series data displayed in tables and figures highlighting trends and changes that occurred in periods from 1970 to 2010. These stylised facts relate to the demographic trends towards population ageing and the labour participation of the population in Malaysia.

2.2 Population Dynamics

Major demographic transitions occur when there are changes in population dynamics moving from high fertility and high mortality to low fertility and low mortality. This demographic transition has contributed towards Malaysia’s economic growth since the 1980s, resulting in improved health, longer life expectancy and higher quality of life. This section highlights Malaysia’s demographic transition, in terms of changes in population age structure, and the links between fertility, life expectancy and mortality. In addition, dependency ratios will be discussed to indicate the burden of young and aged people that is placed on the working population.

Malaysia's population increased significantly from 10.9 million in 1970 to 28.6 million in 2010 (Figure 2.1). However, despite this increase, annual growth rates declined from 3.6% in 1970 to 2.5% in 1990, further declining to 1.8% in 2010. These results are explained by the decline in crude birth rates[6] from 32.4% in 1970 to 17.2% in 2010, and the declining crude death rates[7] from 6.7% in 1970 to 4.6% in 2010.

Figure 2.1 Total population and average annual growth rates, 1970-2010



Source: Department of Statistics Malaysia

The increases in population in Malaysia can be mainly attributed to natural increases[8], i.e., significant declines in crude birth and death rates. The lower neonatal, infant and maternal mortality rate also contributed to the increase in population. Table 2.1 highlights the main trends in the demographic rates for Malaysia.

Table 2.1 Main demographic rates, 1970-2010

Year	Crude Rate of Natural Increase	Crude Birth Rate	Crude Death Rate	Neonatal Mortality Rate	Infant Mortality Rate	Maternal Mortality Rate
1970	25.7	32.4	6.7	21.4	39.4	1.4

[6] Refers to the number of birth per 1,000 population.
[7] Refers to the number of death per 1,000 population.
[8] The difference between live births and deaths (crude rate of natural increase = crude birth rate – crude death rate).

Year	Crude Rate of Natural Increase	Crude Birth Rate	Crude Death Rate	Neonatal Mortality Rate	Infant Mortality Rate	Maternal Mortality Rate
1975	24.8	30.7	6.0	19.3	32.2	0.8
1980	25.4	30.6	5.3	14.2	23.8	0.6
1985	26.6	31.5	5.0	10.4	16.4	0.3
1990	23.3	27.9	4.6	8.5	13.1	0.2
1995	21.5	26.1	4.6	6.8	10.3	0.2
2000	18.9	23.4	4.5	3.7	6.5	0.3
2005	14.0	18.5	4.5	3.9	6.6	0.3
2010	12.6	17.2	4.6	4.3	6.7	0.3

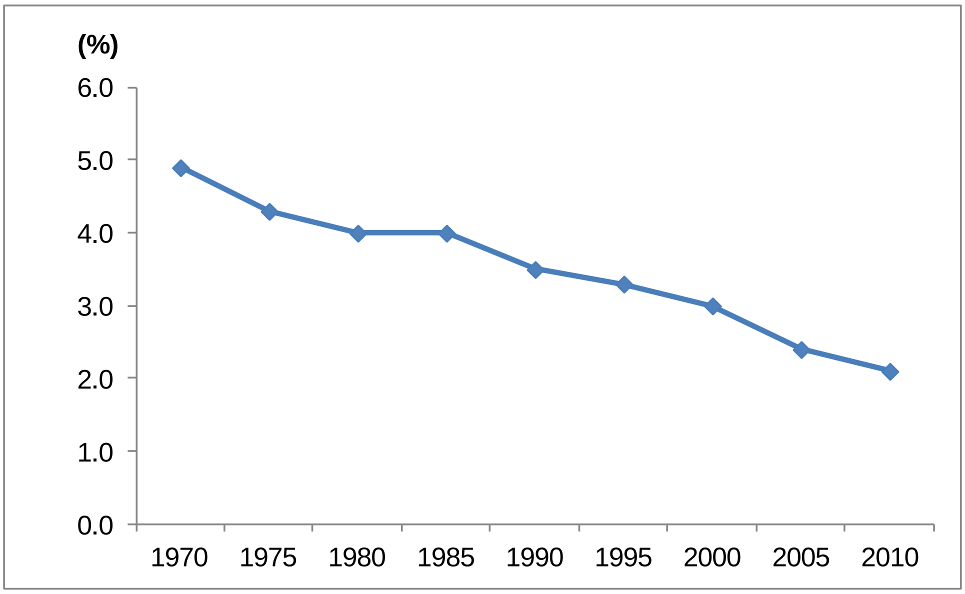
Source: Department of Statistics Malaysia

2.2.1 Fertility and Mortality Trends

The fertility rate is one of the main indicators of population ageing. The female fertility rates have been declining in both developed and developing countries (Prettner, Bloom & Strulik 2012), declining from 5 children per woman in 1950 to 2.5 in 2011. As both low fertility and longer life expectancy contribute to the ageing of the population, the declining fertility will eventually increase the share of the elderly population. Without affecting the life expectancy of older individuals, this contributes to higher proportion of the ageing population. In Malaysia, the fertility rate declined from 4.9 births per woman in 1970 to 2.1 births per woman in 2010 (see Figure 2.2), which equals the replacement fertility rate[9]. This declining fertility rate has contributed to higher proportion of the working-age population.

[9] Replacement fertility rate is the average number of children a woman would need to have to reproduce herself and her partner until the childbearing age.

Figure 2.2 Fertility rates, 1970-2010



Source: Department of Statistics Malaysia

The mean age at first marriage among males and females in Malaysia increased between 1970 and 2010. The mean age at first marriage was 25.6 years for men and 21.6 years for women in 1970, and increased to 28.7 years for men and 25.1 years for women in 2000. The mean age for men decreased to 28.0 years, but increased to 25.8 years for women in 2010, indicating that more women were getting married at a later age.

Mortality rates have been on a declining trend since the 1970s, as shown in Table 2.1. Between 1970 and 2004, all subgroups (gender, ethnic or age) of the population indicated a decline in the mortality level (Nagaraj et al. 2008). Improvements in health services and access have also contributed to lower maternal and infant mortality. The maternal mortality rate[10] reduced from 1.4% in 1970 to 0.2% in 1990 but increased slightly to 0.3% in 2010. Infant mortality also reduced significantly from 39.4% in 1970 to 6.7% in 2010. Low levels of infant mortality are linked with higher levels of socio-economic development. These developments and low infant mortality rates contributed to declining death rates at all other ages (Leete 1996). The crude death rates reduced from 6.7% in 1970 to 4.6% in 2010. The mortality rates among the elderly group in

[10] Refers to deaths which are caused by complications of pregnancies, childbirth and the puerperium, within the period of 42 days after childbirth per 1,000 live births.

Malaysia have increased, indicating better health status of the population (Bujang et al. 2010). Thus, people live longer and they contribute to a bigger proportion of the elderly group in the population.

2.2.2 Life Expectancy

Lower rates of mortality also contribute towards an increased in life expectancy. For instance, life expectancy at birth increased from 61.6 years for males and 65.6 years for females in 1970 to 70.0 years for males and 74.7 years for females in 2000. The life expectancy at birth further increased by 1.9 years for both males and females, with 71.9 years for males and 76.6 years for females in 2010 (see Table 2.2). Looking at the life expectancy among the population reaching 65 years of age in 2010, males are expected to live a further 14.1 years and females an additional 16.2 years.

Table 2.2 Life expectancy at birth by sex, 1970-2010

Year	Male	Female
1970	61.6	65.6
1975	64.3	68.7
1980	66.4	70.5
1985	67.7	72.4
1990	68.9	73.5
1995	69.5	74.3
2000	70.0	74.7
2005	71.4	76.2
2010	71.9	76.6

Source: Department of Statistics Malaysia

2.2.3 Dependency Ratios

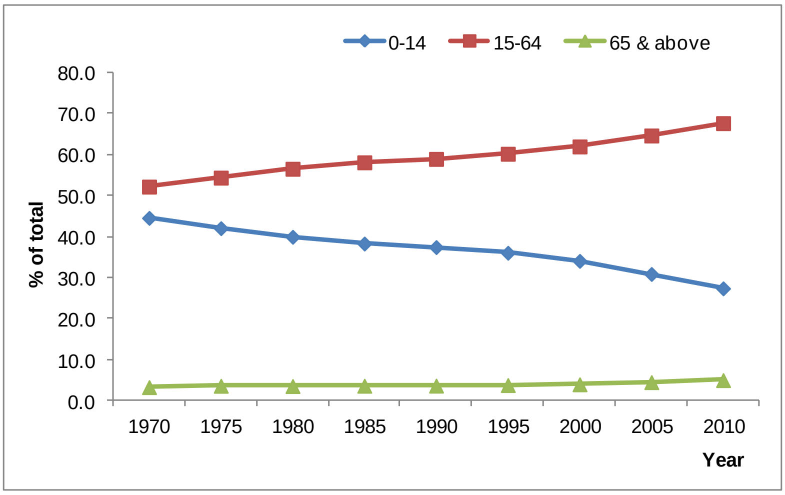
The total dependency ratio that reflects the burden of support of the working age population decreased from 59.2% in 2000 to 46.9% in 2010. The aged dependency ratio depicts a significant increase of people aged 65 years and over to those aged 15-64 from 6.1% in 1990 to 6.9% in 2010. According to

Jackson (2001), using dependency ratios to examine the population can be misleading in some cases as there are many people between 15-64 years that are dependent, such as the unemployed and jobless, youth living at home and people with disability that are not working. In 2010, seven states had old-age dependency ratio above 8.0%, with Perak and Perlis having the highest ratio of 10.5% and 10.2%, respectively. The lowest old-age dependency ratio is in the state of Sabah, with just 3.7%. Although the percentage of dependency ratios of the working age population dropped in 2010, the old age dependency ratios indicate increasing trends.

2.2.4 Population Age Structure

This section elaborates data on the age composition of the population. As shown in Figure 2.3 below, the proportion of population below the age of 15 years decreased from 44.5% in 1970 to 27.6% in 2010. In contrast, the proportion of people from 15 to 64 years continuously increased from 52.2% in 1970 to 67.3% in 2010. Similarly, the number of elderly aged 65 and over showed a substantial increase from 658,500 persons in 1990 to 1.47 million in 2010, representing about 5.1% of the total population. This trend indicates a continuous increase in the proportion of population above 15 years, and this is expected to continue in the future years to result in a much smaller base in the population pyramid.

Figure 2.3 Population age structure of Malaysia, 1970-2010



Source: Department of Statistics Malaysia

As for the population age structure by states, similar trends of decreasing proportion of population below the age of 15 years and increasing share of elderly people are seen across all states, with the states of Perak and Perlis having the highest percentage of aged population in 2010 at 6.8% and 6.6%, respectively. The state of Sabah has the lowest share of aged population at 2.8%, indicating a relatively slower population transition (refer to Table 2.3 below). These similar trends indicate that the decreasing trend of young age cohorts occurs across the states, irrespective of the state's present level of economic development, with exception to Kelantan and Sabah, that indicates the highest young population at 35.3% and Sabah the lowest at 21.4% in 2010.

Table 2.3 State population by age group (%), 1970, 1990 and 2010

State	1970			1990			2010		
	0-14	15-64	65+	0-14	15-64	65+	0-14	15-64	65+
MALAYSIA	44.5	52.2	3.3	37.4	58.9	3.6	27.2	68.1	4.7
Johor	46.6	50.2	3.2	36.7	59.7	3.6	26.4	68.8	4.8
Kedah	43.7	52.9	3.4	37.9	57.7	4.4	29.7	64.8	5.5
Kelantan	43.5	52.4	4.1	43.7	52.1	4.2	35.3	60.1	4.6
Melaka	46.0	50.3	3.7	37.0	58.2	4.8	29.4	64.9	5.7
N. Sembilan	46.4	50.0	3.6	38.3	57.5	4.2	26.6	67.9	5.5
Pahang	45.1	51.8	3.1	41.3	56.0	2.8	25.6	69.7	4.7
Perak	44.5	52.0	3.5	38.1	57.1	4.8	28.9	64.3	6.8
Perlis	40.1	55.5	4.4	36.6	58.5	4.9	29.0	64.4	6.6
Penang	40.6	55.6	3.8	30.6	64.6	4.7	26.0	68.3	5.7
Sabah[11]	47.6	50.3	2.1	40.5	57.6	2.0	21.4	75.8	2.8
Sarawak	46.4	50.6	3.0	37.0	59.1	3.9	29.2	65.5	5.3
Selangor	42.5	54.7	2.9	34.3	62.9	2.8	26.5	69.7	3.8
Terengganu	45.1	51.5	3.5	43.2	53.3	3.6	28.1	67.6	4.3

Source: Department of Statistics Malaysia; Economic Planning Unit 2013

In terms of population growth, as shown in Table 2.4 below, the state of Selangor has the highest population growth rate at 5.1%, followed by the state of Sabah at 3.0% and the state of Johor at 2.3%. The state of Selangor has the

[11] In 1990, figures are for Sabah & Federal Territory Labuan

highest average population at 3.79 million, followed by the state of Johor at 2.77 million and the state of Sabah at 2.55 million. The high average population growth rate in Selangor and Johor could be the results of inter-state migration for working purposes or other economic pull factors, due to Selangor and Johor being more developed states in Malaysia.

Table 2.4 Population and population growth by state, 1990-2010

State	Average population (million)	Growth Rates (%)
Johor	2.77	2.3
Kedah	1.69	1.7
Kelantan	1.44	1.6
Melaka	0.66	1.5
N. Sembilan	0.87	1.7
Pahang	1.32	1.9
Perak	1.36	1.7
Perlis	0.22	0.6
Penang	1.22	1.2
Sabah	2.55	3.0
Sarawak	2.13	2.1
Selangor	3.79	5.1
Terengganu	0.96	1.8

Source: Department of Statistics Malaysia

The population pyramid in Figure 2.4 illustrates the data prediction of higher proportion of aged population by 2030 due to the occurrence of structural ageing. Structural ageing is defined as an increase in the proportion of aged persons in the population. As a result, it is estimated that Malaysia will become an ageing nation by the year 2035 (Economic Planning Unit 2008). Currently Malaysia sets the age of 60 years and above as the threshold age for population ageing. The retirement age for the public sector in Malaysia was set from 58 years old to 60 years old in 2010, while the Bill for the minimum retirement age of 60 years in the private sector was passed by the Malaysian Parliament in 2012. However, in this study, older people are categorised as those aged 65 and over due to the reason that working-age population in Malaysia is defined as workers within the age cohort of 15-64 years. This age threshold also conforms to broader international standards which define the age threshold of above 65 years as older population.

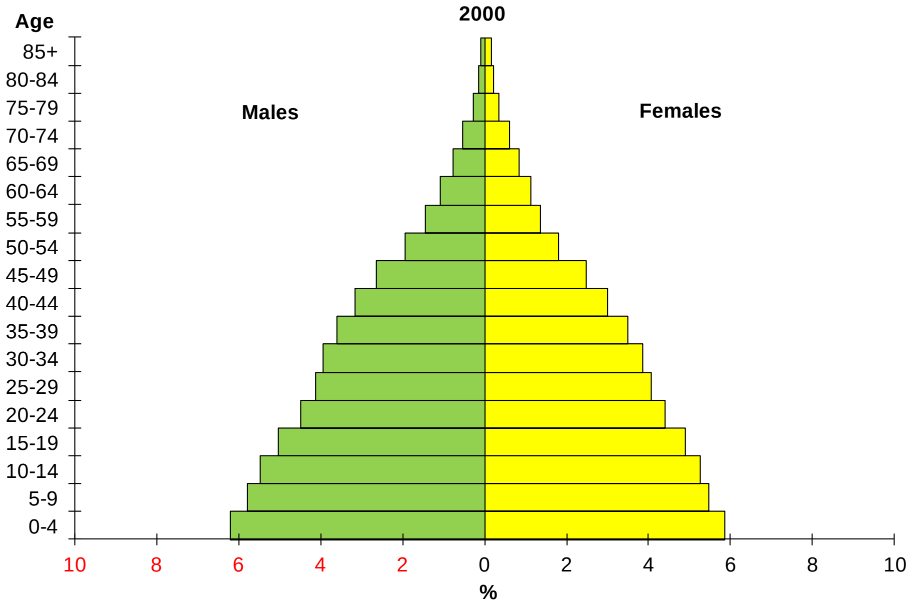
The proportion of population aged 65-84 years old is expected to increase to 7.6% by 2030, with those of the oldest age (85 years and over) also increasing to 0.5% of the total population, compared to 0.3% in 2000 (Table 2.5).

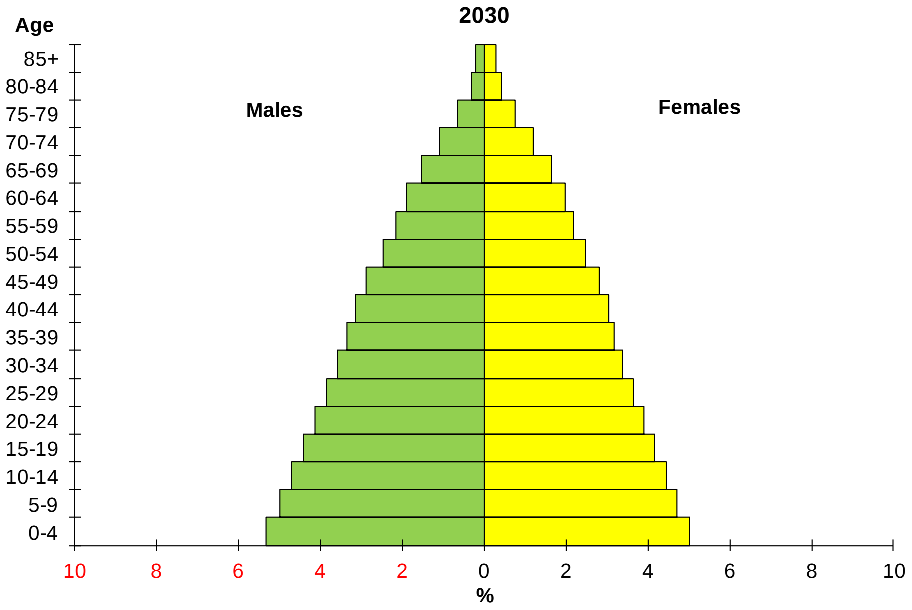
Table 2.5 Population estimation, 2030

Age Group	2000			2010			2030		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Percentage of total population									
0-14	34.1	17.5	16.6	31.7	16.3	15.4	29.2	15.1	14.2
15-64	62.0	31.6	30.4	63.6	32.4	31.3	62.7	31.9	30.7
65-84	3.7	1.7	2.0	4.4	2.1	2.3	7.6	3.6	4.0
< 85	0.3	0.1	0.1	0.3	0.1	0.2	0.5	0.2	0.3
Total	100.0	50.9	49.1	100.0	50.9	49.1	100.0	50.8	49.2

Source: Department of Statistics Malaysia

Figure 2.4 Age-sex pyramid, 2000 and 2030





Source: Department of Statistics Malaysia

The percentage of females in the oldest age population is expected to increase slightly to 0.3% in 2030. This is in line with past trends in Malaysia and globally that women usually live longer than men. Mortality rates among males tend to be higher than females, and this similarity exists across most cultures and countries (Nagaraj et al. 2008). Mortality rate among males in Malaysia is almost three times higher than females (Bujang et al. 2010).

Another indicator of population ageing is the median age of the population. The median age of population in Malaysia increased from 22.2 years in 1970 to 26.2 years in 2010. Population with a median age of less than 20 years is considered young, and when the median age reaches 30 years, the population is considered old. Population with median ages between these ranges are considered intermediate. Given the median age of 26.2 years, Malaysia falls into the intermediate category.

2.3 Indicators of Population Ageing

A declining population growth resulting from declining fertility, as well as lower mortality and increases in life expectancy have contributed to an ageing of the population internationally. As fertility declines and adult mortality rate improves, population will begin to age (Kinsella & Phillips 2005). Low fertility rate is an indicator of an ageing population in both developed and developing countries, with more countries having fertility rates lower than the replacement rate of 2.1 births per woman (Bloom, Canning & Sevilla 2001; Prettner, Bloom & Strulik 2012). Among the main reason for this decline is that more women have access to education and highly educated women tend to have fewer children (Cuaresma, Lutz & Sanderson 2009). Changes in this reproductive behaviour could be attributed to the higher economic growth that has created more opportunities for female labour participation (Leete 1996); expansion of the education system that delays marriage and first pregnancy (Population Bulletin 2012); and the increasing number of women preferring to remain single (Mahari et al. 2011).

Another factor of population ageing is increased in life expectancy. Increasing life expectancy, awareness of healthy lifestyles and new innovations in healthcare may contribute to more people living longer without severe disability (Christensen et al. 2009). Economic growth and progress in social dimensions, especially better health services and infrastructure have increased the wellbeing and quality of life for the population. According to Leete (1996 p.44), 'increases in levels of literacy, improvements in infrastructure, including the provision of safe water and better sanitation, and increased public expenditure on a comprehensive rural health services system were the factors that combined to bring mortality down to exceptionally low level'.

Although there are several indicators used to define population ageing, however structural and numerical ageing are the two widely used technical dimensions. Structural ageing refers to an increase in the proportion of aged people in the population caused by falling fertility, whereas numerical ageing refers to an absolute increase in the number of aged people caused by increase in life expectancy (Jackson 2001).

Other indicators of population ageing include the proportion of population aged 60 and above (Kinsella & Phillips 2005; UN DESA 2013) and the median age of the population. However, the demarcation age of 60 years and above is widely used in developing countries, due to the higher mortality rate, whereas the cut-off age of 65 years and above is used in developed countries. Population is considered young when those aged 65 and above are less than 5 percent of the population[12], and old when this proportion reaches 10 percent. As for the median age, population is considered young when it has a median age of less than 20 years, and old when the median age reaches 30 years, with population having median age in between 20 years to 30 years are considered intermediate age. Another common indicator of population ageing is the dependency and support ratio between the population:

- youth is 0 - 14 year olds in relation to those aged 15 – 64;
- aged is 65+ in relation to those aged 15 – 64;
- total is 0 - 14 and 65+ year olds in relation to those aged 15 - 64 years; and
- potential support ratio (PSR) is 15 - 64 years in relation to those aged 65+

However, there are limitations when using the dependency ratio as the indicator for population ageing because many of those aged between 15-64 years can also be dependent and have limiting active participation in the workforce (Jackson 2001).

Although the changes in population age structure (distribution across different age groups) leading to population ageing is not a new phenomenon (Productivity Commission Australia 2005; Lee & Mason 2010), it is considered one of the most important demographic events of the twenty-first century (Saad 2002). As the term ‘older person’ generally refers to those aged 60 years or above, it was estimated that there were about 840 million (11.7 per cent) older persons in the world in 2013, with this number expected to increase to more than 2 billion persons (21.1 per cent) by 2050. This indicates that one out of nine people in the world is aged 60 years and above, and this figure will increase to become one out of every five by 2050 (UN DESA 2013). Initially experienced in more developed countries (Heijdra & Romp 2009), population

[12] Or more than 35 per cent is aged less than 15 years.

ageing has now started to become more apparent in many developing countries as well (Kinsella & Phillips 2005). Although each country differs in terms of time frame and intensity in the rate of ageing (Gruescu 2006), and the proportion of population 60 years or older is much higher in developed regions, it is expected that the less developed regions will experience faster rate of population ageing, and over a much shorter time period (UN DESA 2013).

Demographic transitions resulting from declining mortality and fertility rates can create opportunities for economic growth in developing countries (Lee & Mason 2010). These opportunities, also known as demographic dividend have been found to contribute to rapid economic growth (Bloom et al. 2012) when the correct policy environment is in place and increases in the working-age population are matched with increased job opportunities and other industrial supports. However, this demographic dividend is time limited (Bloom, Canning & Sevilla 2001) due to continuous decline in mortality and fertility rates. As a result, developing countries in particular need to plan for the upcoming social and economic challenges that they will encounter (Productivity Commission Australia 2005). For Malaysia, the fertility rates are declining ahead of mortality rates and thus, position Malaysia in the third stage of the demographic transition (Hamid 2015). Although efforts to increase the population through the introduction of pro-natalist policies were taken in the 1980's, the birth rates continue to decline (Wong & Tey 2006).

2.4 Population ageing and economic growth

Population ageing affects the national output per capita through productivity and employment to population ratio (Guest 2005). Labour force participation and savings rate will tend to decrease as population ages, thus reducing the labour supply and raise concerns about slower economic growth in the future (Bloom, Canning & Fink 2010, Guest 2008). Changes in the population age structure could also affect the average hours worked. People in the older age cohorts generally have lower participation rates and average hours worked than younger age cohorts (Intergenerational Report Australia 2010). The Intergenerational Australia Report 2010 projected that lower labour participation of the older Australians will reduce the total labour force participation rate of Australian workforce from 65.1% in 2009-2010 to 60.6% by 2049-2050. Population ageing also leads to falling support ratios, i.e., the ratio of effective labour to effective consumers. In addition, a study by Chan et al. (2010) found that factors, such as compulsory retirement, lack of skills, health reasons and family responsibilities, resulted in barriers to work accessibility and limiting the participation of older workers in the job market in Malaysia.

Besides the direct impact of falling participation rate, the increased number of older labour force will have other implications in terms of falling productivity on economic growth. Older workers may also have negative effects on productivity through lack of motivation to acquire new skills and higher wages that might not compensate with rise in productivity. According to Guest (2007), workers of different ages are complementary to varying degrees, such as that the physical strength of young male workers will complements the skills that older workers have in managing people, including mentoring younger workers, and making decisions. Older workers will have higher average levels of work experience (Dixon 2003), which could have positive effects on productivity (Disney 1996).

In examining the effects of population ageing on economic growth, it is important to look at not only the accounting effects (assuming age-specific behaviour remains unchanged), but also the behavioural effects that occur when the population age structure changes. According to Guest (2007), it is unrealistic to assume that workers of different ages are perfectly substitutable. Individual expectations and behaviours tend to alter when family size and life expectancy change (Bloom, Canning & Fink 2011). For example, in terms of consumption, the younger age cohort may require relatively higher investment in education, compared to the older age cohort that may need income support or long-term care. Other factors such as the ethnicity, gender, socio-economic and geo-location will influence the impact of ageing at both the micro and macro levels (Hamid 2015).

The demographic shift to population ageing can be a concern in terms of higher government fiscal expenditure in public pensions to support the elderly. There is also higher expenditure in health care systems as older people have chronic care needs that requires special and often long-term care. Higher old-age dependency ratios will create a burden for future workers, since there will be fewer workers to support retired elders, which then leads to the imposition of higher taxes and transfers. Another impact of population ageing is that as people live longer they need to accumulate more wealth to make provisions for maintaining their way of life in old age. As a result, and with other things being equal, this will also reduce consumption rate among the current working population (Lee & Mason 2010; Productivity Commission Australia 2005). The amount of financial preparation required by working generations for their retirement in terms of saving adequacy, pension peril and intergenerational transfer becomes a matter of concern. Therefore, an ageing nation faces challenges from deteriorating health conditions, lowered economic opportunities and loss of income that decreases the living standards of older persons and increases their vulnerability to poverty in old age.

On the other hand, Bloom (2009) suggests that economic consequences of an ageing population could be mitigated by behavioural responses, in terms of greater female labour participation, and policy reforms, such as an increase in the legal age of retirement. Higher education attainment of young women today will contribute to higher labour participation of older women in the future (Day & Dowrick 2004). Longer life expectancy and better health conditions will contribute to more people willing to work longer and this will have significant effects on labour force participation and human capital accumulation. In this way, the economic consequences of population ageing could be mitigated through investments in people's wellbeing, in terms of better health care and advance skills learning.

2.5 Labour Force Trends

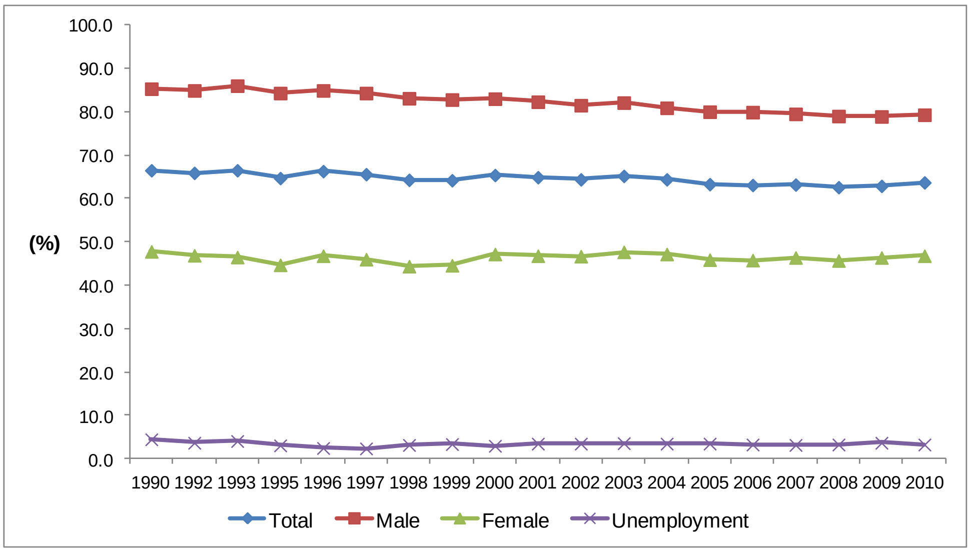
This section analyses the labour force participation by gender and by age based on macro time-series data for Malaysia as a whole and all the states for the period from 1990 to 2010. Further discussions include examining the micro data from the Labour Force Surveys for the year 1990, 2000 and 2010.

2.5.1 Aggregate labour force participation rate

The labour force participation rate declined marginally from 66.5% in 1990 to 65.4% in 2000, with an average labour participation rate of 65.5% over the period (see Figure 2.5). The labour force participation rate further declined to 63.7% in 2010, with an average labour force participation of 63.8% from 2001 to 2010. The decline in the labour participation of males and higher increase in tertiary enrolment contributed to this decrease (World Bank 2012). The unemployment rate remained below 5% from 1990 to 2000, and further reduced to below 4% from 2000 to 2010. The expansion of the labour market contributed to stable unemployment rate (World Bank 2012), with the number of persons employed increasing from 6.68 million in 1990 to 11.89 million in 2010.

The male labour participation rate decreased to 79.3% in 2010, compared to 85.3% in 1990. Since 2005, the male labour participation rates have remained at about 80.0%. Nevertheless, male labour participation rates remain higher than female, as shown in Figure 2.5. The female labour participation rate has decreased marginally since 1990. The period from 1990 to 2000 witnessed a decrease of female labour participation rate from 47.8% to 47.2%. The female labour participation rate further decreased to 46.8% in 2010.

Figure 2.5 Labour force participation rate, 1990-2010



Source: Department of Statistics Malaysia

However, female labour participation rates showed significant increase from 37.0% in 1970. The higher female labour participation could be related to changes in the social environment that supports entry of more women into workforce, as well as wider opportunity for women to pursue higher education. Female labour participation in Malaysia is still relatively low and tends to decline after marriage (World Bank 2010). Malaysian women tend not to return to work after marriage and child birth, thus contributing to lower female labour participation rate in Malaysia, compared to other countries in the region, as well as international standards. For example, in contrast to Malaysia, Australia had a 59% female labour participation in 2010. According to the World Bank (2012), among the factors that restrict higher female labour participation in Malaysia are the limited child care facilities, inflexible working hours and limited part-time work opportunities. Although the Malaysian Government continues to support the establishment of more and better quality child care centres at the work place to encourage more women to return to work (Economic Planning Unit 2008), there are still issues on the availability and quality of services provided by these centres. Details of the Malaysian labour market are shown in Table 2.6, composed of total labour force of about 3.87 million in 1970, which increased to 12.30 million in 2010.

Table 2.6 Labour force ('000), 1970-2010

	1970	1980	1990	2000	2010
Total labour force	3,874	5,109	7,000	9,556	12,304
Employed	3,607	4,817	6,685	9,269	11,899
Unemployed	267	292	315	287	404
Unemployment rate (%)	6.9	5.7	4.5	3.0	3.3

Source: Department of Statistics Malaysia; Taylor 2007.

2.5.2 States Labour Force Participation

The male labour force participation rate also indicates similar decrease in the states in 2010. The states of Johor, Pahang, Penang, Sabah and Sarawak had male labour participation rates above the national level for male labour participation of 78.7% (refer Table 2.7). As for female labour force participation rates, the rate was higher than the national level of 46.1% in four states, namely Melaka, Penang, Sarawak and Selangor.

Table 2.7 Labour force participation rate by states, 1990, 2000 and 2010

State	1990			2000			2010		
	Total	M	F	Total	M	F	Total	M	F
MALAYSIA	66.5	85.3	47.8	65.4	83.0	47.2	62.7	78.7	46.1
Johor	67.9	87.4	48.4	66.9	85.6	46.7	62.3	80.7	42.8
Kedah	61.9	83.7	40.7	62.2	82.2	43.2	59.0	76.6	41.8
Kelantan	64.0	79.7	49.1	60.2	78.0	43.6	55.7	70.8	40.6
Melaka	63.8	81.3	47.6	63.8	81.4	46.3	61.9	76.7	47.0
N. Sembilan	64.3	82.0	47.4	63.5	80.1	46.1	61.1	77.4	43.5
Pahang	64.3	87.9	40.2	62.2	82.1	40.0	62.6	79.5	43.6
Perak	63.6	83.1	45.8	61.5	80.5	42.8	59.1	76.2	41.8
Perlis	58.6	82.6	34.1	60.8	82.2	40.9	55.5	75.1	37.5
Penang	66.2	83.7	49.2	70.8	83.9	58.9	68.1	80.2	56.5
Sabah	63.9	87.4	37.9	64.5	86.4	40.9	64.5	83.4	44.4
Sarawak	77.4	90.6	64.1	72.0	88.0	55.5	66.5	82.3	50.0
Selangor	67.3	84.8	48.7	66.6	82.2	50.5	63.6	77.2	49.5
Terengganu	67.5	85.6	48.9	62.3	80.7	42.5	59.0	75.8	41.1

Notes: M = male, F = female

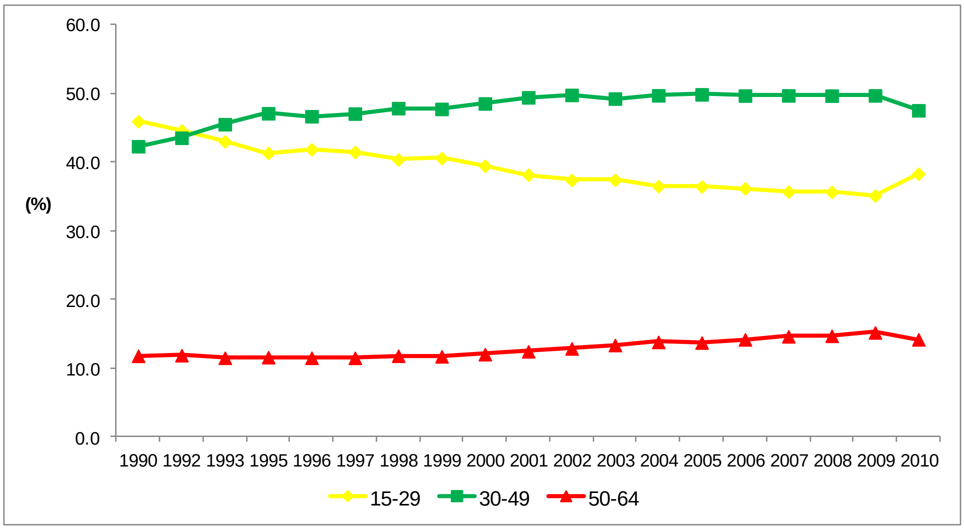
Source: Department of Statistics Malaysia

2.5.3 Labour Force Participation by Age

The working-age population in this study will be divided into three categories: young workers (15 to 29 years), middle workers (30 to 49 years) and older workers (50 to 64 years). Figure 2.6 illustrates these working-age groups from 1990 to 2010. Malaysia's working-age population is relatively young compared to other high- and middle-income countries (World Bank 2012), with about 52.6% of the workforce being under 35 years old or about 85.8% of workers under 50 years old in 2010.

In terms of trends, the level of young workers participation shows a gradual decline from 45.9% in 1990 to 38.3% in 2010. The participation of middle workers continues to remain high averaging at about 47.9%. In contrast, the participation of older workers increased consistently from 11.8% in 1990 to 12.0% in 2000, and further increased to 14.2% in 2010. This trend of increasing older workers participation and declining young workers participation are similar to trends in other developed countries experiencing an ageing population. However, the working age population in Malaysia are expected to decline only after 2060, in comparison to Thailand and China, which will experience the decline of their working age population in 2021 or sooner (World Bank 2012).

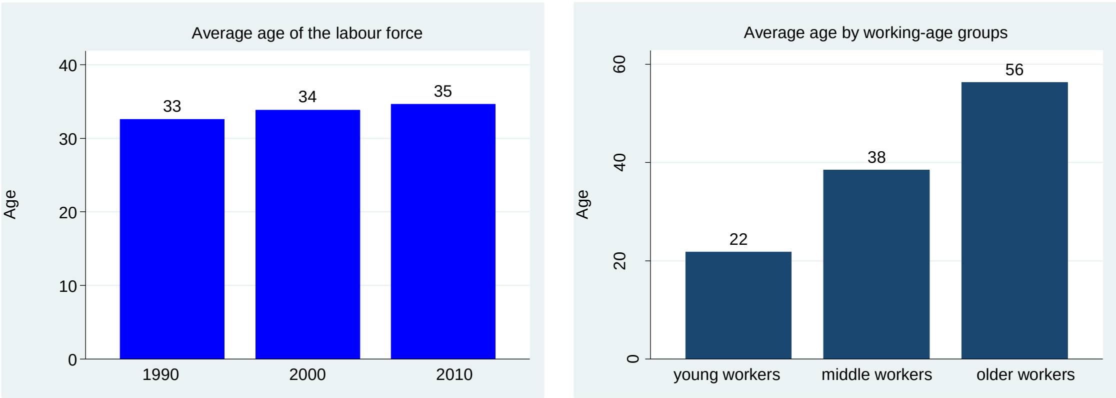
Figure 2.6 Percentage distribution of labour force by working-age groups, Malaysia, 1990-2010



Source: Department of Statistics Malaysia

The decline in fertility rates has resulted in higher share of working-age population contributing to the pool of potential workers in the economy (Bloom 2010). Since the working-age population in Malaysia is not expected to decline until after 2060 (World Bank 2012), this enhances the potential for more economic growth. Figure 2.7 shows that the average age of the labour force in Malaysia increased from 33 years old in 1990 to 35 years old in 2010, indicating continuous changes in the workers age-structure. Meanwhile, during the same period, the average age of young workers was at 22 years old, middle workers (38 years) and older workers (56 years),

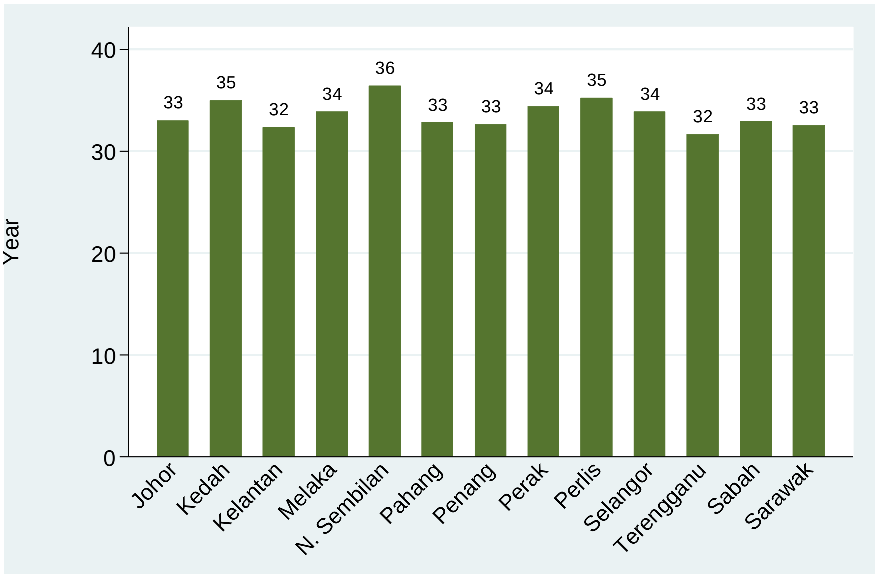
Figure 2.7 Average age of the labour force, 1990-2010



Source: Department of Statistics Malaysia

As shown in Figure 2.8, the average age of the workers in the states ranges from 32 to 36 years old, with the highest average age in the state of Negeri Sembilan and the lowest average age in the states of Kelantan and Terengganu. Although the gap differs marginally, it will be an added advantage to the states for younger working-age population could participate more actively in the labour market, thus contribute more to the state economy (Kim 2012).

Figure 2.8 Average age of the labour force by states, 1990-2010



Source: Department of Statistics Malaysia

2.6 Chapter Summary

This chapter describes the various demographic trends in Malaysia relating to population dynamics, population ageing and labour force, elaborating on the main demographic parameters of age structure and labour force participation that are relevant to this study. The shift towards an ageing population shows declining fertility and mortality rates and higher life expectancy. Although the median age being 26.2 years, the population age structure showed a growing proportion of older people, with labour force trends also indicating growing proportion of older workers. The next chapter will discuss the literature related to economic growth and the human capital development in relation to the Malaysian context.

CHAPTER 3
HUMAN CAPITAL AND ECONOMIC GROWTH TRENDS IN MALAYSIA

3.1 Introduction

This chapter reviews the Malaysian economy, in terms of its economic growth trends and challenges, in particular the challenges of being in the middle-income trap. In addition, the state economic growth and convergence will also be reviewed. The first section on human capital highlights the role of human capital development for economic growth. Next, the section will discuss the role of human capital as a catalyst of economic growth and followed by a discussion on the role of technological progress that provides motivation for human capital accumulation.

Chapter 2 has highlighted the changes in the population age structure and the transition towards an ageing population. Consequently, this chapter elaborates on the empirical evolution of human capital in Malaysia as a result of changes in the population age structure and also as one of the key drivers of economic growth. The final section reviews the education trends in Malaysia for both education quantity and quality.

3.2 Economic Growth and Its Challenges in Malaysia

3.2.1 Malaysia – Economic Trajectory

Prior to independence in 1957, the economy of Malaya (as Malaysia was formerly known) under British colonial rule was mainly based on tin mining and rubber. Before independence as well as in the early years of independence, the Malaysian economy was based on the laissez-faire or open market system. Although the economy adopted free market system, Taylor (2009) found that economic development was spearheaded by the state in the initial stages of development, particularly during times of political instability.

Rapid economic growth had contributed to higher income among the population with total income increase at about 6 to 7% each year from 1970 to 2000 (Yusof and Bhattasali 2008). The per capita income in Malaysia grew at an annual rate of 7% in the 1970s and further increased to above US$2,000 by the late 1980s. Over the decades, Malaysia has successfully transformed from an agriculture-based economy towards a modern manufacturing and services based economy, as shown in Table 3.1. Since the mid-1980s, the manufacturing sector has grown and Malaysia has become one of the world's largest manufacturers of semiconductors, with a sizeable share in global production of electronic and electrical products and textiles (Taylor 2009). The manufacturing sector surpassed the agricultural sector in 1990 in terms of its contribution to GDP, making the manufacturing sector the second main contributor of Malaysia's economic growth. In addition, the services sector contribution increased from 40.0% in 1970 to 52.4% in 2000, however the sector's contribution decline slightly to 51.2% in 2010.

Table 3.1 Gross domestic product by sector, Malaysia, 1960-2010 (%)

Sector	1960	1970	1980	1990	2000	2010
Agriculture	38.0	30.8	22.2	18.7	8.7	10.1
Construction	3.0	3.9	4.5	3.5	3.3	3.4
Manufacturing	9.0	13.4	20.5	27.0	33.4	23.4
Mining	6.0	6.3	4.6	9.7	6.6	10.9
Services	43.0	40.0	42.8	40.4	52.4	51.2

Sources: Economic Planning Unit

The economic trajectory taken by Malaysia can be divided into two main phases. The import-substitution policy phase was implemented from 1957 to 1968. This policy encouraged diversification in the domestic industries. Various forms of tariff and non-tariff protection were imposed to protect the growth of the domestic industry. However, the size of the domestic market limited the growth and efficiencies of these local industries. The second phase draws the government towards adopting an export-oriented strategy (1968 onwards). This period marked the start of heavy industrialisation in Malaysia. Under this policy, various incentives were given to promote export-based industries. This created greater competition and wider market penetration at international level. In the early 1980s, FDI was the main contributor to Malaysia's economic progress. Huge investments in the manufacturing sector, particularly in the electrical and electronic sub-sector contributed to the rapid economic growth. However, since the year 2000, Malaysia has started to focus more towards knowledge-based economy. Malaysia has placed strong emphasis on human capital development over the past few decades and the emphasis has been translated into a national vision to transform Malaysia into a knowledge-based economy. The increase in proportion of educated workers and the expansion of the services sector has created more demand for knowledge workers.

National development planning in Malaysia are based on a series of long-term, medium-term, annual and special development plans, as well as sectoral and industry-specific master plans (Economic Planning Unit 2004). The main development policies consisted of the New Economic Policy (NEP), 1970-1990, the National Development Policy (NDP), 1991-2000 and the National Vision Policy (NVP), 2001-2020. In addition, Vision 2020 was launched by the former Prime Minister Mahathir in 1991 to drive Malaysia towards becoming a developed nation by the year 2020. The vision charted a broad plan for Malaysia to achieve the status of a developed economy, which includes nine strategic challenges that need to be overcome by 2020. The nine specific targets, namely, establishing a united Malaysian nation; creating a psychologically liberated, secure, and developed Malaysian society; fostering and developing a mature democratic society; establishing a fully moral and ethical society; establishing a mature, liberal and tolerant society; establishing a scientific and progressive society; establishing a fully caring society and a caring culture; ensuring an economically-just society; and establishing a prosperous society. In achieving these targets, real GDP need to be increased by eightfold for the period of 1990 to 2020, by setting average annual growth of 7%. The years following the adoption of this vision saw rapid economic growth, until the Asian financial crisis brought a dramatic fall in real GDP in 1998.

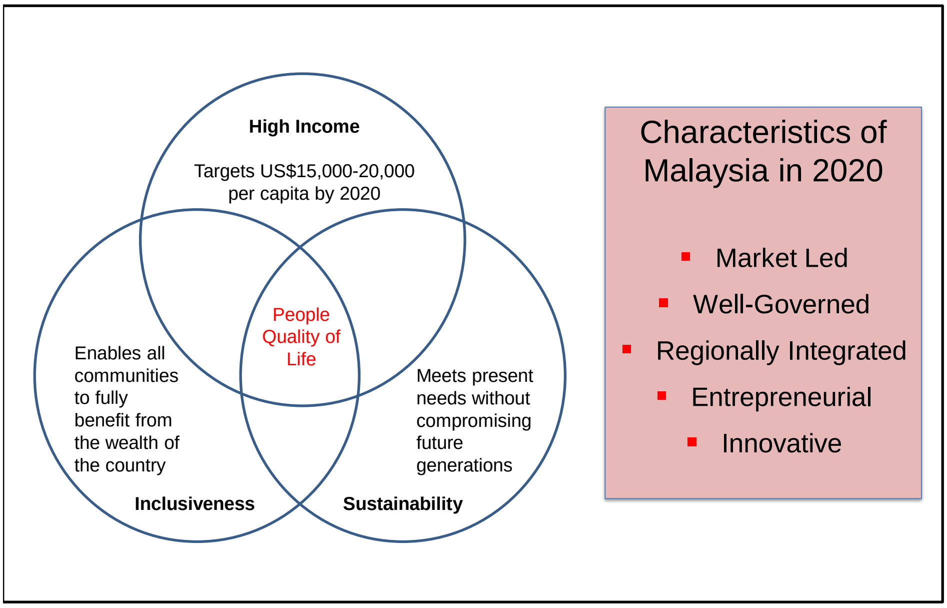
Malaysia economic policies since the 1970s were underpinned by the development philosophy of growth with distribution. This development philosophy presumes that growth will have a ‘trickle-down effect’ that will benefit all. The implementation of these policies spurred economic growth and brought significant reduction of the poverty rate from 49.3% in 1970 to 3.8% in 2009 and further reduced to 0.6% in 2014, as well as significant reduction of poverty rates in both urban and rural areas. Significant progress has been achieved through a more balanced economic participation among the ethnics and wider coverage of basic services. Although the policy has been successful for many years in reducing poverty, in recent years the income shares of bottom 40% of households increased marginally from 14.5% in 1989 to 14.8% in 2010, with Gini coefficient of 0.431 in 2012 (Economic Planning Unit 2015). Income growth tends to be faster in the middle and top income households. If these trends persist, there will be wider gap or income inequalities among the households. Therefore, in moving towards becoming a high-income nation, measures need to be taken to support those in the low-income households.

3.2.2 Middle-income Trap

Malaysia has experienced rapid economic growth since the 1980s but the progress has slowed and economic growth prospects have weakened (NEAC 2010), especially after the Asian and global financial crisis. Previous growth models have provided three decades of rapid economic growth, but Malaysia is now considered to be in the middle-income trap. Among the factors that contributed to the trap are the rising labour and capital costs that hinder competitiveness with lower-income countries which are able to produce low-cost manufactured exports. It may also prevent ‘trapped’ countries from competing successfully with highly-skilled producers in the advanced economies which rely more on knowledge and innovation-based products and services (World Bank 2010). Malaysia reached the middle-income state in 1992, and the slowing of economic growth after the Asian financial crisis brought Malaysia into the middle-income trap.

According to the National Economic Action Council (NEAC 2010), Malaysia needs to undertake radical changes in its economic development as the existing policies and strategies are inadequate to take Malaysia to the next level of development. Malaysia needs to escape from the middle-income trap and strategise its economic growth trajectory towards becoming a high-income nation. The NEAC suggests the implementation of more specific policies with eight Strategic Reform Initiatives (SRIs) as well as a more holistic approach focusing on the human dimension of development. They proposed the New Economic Model (NEM) in 2010 as the catalyst to enhance Malaysia's growth potential. NEM highlights the tough decisions and bold measures needed to transform the economy to become a high-income advanced nation with inclusiveness and sustainability by 2020. The main goals and characteristics of the New Economic Model are as shown in Figure 3.1 below.

Figure 3.1 The new economic model: Goals and characteristics



Source: National Economic Advisory Council 2010

The Tenth Malaysia Plan highlighted the need for Malaysia to increase the productivity level as to compete with other emerging economies in the Asia region. This productivity growth will be achieved through higher levels of input from human capital, adoption of new technologies and development of entrepreneurship to drive innovation and creativity (Economic Planning Unit 2010). These measures will lead to rapid adoption of new technologies that will enable Malaysia to match the research and innovation intensity of world leaders.

In a condition when growth momentum slows down in a middle-income country, shifting focus on education to create the right skills to enhance productivity could be the solution to enhance growth (Jimenex, Nguyen & Patrinos 2012). In Malaysia, development policies since the 1970s have stressed on the importance of education as an input for growth and higher income. Educational attainment is used as a tool not only to obtain more highly paid employment but also as a successful mechanism to reduce poverty levels and increase household income. The Tenth Malaysia Plan (2011-2015) highlighted the need to accumulate human capital through education as the primary means of improving productivity in a knowledge-based economy. The global shift towards knowledge and innovation-based economy needs Malaysia to have an efficient labour market and highly-skilled human capital. The NEM outlines eight strategic reform initiatives, with one specific initiative focusing on human capital development to continuously improve productivity for sustainable economic growth. This initiative aims to further enhance the quality of the education system to nurture skilled, inquisitive and innovative workers (National Economic Advisory Council 2010).

In addition, the focus on science and technology (S&T) in Malaysia started from the 5th Malaysia Plan (1986-90) and through the promulgation of a National S&T Policy in 1986. The launching of the Industrial Master Plan (IMP) enhanced further technology promotion across industrial sectors to augment the growth of S&T, as well as integrate S&T policy into national development planning (Felker 1999). According to Felker (1999), there are wide disparities in technological advancement across sectors as foreign-dominated export industries in Malaysia use modern production technologies, while domestic-oriented and small-scale industries often use outmoded techniques and equipment. This indicates issues of technology diffusion within the industrial sector, although efforts are being taken by the government to raise technological capabilities by promoting, coordinating and strategically managing the technology diffusion and industrial integration. The limited progress in technology diffusion among the local industries, particularly small and medium-sized industries reflects the continued weakness of the absorptive capabilities of the industries (Felker 1999).

Asher (2005) in World Bank (2010) estimated that 31% of the Malaysian workforce is in the informal sector, with the contribution level to GDP per capita relatively low. Informality can lead to losses in productivity and adversely affect growth for it may encourage firms, among others, to stay small, reduce incentives to innovate or improve human capital, promote tax evasion and promote unfair competition. The likelihood of a worker being informal declines significantly with higher levels of education. Education increases productivity, thus making business costs less onerous and returns to investment potentially larger. Malaysia's emphasis on moving to a knowledge-based economy and developing its human resources will eventually reduce the numbers of workers in the informal sector and able to further enhance economic growth.

3.3 State Economic Growth

This section will discuss the mean monthly gross household income and poverty level in the states of Malaysia. The Malaysian economic development policies have been shaped by the government's commitment in ensuring that the benefits of economic growth are shared equitably among the population (Malaysia 2006).

The Malaysian economic policies since the 1970s were underpinned by the development philosophy of growth with distribution. This development philosophy presumed that growth will have a 'trickle-down effect' that will benefit all. This resulted in significant reduction in poverty rate from 49.3% in 1970 to 3.8% in 2009, as well as significant reduction in poverty rate in both urban and rural areas. Significant progress was also achieved in having a more balanced economic participation among the ethnics and wider coverage of basic services. However, there remain vulnerable sections of the population due to low incomes or disadvantaged circumstances. Although such policy has been successful for many years, in aspiring to become a high-income nation, Malaysia may need to channel more resources to support low-income households in increasing their income level. Income growth tends to be faster in the middle- and top-income households. If the trends persist, there will be increased income inequalities among the households. Therefore, as Malaysia continues to grow, more focus should be given towards increasing the income levels of the bottom 40% household income group, which constitutes a total of 2.7 million households in 2014, with a mean monthly household income of less than MYR2,537[13] (Economic Planning Unit 2015).

The majority of these households are single-income recipients, with the heads of household attaining secondary level or lower qualifications, and self-employed or involved in low-skilled jobs. In addition, due to their lower skills level and sometimes remote locations, the bottom 40% households are limited in their economic mobility and ability to secure higher paying jobs as well as income opportunities. In 2009, a total of 51.4% of the bottom 40% households resided in urban areas. These households were predominantly engaged as employees in the elementary occupation classifications in the public and private sectors and among the self-employed in the informal sector.

Table 3.2 Mean monthly gross household income and incidence of poverty by state

State	Mean Household Income (MYR)			Incidence of Poverty (%)		
	1989	1999	2009	1989	1999	2009
MALAYSIA	1,169	2,472	4,025	16.5	8.5	3.8
Johor	1,220	2,646	3,835	9.8	3.1	1.3
Kedah	860	1,612	2,667	29.9	14.2	5.3
Kelantan	726	1,314	2,536	29.6	25.2	4.8
Melaka	1,190	2,260	4,184	12.4	2.9	0.5
N. Sembilan	1,162	2,335	3,540	9.1	4.1	0.7
Pahang	1,092	1,482	3,279	10.0	9.8	2.1
Penang	1,375	3,128	4,407	8.7	0.7	1.2
Perak	1,067	1,743	2,809	19.2	6.8	3.5
Perlis	852	1,431	2,617	17.4	13.6	6.0
Selangor	1,790	3,702	5,962	7.6	1.9	0.7
Terengganu	905	1,600	3,017	31.3	22.7	4.0
Sabah/FT Labuan	1,358	1,905	3,144	29.7	23.4	19.2
Sarawak	1,199	2,276	3,581	21.0	10.9	5.3

Source: Economic Planning Unit and Department of Statistics Malaysia

[13] About $875 (AUD1=MYR2.90).

The government has implemented various programmes to improve the income level of the poor households, particularly through skills training and better income opportunities, as well as improving the education delivery through better access and quality. The mean monthly gross household income has increased from MYR1,169 in 1989 to MYR4,025 in 2009, as shown in Table 3.4 above. Three states have higher than national mean household income, namely the state of Melaka, Penang and Selangor. According to Lucas (1996), towards the later years of the New Economic Policy (1970-1990), Malaysia further increased its focus on human capital development to accelerate growth as well as a mechanism to restructure the society. The human capital development contributes to the labour force by having higher level of education and skills set, as well as shifting the economy from highly dependent on unskilled and cheap labour to higher skilled and knowledgeable worker.

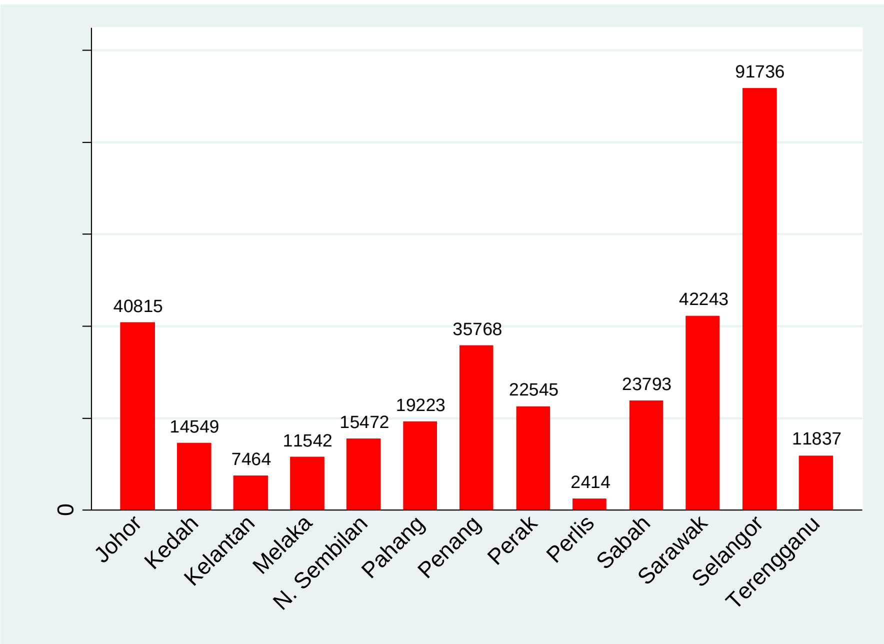
3.4 State Economic Convergence

This section discusses on the role of human capital in economic growth and convergence. Convergence theory hypothesises that in poorer economies income per capita will grow faster than in richer economies. Rodrik (2011) suggests that the convergence gap could be reduced through rapid economic growth, but only if the lagging states could increase their ability to absorb ideas and knowledge from the technology frontier. He points out that although policies and structures play an important role in enhancing growth as well as managing shocks and crises, they do not provide certainty for economic growth. The relative magnitude of the catch-up rate and the difference in the growth rate due to innovation will determine the steady state growth relationship. This highlights the critical role of the nature of the technology diffusion process and its interaction with education in fostering economic growth. That is, a country with a low level of education may still keep within the gravitational pull of the technology leader provided that the level of education is high enough to permit sufficient diffusion. A study by Cuaresma, Havettova and Labaj (2013) on the role of educational improvements on income convergence in Europe reveals that improvements in human capital contribute significantly to the income convergence potential of European emerging economies.

Although studies on income convergence have proliferated, analysis of convergence between regions has been scare due to data limitations (Gennaioli et al. 2014). Using a sample of 1,528 regions from 83 countries, these authors analysed the patterns of convergence among regions and compared them to convergence across countries. They claimed that income differences contributed to the speed of regional convergence. They analysed regional growth regressions by including interactions of regional GDP with proxies for national market institutions as well as governments transfer and found that regional convergence is faster in richer countries and in countries with better-regulated capital markets and fewer trade barriers.

According to Ali and Ahmad (2009), the development gaps between states, as well as the gaps between urban and rural areas in Malaysia have remained wide. The heterogeneity across states in Malaysia due to historical background and resources, contributes to continuous gap between per capita incomes among the 13 states. In the period between 1990 and 2010, the average state GDP in Perlis (the state with the lowest state GDP) was 2.32% compared to the highest average state GDP of the state of Selangor. Figure 3.2 highlights the average state GDP, which clearly indicates disparities in state income.

Figure 3.2 Average state GDP, 1990-2010 (2005=100)



Source: Author’s calculations

3.5 Human Capital Development for Economic Growth

The endogenous growth theory, which is an extension of the neoclassical growth model, proposes that the introduction of new accumulation factors, mainly knowledge and innovation, contributes to economic growth and divergent growth patterns across the world. On the other hand, the neoclassical growth model assumes that technological progress is the only determinant of growth beyond the steady state and treats technological progress as exogenous.

Although several factors contribute to economic growth, the literature on human capital points to a positive relationship between human capital and economic growth. However, there is also evidence that as the age structure of the population changes and moves towards an ageing population, the phenomenon leads to a slower rate of economic growth and therefore increases the need to support productivity growth through investment in skills and education (Intergenerational Report Australia 2010). Since human capital is embodied knowledge and skills, and economic development depends on advances in technological and scientific knowledge, development presumably depends on the accumulation of human capital (Becker & Murphy 1990).

3.5.1 Human capital as a catalyst for economic growth

Perspectives on human capital have changed over time, from early perspectives that focused on returns to education on income to a broader perspective that looks at human capital in terms of the overall development of individuals and countries. Studies on human capital attract greater attention following the research works of Schultz, Mincer and Becker in the 1950s and early 1960s. Their research provides new insights into the significant role of human capital in economic development (Becker 2011).

Lucas (1988) defines human capital as the skills embodied in workers who have gained ‘know-how’ through education and training. Human capital represents the knowledge, skills, health and values embedded in an individual that cannot be analysed in a disaggregated manner as other financial and physical asset (Becker 1992). Therefore, expenditure on education, training and medical care constitutes an investment that enhances human capital (Schultz 1961; Becker 1993). Human capital is also perceived as the capacity of people to adapt to the changing environments (Schultz 1961; Nelson & Phelps 1966, Day & Dowrick 2004), thus contributing to competitive advantage in output production (Nonaka, Toyama & Peltokorpi 2011). The ability to absorb and diffuse knowledge by labour or society contributes towards higher economic output (Taylor 2007). In addition, Dowrick (2003) highlights the distinction between embodied and disembodied human capital, identifying disembodied human capital as knowledge and ideas that do not remain with their inventors and can be transmitted freely between people and over time.

In this study, human capital will be analysed in terms of level and growth effects. The level effect suggests that the level or stock of human capital will enhance economic growth, but the growth effect suggests that it is the accumulation of human capital that affects economic growth. Therefore, this study aims to ascertain the human capital level effect and growth effect on economic growth in Malaysia, as both effects have different connotations to economic growth.

The importance of human capital on economic growth has been widely established in the research literature. Higher government expenditure and investment by parents or individuals on education contribute in enhancing the economic growth potential of a country. Results from earlier research on return of investment in education have indicated that individuals with higher educational accumulation have more opportunity to get higher paying jobs or wages. Studies based on the Mincer model provide empirical support on the importance of human capital on economic growth. In addition, Nelson and Phelps hypothesis also propose that a backward economy could still grow rapidly just by depending on human capital and imitation (Messinis & Ahmed 2013).

3.5.2 Technological progress and human capital accumulation

Technological advance can be considered as one of the main catalyst for economic growth (Nelson 2005). According to Romer (1990), capital accumulation and technological change contribute for most of the increase in output per hour worked, as technological change provides the incentive for continued capital accumulation. The creation of technology and adoption of these technological changes rely on greater human capital knowledge and capabilities, thus acknowledging that knowledge are fundamental to economic growth (Dowrick 2003).

Becker (1994) is one of the first scholars to claim that increased investments in education and training for human capital accumulation have the potential to increase the development of new technologies that can enhance economic growth. Dowrick (2003) also reaffirms that technological advances depends on the level of education of the workforce and that investment in human capital, apart from physical capital, contributes to rapid economic growth.

There are two ways which human capital can influence the long-run growth of productivity (Nelson & Phelps 1966; Day & Dowrick 2004). First, the increasing number of researchers with higher skills level will speed the rate of innovations in research and development. Second, higher skills level among the workforce will help in efficient absorption of new technologies in the workplace. There is general consensus in the literature now that human capital can affect technological progress by influencing both domestic innovation and diffusion of technology (Nelson & Phelps 1966; Benhabib & Spiegel 2005; Cuaresma, Lutz & Sanderson 2009).

3.6 Population Ageing and Human Capital Accumulation

The role of human capital accumulation in economic growth becomes even more important in an ageing nation as labour-intensive and low-skills manufacturing work cannot provide the momentum needed for high productivity. Labour force participation rates will tend to decrease as the population ages, thus reducing the labour supply (Bloom, Canning & Fink 2010), which may affect economic growth in the long-run. Maestas, Mullen and Powell (2016) find that population ageing contributes to slower growth in the labour productivity of workers, whereby a 10% increase in population ages 60 plus reduces the growth rate of GDP per capita by 5.5%.

On the other hand, demographic transition towards low fertility rate has contributed towards higher investment in human capital (Lee & Mason 2010). Empirical research has supported the link between fertility rate and investments in human capital, with lower fertility rates enhancing higher investment in human capital per child (Becker & Barro 2001; Lee & Mason 2010). This is because lower fertility and mortality rate changes the family structure over time and parents can invest more in their children's education. Lower fertility rates contribute to smaller family size and raise incentives among parents to invest in their children's education. Parents may derive utility directly from the achievements of their children and invest in their children's education for purely altruistic reasons. These investments will also lead to higher accumulation of human capital that may contribute to an even higher labour productivity in the future. Initially, support ratio will rise as fertility falls, however higher support ratio could also generate higher investment in human capital (through partially investing in the first demographic dividend) and this will lead to increase in worker productivity. With more investment for children's education, higher productivity from high-level skills could offset the effects of the rising old-age dependency ratio in the future.

This debate on child quantity and quality will affect the decision to invest in human capital (Becker 1993, Bloom et al. 2012), although the quantity-quality substitution alone is not able to completely reverse the negative impact of declining fertility on the aggregate human capital. In addition, Prettner, Bloom and Strulik (2012) find that lower fertility could enhance effective labour through higher investments in education for children, which will contribute to higher-quality labour force and able to overcompensate the negative effect of the lower fertility rate. Meanwhile, Becker, Murphy and Tamura (1994) argue that when human capital is abundant, rates of return on human capital investments are high relative to rates of return on children, whereas when human capital is scarce, rates of return on human capital are low relative to those on children. Therefore, societies with limited human capital choose large families and invest little in each member and those with abundant human capital do the opposite.

3.7 Education as human capital

Existing literature suggests that education is the most important determinant of human capital and it is crucial in generating long-term economic growth (Barro & Lee 2010; Bloom 2010; Dowrick 2003; Becker 1994; Lucas 1988). Education has also been identified as an important factor that yield better health status, which will eventually enhance labour productivity (Lutz et al. 2010). Higher educational level of the labour force could enhance labour productivity and absorption of technology.

One of the important aspects about education as a determinant of human capital is that highly educated workforce can more readily identify, adapt and implement new ideas, whether these ideas are generated domestically or overseas (Dowrick 2003). Dowrick (2003) observes that higher rates of investment in education and research could enhance strong productivity growth, as observed in leading OECD economies. The increase in educational attainment contributes in enhancing labour productivity and ability to absorb advanced technologies (Barro & Lee 2010; Wilson & Briscoe 2004) and thus, enhancing economic growth (Papageorgiou 2003; Hicks, Basu & Sappey 2010). Lucas (1988) also proposes that the decision to spend time in the education sector and in the production sector will determine the long-term growth rate. In addition, Becker, Murphy and Tamura (1994) suggest that as the stock of human capital increases, the rates of return on investments in human capital will continue to rise rather than decline. This is because education and other sectors that produce human capital use educated and other skilled inputs more intensively than sectors that produce consumption goods and physical capital.

There is a large body of literature on measuring and conceptualising education as a determinant of human capital accumulation that has direct implications for productivity and economic growth. Early works on human capital strongly focused on the perspective of investment and financial returns resulting from formal education and training - linking earnings to years of schooling (Schultz 1961; Becker 1964). Researchers have also linked years of schooling with higher economic growth. Previous literature examining the relationship between education and economic growth, used school enrolment ratios or literacy rates (Romer 1990; Barro 1991). However, in enhancing the accuracy of the relationship estimation, Barro and Lee (2010) utilised data from 1950 to 2010 to measure overall years of schooling as well as by the composition of educational attainment of workers at various levels of education.

According to Krueger and Lindahl (2000), workers that attend longer schooling years usually have the attributes that enables them to earn higher income. Using data which are disaggregated by sex and by 5-year age intervals with coverage of 146 countries, they estimated the relationship between education and output based on a simple production-function approach. They find schooling has a significantly positive effect on output and levels of income at the country level, and the estimated rate of return on each additional year of schooling is higher at secondary and tertiary levels than at primary levels. As Barro and Lee (2010, p.9) point out, 'improvements in completion and enrolment ratios at all levels among the younger cohorts in every generation continually contribute to rising average years of schooling as they mature over time'. The level of education is expected to increase in the future as labour force continually invests in increasing their skills level and educational attainment.

Several studies have shown that more developed regions or states have higher human capital due to their higher rates of investment in human capital (Becker 1994; Zhang & Zhuang 2011), and that higher estimated rates-of-return for each additional year of schooling have been linked with economic development (Barro & Lee 2010; Bloom 2010). Meanwhile, Benhabib and Spiegel (1994) estimated that an additional year of schooling will increase long-run growth of productivity by 0.3 percentage points and a study by Dowrick and Rogers (2002) also produces similar estimate of 0.3 percentage points. Bloom, Canning and Fink (2011) show that school enrolment and educational attainment across countries have improved, with average years of schooling completed for individuals aged 25-29 increased by 1.87 year for males and 2.58 years for females between the periods of 1970 to 2000.

In addition, researchers have also established the link between fertility rate and investments in human capital, whereby lower fertility rates enhance higher investment in human capital per child (Becker & Barro 2001; Lee & Mason 2010). The smaller family size enables additional funds to be invested in health, education and well-being of each child (Population Bulletin 2012). These investments will eventually lead to higher accumulation of human capital that may contribute to an even higher labour productivity in the future.

Education could affect economic growth through years of schooling as well as through educational attainment (Cuaresma, Lutz & Sanderson 2009). Difference in structures of education also plays an important role for economic growth. The contribution of primary education to output production, particularly in the developing countries is substantial whereas its contribution to R&D is limited (Papageorgiou 2003). Nevertheless, primary education is still important for early stage of industrialisation in developing countries. Therefore, education for the young age group is particularly important to enhance economic growth in developing countries (Cuaresma, Lutz & Sanderson 2009). In addition, Cuaresma and Mishra (2009) find that age-structured human capital data improves economic growth forecasts significantly. Their study finds that while tertiary education acts as an engine of technology innovation in highly developed countries, secondary schooling is the key variable to technology adoption in developing countries. The distance to the technology frontier thus appears a robust determinant of the returns to education in terms of economic growth.

Higher investments in education and training for human capital accumulation have the potential to increase the development of new technologies that can enhance economic growth (Becker 1994). A study on the effect of the composition of human capital on China’s economic growth relates the more important role of tertiary education, compared with primary and secondary education (Zhang & Zhuang 2011). Developed provinces were found to have benefited from an increase in tertiary educated workers, while the underdeveloped provinces depend more on workers with lower levels of education. Furthermore, Barro and Lee (2010) also find that schooling has a significant effect on economic output and the estimated rate of return on each additional year of schooling is higher at secondary and tertiary levels than at primary levels.

The link between higher education and economic growth was earlier demonstrated by Denison (1985), who found that increased years of schooling in the United States of America (USA) between 1929 and 1982 contributed to about 25% of growth in USA per capita income. More recently, Barro and Lee (2010) estimate that the rate-of-return to each additional year of schooling ranges from 5% to 12%. Furthermore, increasing employment opportunities for those with higher education strengthens the important role of education in providing access to employment (Serban 2012), as well as higher wages. Nevertheless, the ability and willingness to contribute differs between people, not all members of the population are able to contribute to the economy (Cuaresma, Lutz & Sanderson 2009).

Despite the general consensus in the literature on this issue, Lutz, Cuaresma and Sanderson (2008) argue that the empirical basis for assuming that education has a positive effect on economic growth is rather weak. They claim that at the macroeconomic level, the empirical evidence relating to changes in education level and its contributions to economic growth has been ambiguous. Therefore, despite the research supporting the need for more tertiary education, there is also concern about oversupply of university graduates and the capacity of the labour market to absorb these graduates. This raises the need for a serious consideration of the role and efficacy of education as well as the type of investment and education policy for Malaysia.

3.8 Human Capital Development in Malaysia

In achieving economic transformation, higher levels and different types of skills are needed to increase productivity and innovation (World Bank 2012). World Bank (2013) stresses the importance of education for Malaysia's growth, describing it as an essential element in achieving the high-income nation status. For this reason, the Malaysian Government regards education as a national priority, and remains committed to providing an education-related infrastructure that continuously promotes the development of human capital in Malaysia. This section begins with some background information on education and economic development, and is followed by a discussion of reforms in higher education that have resulted in further growth in tertiary education in Malaysia, as well as its quality.

The development of human capital and provision of educational-related infrastructure has always been an important agenda for the Malaysian Government. Policies to reduce income imbalances and various programmes to enhance the quality of life of the population have augmented the need for higher level of education among the population. In addition, the government has further emphasised the need to upgrade the skills and capabilities of the existing workforce under the Tenth Malaysia Plan as part of the nation's efforts towards becoming a high-income economy by 2020 (Economic Planning Unit Malaysia 2010).

In the case of Malaysia, substantive investments in educational infrastructure[14] have demonstrated the government's commitment to improving access to education and raising educational standards (Malaysia 2012). For example, the expenditure for education and skills training in 1990 was 18.5% of total government expenditure or 5.5% of GDP, increasing to 25.1% of total government expenditure or 6.7% of GDP by 2010 (Ministry of Finance Malaysia 2012), as shown in Figure 3.3 below. As a result of these policies and

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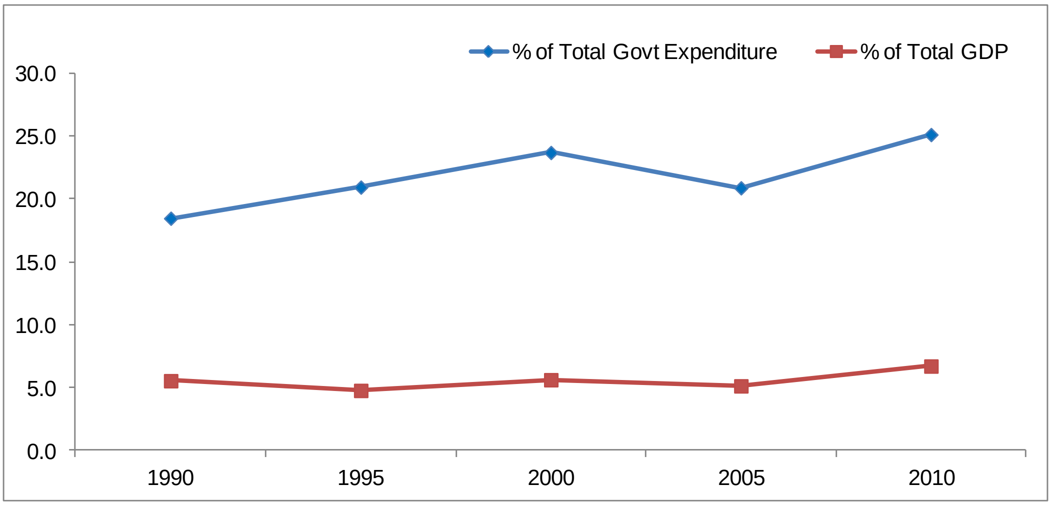
[14] The World Competitiveness Ranking for education infrastructure showed that Malaysia ranked at 28th place in 2012, improving from 34th place in 2001.

investments, Malaysia has been able to achieve remarkable progress in educational attainment since the 1980s.

Figure 3.3 Education and skills training expenditure, 1990-2010 (%)



Source: Ministry of Finance Malaysia 2013

Prior to the mid-1990s, the provision of higher education in Malaysia was mainly the responsibility of the federal government (Ahmad 1998; Wilkinson & Yussof 2005). The establishment of the Universities and University Colleges Act in 1971 has given the Ministry of Education full control over all universities in almost all matters (Sato 2005). However, the perception during that period was that primary schooling would contribute to higher economic returns than higher education, thus justifying a higher budget allocation for primary level (Sivalingam 2007). Since the bulk of the education budget allocation was for the primary schools, there were limitations in providing educational infrastructure for higher education in Malaysia. The limited places in local public universities or colleges were insufficient to meet the increasing demand for tertiary education (Wilkinson & Yussof 2005). Furthermore, the rising costs of overseas tertiary education as well as global recession that hit Malaysia in the mid-1980s made the popular option of overseas education too expensive (Sato 2005; Wilkinson & Yussof 2005).

In addition, the rapid economic growth during the 1990s created higher demands for tertiary level graduates, especially from multinational corporations investing in Malaysia. Rapid economic growth experienced in Malaysia since the early 1990s has created a higher demand for educated and skilled workers. In Malaysia, higher educational attainment is associated with higher wages, with workers having tertiary education getting higher wages. The increasing demand for higher educated workers and higher earnings are important factors that could attract more people to acquire knowledge and skills in the future. The emphasis on educational opportunities along with higher awareness among parents to invest in education has contributed to the rising levels of educational attainment. In addition, the changes in population demographics due to lower level of fertility also allowed parents to invest more on their children's education.

These demand factors prompted the government to revise its education policies to meet the demands for higher education, and provide for a more structured development of private higher education (Sato 2005). Following this, the establishment of the Education Act 1996 created the platform for further growth in private education, particularly private tertiary institutions (Ahmad 1998). This shift to education liberalisation created greater autonomy in higher education and encouraged educational institutions in both the public and private sectors to adopt a more commercial approach.

The shifts in education policies were also associated with the changes in industrialisation policies in Malaysia. The different phases of industrialisation lead to transformations in the national economy. Linking industrialisation and education development in Malaysia, Taylor (2007) points out that during the import-substitution phase of industrialisation in Malaysia (1958 to 1970), the role of the education sector was to increase the supply of the semi-skilled labour. During the export orientation phase (1971 to 1990), education was to support new employment by increasing the supply of semi-skilled and skilled labour force. The education focus shifts to emphasising more on science and technology during the export-led growth. The productivity driven economy plays an important role in further developing human capital and provide rapid expansion of the tertiary education. Public expenditure on tertiary education increased significantly, in line with the shifts to services sector as the new source of growth.

Theories on human capital support the hypothesis of significant returns on investment in education. Returns to education in Malaysia, especially at the higher education levels, remain high and positive (Chung 2003). In examining the impact of human capital and international trade on the coefficient of the capital share of output on Malaysia's economic growth, Taylor (2007) found that the value of the coefficient of capital could be lowered with improvement in labour quality. The reduction of coefficient of capital share contributed to less capital expenditure and greater savings. These improvements are the results of human capital enhancement from learning-by-doing and technological progress embodied in using foreign equipment made possible through international trade. However, to what extent does human capital affect the differences in levels and growth rates of TFP and income? This question becomes one of paramount importance, particularly in light of the rising interest and debates on the costs and benefits of education policy and programs.

3.9 Education trends in Malaysia

This section will examine the links between educational attainment and population age groups in Malaysia to enhance understanding of the levels and distribution of knowledge within the population. In this study, the educational attainment is used as an important predictor for human capital. Workers with higher level of educational attainment could better absorb and utilise technology, which contributes to higher productivity and economic growth (Benhabib & Spiegel 1994; Dowrick 2003; Zhang & Zhuang 2011).

Higher level of educational attainment also expands the pool of knowledge workers that continuously seek training to enhance their skills. Benhabib and Spiegel (1994) also points out that physical capital and per capita income growth positively linked to average levels of human capital. The discussion will address the quantitative aspects of measuring human capital in terms of educational attainment of the labour force, and compares the educational attainment of the labour force across states and over time from 1990 to 2010 within the states. Improvements in the education systems in the past few decades have enabled students to further continue their study to the upper secondary level. The high demands for tertiary education have led to reforms in the higher education systems and the proliferation of private higher education institutions. These changes have contributed to increase in the average years of education as well as the higher educational attainment among the working-age population in all states.

3.9.1 Educational Attainment of Malaysian Workers

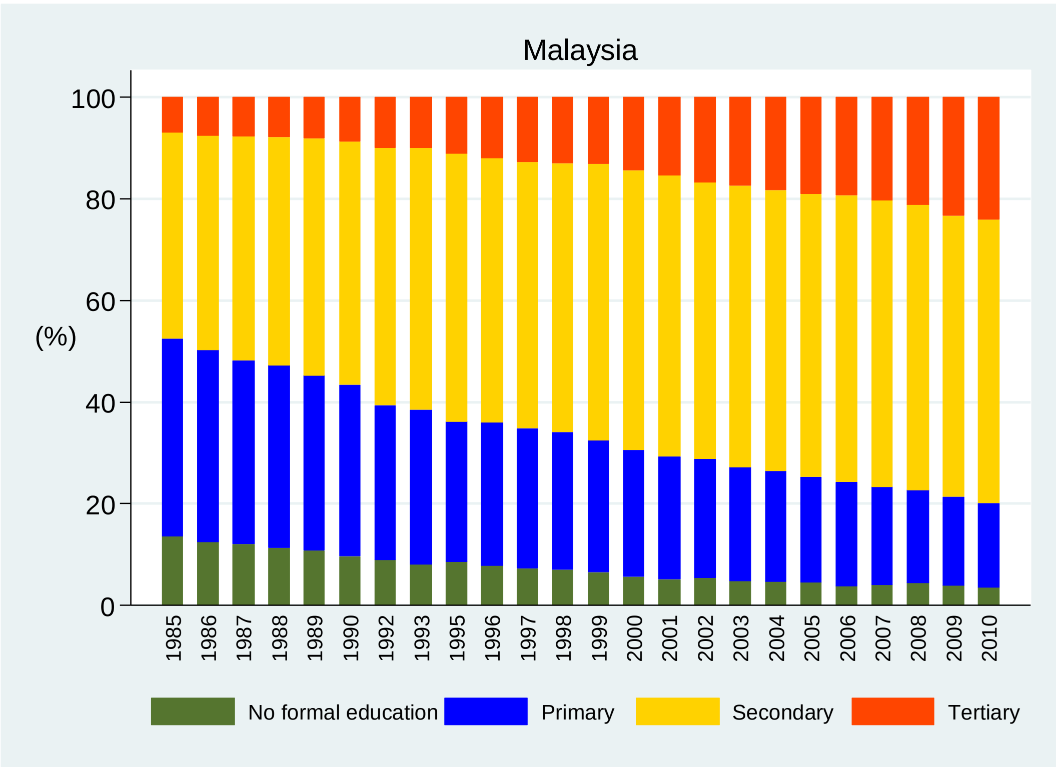
The expansion of education infrastructure in Malaysia has contributed towards remarkable progress in terms of higher adult literacy [15] and educational attainment among the population. Literacy rate among Malaysians has increased, with the adult literacy rate increased from 82.9% in 1991 to 93.6% in 2010. Female literacy rate increased 13.4 percentage points, from 77.3% in 1991 to 90.7% in 2010. Similarly, male literacy rate increased from 88.6% in 1991 to 95.4% in 2010 (Economic Planning Unit Malaysia 2012).

Greater awareness among the population to seek formal education, both in rural and urban areas, has resulted in the impressive progress achieved in terms of school enrolment rates. In the early 1990s, reforms in the education system in Malaysia had extended the provision of basic education from 9 years to 11 years (Lee 2010). Therefore, basic education covers 6 years of primary education, 3 years of lower secondary education and 2 years of upper secondary education. This expansion of education enabled more students to proceed to upper secondary education (Tan 2012), which resulted in an increasing demand for post-secondary education and further expansion of higher education (Lee 2010). Data from the Labour Force Surveys (LFS) time series data indicated that average years of education of the labour force increased from 9.3 years in 1990 to 10.1 years in 2000 and further increased to 10.8 years in 2010.

[15] Literacy is defined as the skills to read and write a simple sentence about everyday life (UNESCO Institute for Statistics 2012).

Gross enrolment rates[16] for primary education were above 90% during the period of 1990 to 2010, achieving near universal enrolment at the primary level. Meanwhile, secondary level enrolment rates indicated an increase of 14%, from 55% in 1990 to 69% in 2010. The highest percentage increase was at the tertiary enrolment rates, where there was a remarkable increase of 35%, from 7% in 1990 to 42% in 2010 (Economic Planning Unit 2012; World Development Indicators 2012). In general, increases in the tertiary educated labour force could further enhance expansion of the economy and higher GDP per capita in Malaysia. The Malaysian labour force is now more highly educated than it was three decades ago. In terms of higher educational attainment in the labour force, data trends showed a cumulative increase across all states since 1985, as shown in Figure 3.4 below.

Figure 3.4 Percentage distribution of labour force by educational attainment, 1985-2010



Source: Department of Statistics Malaysia

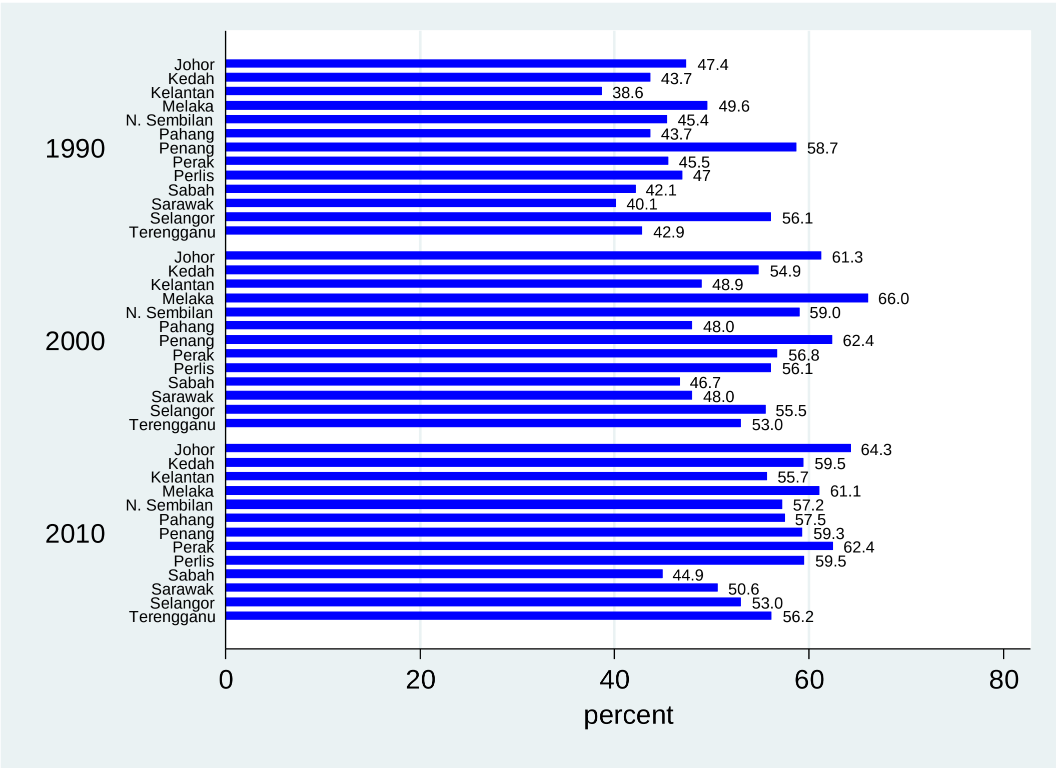
[16] Gross enrolment ratios refer to the total enrolment in either primary, secondary or tertiary education, regardless of age, expressed as a percentage of the population of official (either primary, secondary or tertiary) education age (World Development Indicators 2012).

The proportion of the labour force with tertiary education has increased by 15.4%, rising from 8.8% in 1990 to 24.2% in 2010. The share of labour force with no formal education reduced from a double digit share in 1985 to 5.6% in 2000, and further reduced to 3.6% in 2010. Similarly, the share of labour force with primary education reduced by nearly two-fold from nearly 40% in 1985 to less than 20% in 2010. However, the share of labour force with secondary education increased from 40.7% in 1985 to 55.7% in 2010. In general, about 76% of the labour force in 2010 had achieved secondary or lower educational levels. Although the share of labour force with tertiary education in Malaysia has increased, this level is still relatively low compared to other high-income countries and some ASEAN member countries (World Bank 2012).

The educational level among the labour force in the states has increased since the 1990s. Analysis using the time-series data from the labour force surveys indicated that the proportion of the labour force with secondary and tertiary level education has increased in all states. However, even though educational attainment has improved over the years, disparities among the states still persist, especially in the state of Sabah. The increase was also contributed by the decrease in the proportion of the labour force with no formal education and primary level. Those with no formal education decreased to less than 8% for all states in 2010, but still remained relatively high in the states of Sabah (12.4%) and Sarawak (10.5%), while the states of Johor and Penang had the lowest proportion at less than 1.0%. These decreases indicated that wider access to basic education has contributed in reducing the proportion of labour force with no formal education or only primary education.

Efforts to widen formal access to secondary education in the early 1990s by the Malaysian government has contributed to higher percentage of secondary educated labour force. Figure 3.5 showed that the labour force with secondary education increased in all states, with all states having more than 44% secondary educated labour force in 2010, indicating an average increase of 10.8% from 1990 to 2010. Those with secondary education were highest in the states of Johor (64.3%), Perak (62.4%) and Melaka (61.1%) in 2010. However, the proportion remained low in the states of Sabah and Sarawak. Sabah indicated a slight increase of 2.8%, from 42.1% in 1990 to 44.9% in 2010, and Sarawak indicated an increase of 10.5%, from 40.1% in 1990 to 50.6% in 2010. The state of Selangor showed a reducing trend, from 56.1% in 1990 to 53.0% in 2010, a decrease of 3.1%, which may have resulted from the higher level of tertiary educated labour force in Selangor. In 1990, the secondary level was highest in the states of Penang at 58.7%, followed by Selangor (56.1%) and Melaka (49.6%).

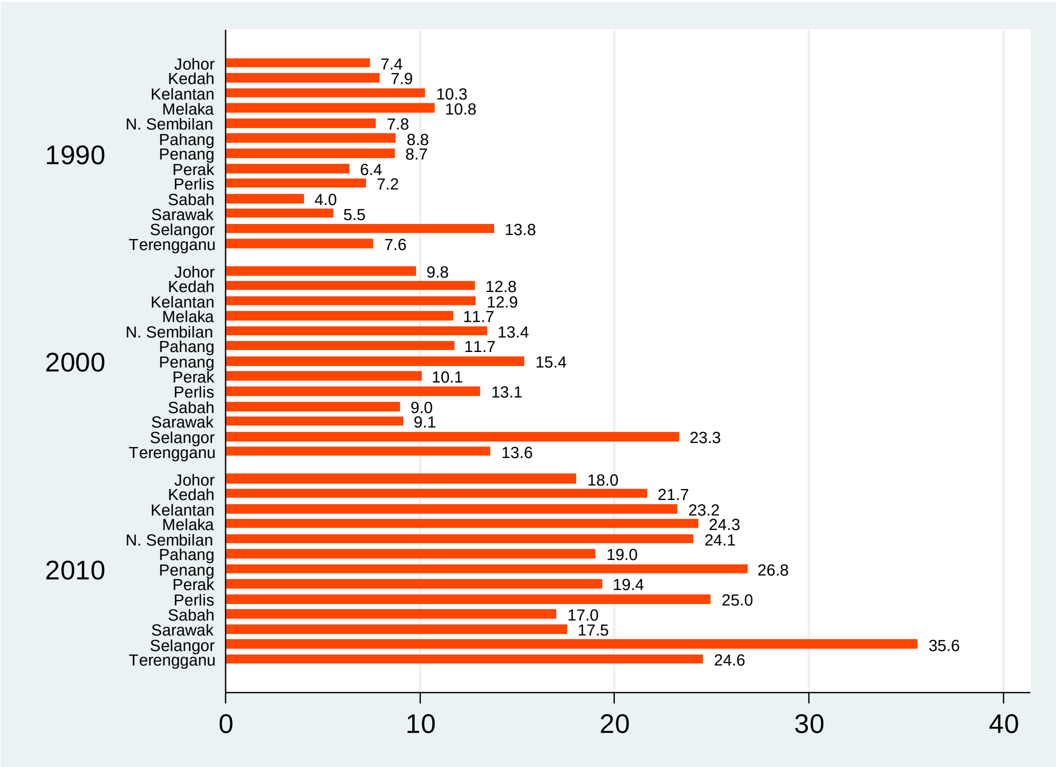
Figure 3.5 Percentage distribution of secondary educated labour force by states, 1990-2010



Source: Department of Statistics Malaysia

The proportion of the labour force with tertiary education has recorded a double digit growth in all states. The higher education reforms which started in mid 1990s helped to meet demands for higher education among the state population. The establishment of new higher education institutions in the states, with each state having at least one public university amidst numerous public colleges and private higher education institutions, probably contributed to the higher proportion of tertiary educated labour force in all states. Figure 3.6 below showed the increasing proportion of tertiary educated labour force from 1990 to 2010.

Figure 3.6 Percentage distribution of tertiary educated labour force by states, 1990-2010



Source: Department of Statistics Malaysia

The more economically advanced states, such as Selangor and Penang, showed higher proportion of tertiary educated labour force. The state of Penang saw the highest proportional increase of tertiary educated labour force, rising from 8.7% in 1990 to 26.8% in 2010, an increase of 18.0%. Meanwhile, the lowest increase was in the state of Johor, with an increase of only 10.6%, from 7.4% in 1990 to 18.0% in 2010. The share of labour force with tertiary education in 1990 was highest in the state of Selangor (13.8%), Melaka (10.8%) and Kelantan (10.3%). In 2010, Selangor remained at the top with the highest proportion of tertiary educated labour force at 35.6%, followed by Penang (26.8%) and Terengganu (24.6%). In this context, the higher proportion of workers with tertiary education in the state of Selangor may have contributed to the higher state GDP, which was RM1.3 billion in 2010, with state GDP per capita of RM31,363. Besides being more economically advanced due to early industrialisation since colonial times, its proximity to the capital city of Kuala Lumpur gives Selangor commercial advantages that help it attracts higher proportion of tertiary educated labour force. Concurrently, the proportion of tertiary-educated workers in the states of Kedah, Kelantan, Melaka, Negeri Sembilan, Perlis and Terengganu was between 21% and 25%. The proportion of tertiary educated labour force remained lowest in the state of Sabah, but has seen a substantial increase of about 13%, from 4.0% in 1990 to 17.0% in 2010. This issue needs to be addressed to further improve education equity and quality of life in Sabah.

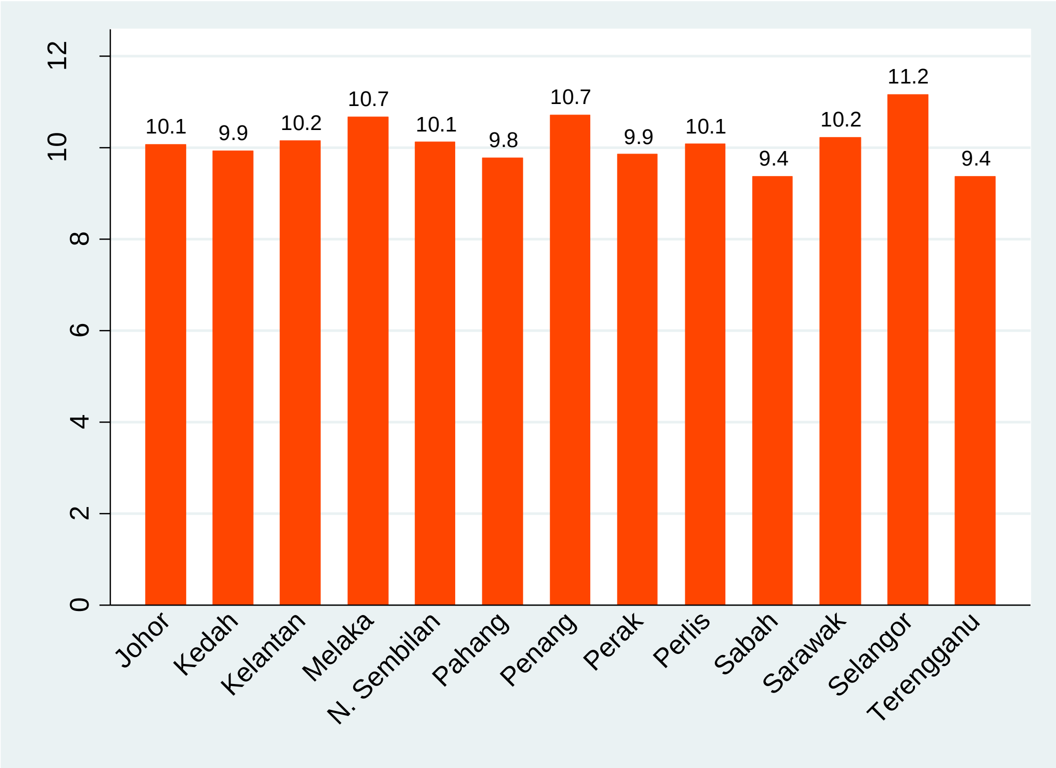
In summary, the labour force educational attainment trends in all states for the period of 1990 to 2010 showed similar patterns. The proportion of the labour force with no formal education and primary education indicated decreasing patterns, while labour force with secondary and tertiary education indicated increasing patterns. This trend also indicated the possibility of higher proportion of older workers having secondary and tertiary education across states in the future.

3.9.2 Age Structure and Years of Education

Further analysis on the average years of education of the workers among the states in Malaysia found that the state of Selangor had the highest average years of education at 11.1 years, followed by the states of Melaka and Penang, as shown in Figure 3.7. Four states had an average of less than 10.0 years of education, namely the states of Pahang, Perak, Sabah and Terengganu. These figures indicated that most workers have at least lower secondary education.

Details of the percentage of secondary and tertiary educated labour force by states and working-age groups are as Table 3.3 below.

Figure 3.7 Average years of education of workers by states, 1990-2010



Source: Department of Statistics Malaysia

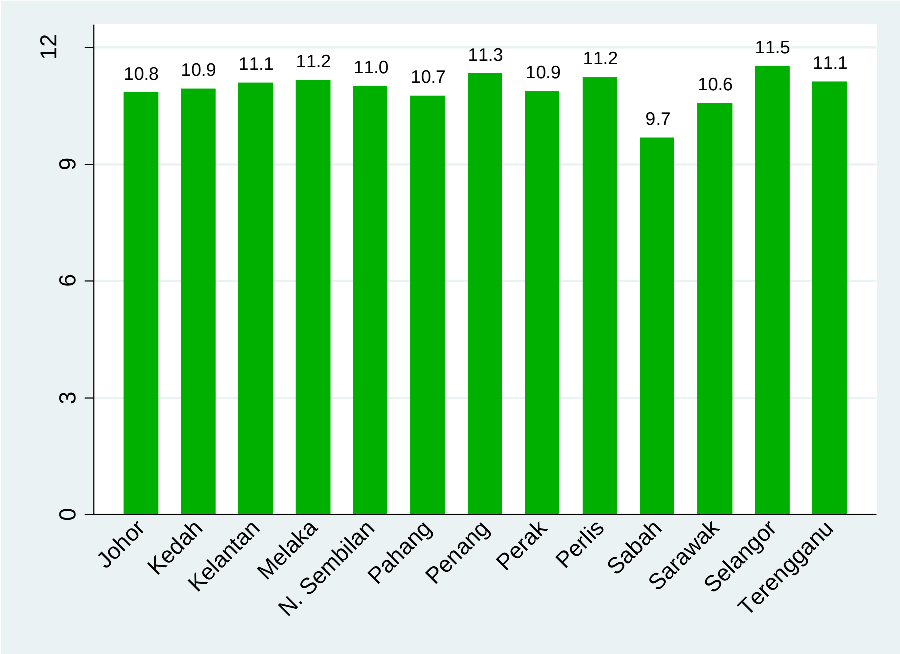
Table 3.3 Percentage of secondary and tertiary educated labour force by states and working-age groups, 1990-2010

State	Secondary			Tertiary		
	Young	Middle	Older	Young	middle	older
Johor	73.5	55.8	27.6	13.0	12.6	6.4
Kedah	72.0	52.5	22.1	14.8	14.9	5.3
Kelantan	70.1	51.7	21.2	17.5	17.8	7.7
Melaka	74.8	66.7	30.6	15.9	17.7	8.4
N. Sembilan	70.5	53.3	30.0	16.5	15.2	8.0
Pahang	69.3	49.9	21.3	14.3	13.1	4.1
Penang	71.9	59.2	38.3	19.3	18.1	9.0
Perak	74.6	55.6	27.7	12.6	12.0	6.2
Perlis	75.6	57.0	21.8	16.2	15.5	7.3
Sabah	54.4	55.5	38.8	10.6	9.4	5.5
Sarawak	69.4	48.3	26.6	12.1	13.3	6.1
Selangor	65.5	52.7	37.0	24.9	26.9	16.7
Terengganu	70.2	49.9	19.8	17.8	17.7	4.6

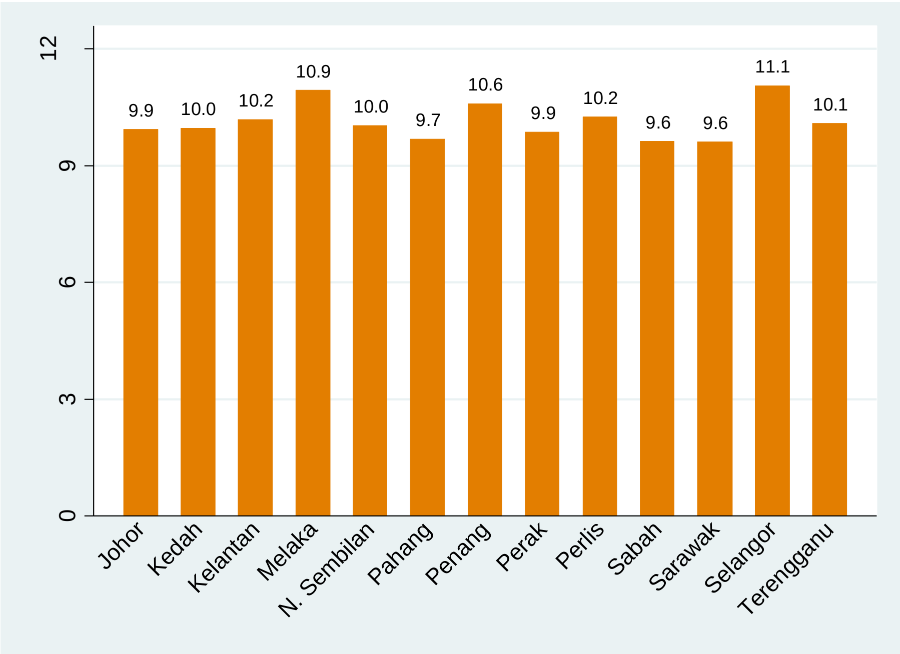
Source: Department of Statistics Malaysia; Author’s calculations

Meanwhile, analysis on the average years of schooling among the working-age population found that young workers have relatively higher average years of schooling compared with the middle and older workers, as shown in Figure 3.8.

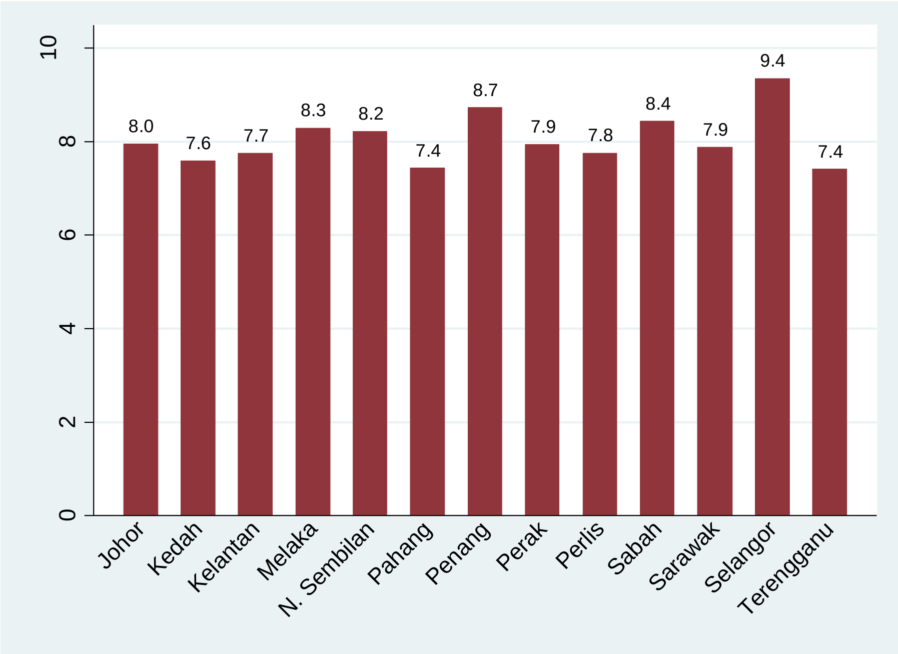
Figure 3.8 Average years of education by states and working-age groups, 1990-2010



Young workers



Middle worker



Older workers

3.9.3 Education Quality

The Malaysian government has implemented various policies to enhance human capital through education and skills training particularly since the 1970s. Improvements were made at all levels of education, both in terms of education quantity and quality. Programs to enhance educational quality were targeted at improving the quality of teaching personnel and infrastructures[17] (Tan 2012). Extensive reforms were also implemented in the national school curriculum (Lee 2010). The curriculum revision focussed on the introduction of new subjects, outcome-based learning, as well as promotion of ICTs usage at primary and secondary level (UNESCO-IBE 2010/11). In addition, a comprehensive review of the education system in Malaysia was undertaken in 2011 to better equip young Malaysians for the challenges of the 21st century (Malaysia 2012). Following this review, a National Education Blueprint was launched in 2012, which also included the provision of equal access to quality education of an

[17] The programmes include, among others, increasing the levels of qualifications among the teachers by encouraging non-graduate secondary school teachers to pursue tertiary education and become graduate teachers, upgrading teacher training colleges into teaching university, implementing cluster schools projects as well as ranking system in the primary and secondary schools. The ranking will form the basis for rewards, extra funding as well as more autonomy in school management (Tan 2012).

international standard and leveraging on the information, communication and technology (ICT) to scale up quality learning across Malaysia (Malaysia Education Blueprint 2013-2025).

Internationally, there are two widely referred international benchmarks on quality of education, namely the Trends in International Mathematics and Science (TIMSS) and the OECD Programme for International Assessment (PISA)[18]. TIMSS was started in 1995 to assess students' proficiency in mathematics and science in the fourth and eighth grade. Malaysia only started to participate in this survey in 1999, but limited only for assessment of the eighth grade students. The TIMSS 2011 reported declining student performances in Malaysia, about 35% of Malaysian students failed to meet minimum benchmarks for mathematics and 38% for science, compared to only 7% for mathematics and 13% for science in 1999.

Meanwhile, PISA is a comparative survey on knowledge and skills in reading, mathematical and scientific literacy among those aged 15 years. PISA seeks to measure whether these young adults have acquired the knowledge and skills that are required to function as successful members of society. Although the programme started in 2000, Malaysia only started to participate from 2009 onwards. The PISA results created further concerns as Malaysian students performed way below the OECD average in all three categories, as shown in Table 3.4. Malaysia attained a mean score of 414 on reading literacy, 404 on mathematical literacy and 422 on scientific literacy scale.

Table 3.4 Mean performance of selective countries based on PISA 2009 and PISA 2009+

Country	Reading	Mathematics	Science
Shanghai-China	556	600	575
Singapore	526	562	542
Korea	539	546	538
Australia	515	514	527

[18] Students completed an assessment on reading, mathematical and scientific literacy, as well as extensive questionnaire on students' background.

Country	Reading	Mathematics	Science
PISA/OECD average	493	496	501
Thailand	421	419	425
Malaysia	414	404	422
Indonesia	402	371	383

Source: OECD website www.oecd.org downloaded 31 May 2013

There are many issues in conceptualising education quality as well as the variables used to measure education quality. Although literature on quality education lists indicators, such as the teacher quality and teacher-student ratio, presently the assessment by TIMSS and PISA are internationally accepted benchmarks for quality education. But data constraints in the PISA and TIMSS surveys in Malaysia limit their usefulness for examining education quality in Malaysia.

As an alternative, following Messinis and Ahmed (2013), this study utilises the scientific research publications as a critical dimension of education quality. Messinis and Ahmed (2013) proposed a new measure of human capital as a composite index, with per capita scientific research publication in sciences (SciP) being an increasingly important component of applied cognitive skills. This variable measures research outcomes and quality of education, which provides the foundation for cognitive and research skills. The data here are based on per capita scientific publications in SCOPUS for the 13 states in Malaysia for the period of 1990 to 2010. This quality measurement reflects research outcomes, indicating higher research and innovation activities with higher quality of education.

3.10 Chapter Summary

This chapter has focussed on the research context by reviewing the economic growth trends in Malaysia, its challenges of being in the middle-income trap, as well as the empirical trends in human capital development. Identifying the challenges of economic growth in an ageing population, discussions in this chapter reviewed on the need of human capital development, as well as elaborated on the links between education (quantity and quality), human capital and economic growth.

The data on education trends showed impressive increase in educational attainment, particularly the double digit growth in the tertiary educated population. In light of the data limitation problems on education quality in Malaysia, this study will utilise the scientific research publication in SCOPUS as an indicator of education quality. The challenges of being in the middle-income trap and the need to further enhance educational attainment for higher human capital have set the research focus for this study. The next chapter will discuss on the growth theories, the theoretical frameworks and data description of the study.

CHAPTER 4
THEORETICAL FRAMEWORK AND EMPIRICAL MODEL: AGEING AND EDUCATION IN ENDOGENOUS ECONOMIC GROWTH

4.1 Introduction

Following the literature discussion in Chapter 3, this chapter describes the theoretical frameworks and empirical models of the relationships between age structure, human capital, technology diffusion and total factor productivity (TFP) growth or economic growth. Endogenous growth theory forms the theoretical framework for this study, incorporating two theoretical models: endogenous technological change (Romer 1990) and human capital accumulation (Lucas 1988). Romer (1990) extends the work of endogenous growth models by identifying technological change as an endogenous input factor that provides incentives to enhance capital accumulation and contribute to higher economic growth. On the other hand, Lucas (1988) emphasises that human capital is the engine of economic growth, assuming individuals invests in the education sector to accumulate new skills and knowledge.

The empirical models will investigate two important links for Malaysia's states: one, the nexus between human capital, technology diffusion and total factor productivity growth and two, the relationship between human capital and economic growth. The models are extended to go beyond quantitative indicators of education to consider education levels (i.e., primary, secondary and tertiary) and scientific research as measures of educational quality. Further extended interaction model includes the impact of ageing in the working-age population on human capital and economic growth. In this context, the Benhabib and Spiegel (2005) model of logistic diffusion and the Aghion, Howitt and Murtin (2010), hereafter AHM model of human capital and economic growth, will be re-examined to test the capacity of these models to explain economic growth in regional Malaysia. Therefore, this study will compare both models to ascertain the level effects and growth effects on economic growth in Malaysia, as level and growth effects have different connotations to economic growth. The level effect suggests that the level or stock of human capital will enhance economic growth, but the growth effect suggests that it is the accumulation of human capital that affects economic growth.

Mirestean and Tsangarides (2016) observe that despite the extensive research on growth empirics, there are few agreements among the researchers on the mechanics of economic growth, which is attributed by the lack of an explicit theory identifying growth determinants. Various additions to the growth determinants were tested and a survey by Durlauf et al. (2005) has listed more than 140 proxies of growth determinants, leading to questions on the existing economic growth theories. Therefore, the next section will discuss neoclassical and endogenous growth theory of human capital and its capacity to explain the contribution of human capital and technology diffusion to TFP and economic growth. Consequently, this study will explore endogenous growth theory, exploring the effect of ageing and human capital on technology diffusion, TFP and economic growth.

4.2 Economic Growth Theory: Neoclassical and Endogenous

Economic growth is widely defined as a condition whereby there is an increase in the real value of goods and services produced in a country over the past year. Economic growth theories propose that the quantity of input factors, such as land, labour and capital, will determine the aggregate real output produced in a country (Nelson 2007). In addition, human capital and technical progress are also identified as one of the most important determinants of economic growth. Since economic growth brings about better quality of life through higher income, advanced technologies, modern infrastructures and quality services; achieving higher growth continues to remain the central goal in a country's development policy. Although human capital is considered to be a critical factor of economic growth, the empirical results on the growth contributions of human capital at macro-level are mixed (Islam, Ang & Madsen 2014).

The basic proposition of growth theory is that technological advancement is crucial to sustain a high per capita growth rate in the long run. The neoclassical model developed by Solow (1956) and Swan (1956) shows that without technological progress, which is assumed to be exogenous, the effect of diminishing returns will cause economic growth to cease (Aghion & Howitt 1988; Taylor 2009). The endogenous growth models, however, assume technology to be the endogenous factor of productivity. As proposed by Nelson and Phelps (1966), human capital with higher educational attainment could better absorb new technologies, and thus, contribute to higher levels of productivity. The basic principles of neoclassical and endogenous growth models are discussed below.

4.2.1 Neoclassical Growth

The neoclassical growth model utilises an aggregate production function that assumes constant returns to scale in capital and labour, with diminishing marginal productivity of capital and exogenous technological change (Arvanitidis, Petrakos & Pavleas 2010; Solow 1956, 2007; Barro & Sala-i-Martin 2004; Aghion & Howitt 1998). The neoclassical growth model postulates that without technological improvements, the accumulation of capital would yield diminishing returns over time, which would eventually cease economic growth (Nelson 2005; Taylor 2009). As Taylor (2009, p.9) states, 'when the economy finally arrives at the steady state growth path, output per worker is determined primarily by the rate of technological progress'. The neoclassical model also indicates that an increase in the capital-to-labour ratio is the key contributor of economic growth, although the model treats human capital as a separate factor of production.

The economic growth accounting generally assumes a Cobb-Douglas production function (Wilson & Briscoe 2004; Hicks, Basu & Sappey 2010), which provides a reasonable description of actual economies (Barro & Sala-i-Martin 2004). This aggregate production function relates the level of output with the level of factor inputs (Froyen 2005, 1999). Here, changes in output could be explained in terms of changes in the inputs of the production function and changes in productivity. The production function can be written as:

$$Y_t = AK_t^{\alpha}L_t^{\beta} \tag{4.1}$$

where national income (Y) is a function of total factor productivity (A), capital (K) and labour (L). The neoclassical growth model regards (A) as an exogenous efficiency or technology parameter; the higher the amount of (A) is for any given value of inputs, the higher is the consequent output. Labour and capital are constant[19], with α and β representing constant terms that express the responsiveness of output to capital and labour, respectively.

The basic neoclassical model is an aggregate production function exhibiting constant returns in labour and reproducible capital. Assuming a constant labour supply normalized to equal unity, the aggregate production function can be written as a function of capital alone (Aghion & Howitt 1988), which expresses how much output (Y) can be produced given the aggregate capital stock (K).

$$Y = F(K)$$

Since the accumulation of capital leads to diminishing returns over time, productivity falls despite having the stock of capital. Although the marginal products are positive: $F'(K) > 0$, marginal productivities are diminishing: $F''(K) < 0$ for all capital (K).

The augmented Solow model proposed by Mankiw, Romer and Weil (1992), henceforth referred to as MRW, is one of the most widely cited theories in the field of neoclassical growth literature (Bernanke & Gürkaynak 2002). MRW performed an empirical evaluation on Solow's growth model and found support for the model's predictions. This stipulates that in the long-run, with a steady state economy, the level of real output per worker by country should be positively correlated with the saving rate, and negatively correlated with the rate of labour force growth. In addition, the MRW model includes human capital as a factor of production along with physical capital and raw labour, and concludes

[19] Constant returns to scale indicate that if all inputs rise in certain proportion, output will increase equally (Froyen 1999).

that accumulation of human as well as physical capital provides an excellent description of the cross-country growth data[20].

In reviewing the augmented Solow model that was proposed by MRW, other researchers also found similar support for the role of human capital as a factor of production (Bernanke & Gürkaynak 2002; Durlauf & Quah 1999; Islam 1995). Bernanke and Gürkaynak (2002) constructed estimates of TFP growth rates for more than 50 countries using MRW framework and found that TFP growth is strongly related to the saving rate, and in most cases, to the growth rate of the labour force. TFP growth rates also tend to be related to schooling rates, but when combined, the saving rate and the schooling rate tend to become statistically insignificant. When the labour force is being adjusted for human capital accumulation, the effect of the schooling variable was reduced and their estimates rejected the Solow prediction.

In conclusion, the MRW revision of the neoclassical model showed that the Solow model is unable to provide a complete theory of growth. It is important to understand the determinants of saving, population growth, and technological change, all of which are treated as exogenous by the Solow model. The concept of diminishing returns to capital with exogenous technological change predicts zero per capita growth in the long run.

4.2.2 Endogenous Growth and Human Capital

Given the gaps in the Solow model of neoclassical growth, there was further research on theories that could explain economic growth. The gaps ignited diverse theoretical and empirical discussions in the 1980s on the need to broaden the concept of capital by including human capital and assuming that diminishing returns did not apply to human capital (Barro & Sala-i-Martin 2004). These discussions led to the generation of the term ‘endogenous growth’ (Romer 1994). The endogenous growth theory proposes that the introduction of

[20] MRW estimates human capital accumulation using a variable named SCHOOL, which represents the percentage of school-age population (12-17) attending secondary school times the percentage of the working-age population that is of secondary-school age (15-19).

new accumulation factors, mainly knowledge and innovation, contribute to economic growth and divergent growth patterns across the world. The endogenous growth model is an extension of the neoclassical growth model, by treating technological progress as an endogenous factor of economic growth. In contrast, although the neoclassical growth model postulates that technological progress (TFP growth) is the only determinant of growth beyond the steady state, the theory assumes technological progress as exogenous.

According to Romer (1990), incentives for continued capital accumulation depends on technological change as both capital accumulation and technological change contribute towards enhancing the output per hour worked. In general, endogenous growth departs from neoclassical growth 'by emphasising that economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside' Romer (1994 p.3). In addition, Solow (2007) also suggests that the most valuable contribution of endogenous growth theory is the extensive discussion it has provided in thinking about human capital and technological knowledge. The theory attempts to explore and understand the role of technological progress by considering it to be an endogenous factor in an endogenous model of growth. In contrast to neoclassical growth theory, the focus in endogenous growth is on the likely determinants of endogenous technological change or TFP. In addition, innovation and technology contribute to enhancing productivity and growth through new and better quality processes and products. As a result, this work is complementary to, but different from, the study of research and development of productivity at the level of the industry of firm (Romer 1994).

Endogenous growth models incorporate technology and relate technological change to various critical drivers of which human capital is key, with education as an important measure of human capital (Wilson & Briscoe 2004; Froyen 1999; Romer 1990). Therefore, in this study, the growth rate of output per capita will depend on total factor productivity or technology diffusion (A) and labour participation with human capital accumulation (hL), as specified below:

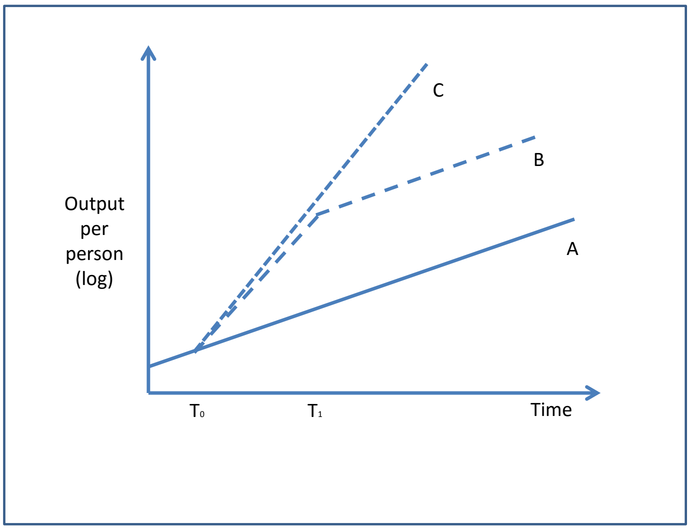
$$Y = AK^{\alpha}(hL)^{1-\alpha} \tag{4.2}$$

Expressing the variables in log yields:

$$\log(y_t) = \beta_0 + \beta_1 \log(k_t) + \beta_2 log(h_t L_t) + \varepsilon_t \tag{4.3}$$

There are different impacts for the two growth models in terms of increase in investment, as clearly illustrated by Dowrick (2003). Figure 4.1 below illustrates that for neoclassical growth model, an increase in investment will raise the rate of growth from line A to B. However, with the assumption of diminishing returns to capital accumulation, this will revert line B to be parallel to line A. Whereas, the endogenous growth model suggests that policy or institutional change could totally alter the slope of the growth path, as can be seen by line C. The high growth experienced by the Japanese economy in the period from 1960s to 1980s provides an example of the benefits of endogenous growth modelling that focused on capturing higher market share through all forms of innovation, including managerial, organizational and human resources (Lucas 1988; Romer 1986).

Figure 4.1 Investment in neoclassical and endogenous growth theory



Source: Dowrick (2003)

4.3 Empirical Approach and Data

4.3.1 Human Capital, Technology Diffusion and Total Factor Productivity: Level Effects Model (Benhabib and Spiegel 2005)

The literature on human capital as an important component of progress and economic growth has been growing (Dowrick 2003, Murphy & Tamura 1994, Mincer 1981), particularly through the works of Lucas (1988) and Romer (1986). For example, Lucas (1988) presented a model of human capital as the engine of growth, suggesting human capital accumulation raises productivity level of both labour and capital. According to Gruescu (2006), the Lucas model is widely accepted and employed in both growth theory and growth empirics. In addition, the rate of innovation is assumed to be proportional to the human capital stock (Romer 1986; Dowrick 2003).

Human capital acts as a catalyst for economic growth and amid the abundant literature, there are two important frameworks of analysis that describe the relationship. On one hand, Lucas (1988) emphasises the role of new investments in human capital, while on the other hand, Nelson and Phelps (1966) stress the importance of level of human capital and total factor productivity or technology diffusion (Messinis and Ahmed 2013). The Lucas framework relates to accumulation of human capital or growth effects, whereas Nelson and Phelps framework relates to the stock of human capital or level effects. There are also attempts to combine the two frameworks, as can be seen from the works of Dowrick and Rogers (2002)~~, Aghion (2010)~~ and Aghion, Howitt and Murtin (2010).

In general, productivity is a measure of the efficiency with which inputs (such as labour, capital, land, knowledge, etc.) are used to produce output in terms of goods and services (Mahmood 2008, Lindsay 2004). High national productivity level typically indicates efficient production of goods and services and a competitive economy (Lindsay 2004). Productivity growth is achieved through higher levels of input from human capital, adoption of new technologies and development of entrepreneurship to drive innovation and creativity (World Bank

2009). According to Bhattacharya and Narayan (2010), labour productivity contributes towards economic growth, labour demand and employment.

The link between level of human capital and total factor productivity growth was first introduced by Nelson and Phelps (1966). They emphasised the important link between human capital and disembodied knowledge in speeding the process of technological diffusion and economic growth. In clarifying their hypothesis, Nelson and Phelps (1966) developed two models to explain economic growth through technology diffusion and education. The first model proposed that the increase in total factor productivity depends on the stock of human capital and varies positively in terms of distance from the technology frontier. The second model suggested that the level of human capital will determine the gap between the technology frontier and the current level of productivity. These models indicate that human capital contributes to a country's technological progress through innovation and technology adoption.

The Nelson-Phelps hypothesis raises questions on the costs of innovation and the need for research and development (R&D). Innovation is defined as the successful exploitation of new ideas (World Bank 2009), and the concept of innovation encompasses not only the creation and commercialisation of new knowledge but also the diffusion and absorption of existing knowledge. Innovation allows a country to produce goods and services of higher value and at greater efficiency, increasing the potential growth of output. As innovations contribute in producing higher value goods and efficient services, inventors could gain monopoly rents. The Nelson-Phelps hypothesis, however, does not provide answers on the need and cost of innovation.

Therefore, building on Nelson and Phelps (1966) hypothesis, Benhabib and Spiegel (2005) proposed a model of diffusion which allows a greater role of human capital in domestic innovation and acknowledges the potential for poverty traps due to barriers of assimilating foreign technology. The model emphasises the interaction of human capital and technology gap by the distance to the frontier, in this case, the USA as the technology leader. The research findings suggest that nations closer to the technology frontier have higher human capital accumulation that could support innovation, while countries far from the frontier focus on technology diffusion. These factors contribute to divergences in world income. This makes intuitive sense since new inventions usually generate monopoly rents and innovation needs to yield financial advantages if it is to play a role in economic growth (Benhabib and Spiegel 2005).

The divergence in total factor productivity in this model depends on the human capital stock of the follower country because human capital acts as a catalyst of innovation as well as of catch-up in total factor productivity (Benhabib & Spiegel 2005). Although the literature on technology diffusion is extensive, research on measurement of human capital has not been as advanced (Messinis & Ahmed 2013). Empirical studies on human capital and TFP growth relationship remain limited particularly with respect to the effects of human capital on TFP growth. In general, countries that promote greater human capital accumulation are more likely to benefit from higher TFP growth. Benhabib and Spiegel (2005) claim that increases in stock of basic knowledge will enhance the productivity of future research, and further facilitate innovations.

Motivated by the work of Nelson and Phelps (1966), Benhabib and Spiegel (2005) derived a nonlinear specification for total factor productivity growth that nests technology diffusion in exponential and logistic forms. Comparing the two formulations, they argue that confined exponential diffusion leads to a balanced growth path (all countries eventually grow at the same rate), whereas logistic diffusion allows the dampening of the technology diffusion process (allowing for further gaps between the technology leader and follower countries). Using data for 84 countries and covering the period from 1960 to 1995, Benhabib and Spiegel (2005) estimated the two models of diffusion, using both, a cross-section of 35 years of growth and as a panel of five-year growth rates. Their results favour a logistic form of technology diffusion and confirm that some countries experience divergence in TFP growth.

Messinis and Ahmed (2013) simplified the Benhabib and Spiegel (1994) model estimate of exponential and logistic diffusion as below:

i. Exponential diffusion model:

$$\Delta a_t = gh_t + mh_t \left[\frac{A_t^{max} - A_t}{A_t}\right] = (g-m)h_t + mh_t \left[\frac{A_t^{max}}{A_t}\right] + \varepsilon_t \quad (4.4)$$

The specification for logistic model if s=1 is as below:

ii. Logistic diffusion model:

$$\Delta a_t = gh_t + mh_t \left[\frac{A_t^{max} - A_t}{A_t}\right]\left[\frac{A_t}{A_t^{max}}\right] = (g+m)h_t - mh_t \left[\frac{A_t}{A_t^{max}}\right] + e_t \quad (4.5)$$

where Δa_t represents technological progress (the growth of TFP), h_t is initial or average human capital stock, $\frac{A_t}{A_t^{max}}$ is the closeness to frontier (the gap between the technology in the leading country, A^{max}, and that in the home country, A_t), and ε_t is the error term.

From equation (4.6), the values of c, g and s will determine whether a state will converge to the growth rate of the leader or whether the growth rate will diverge. Therefore, the catch-up condition for the growth rate of a country to converge to the growth rate of the leader becomes (for s ϵ (0,1]):

$$c^* = 1 + \frac{c}{sg} > \frac{h_{mt}}{h_{it}} \quad (4.6)$$

States for which $\frac{h_{mt}}{h_{it}}$ > c* will not converge to the leader's growth rate unless they invest in their human capital. If the follower's human capital stock is low, the logistic diffusion model indicates divergence, instead of catch-up in TFP growth.

The closeness to the frontier in the above model indicates the catch-up or convergence process, whereby the convergence is slower when a country is very far, unless the country invests in their human capital. In conclusion, the model derives an empirical specification where TFP growth depends on initial backwardness relative to the stock of potential world knowledge, proxies as the TFP level of the leader country (Benhabib & Spiegel 2005). In estimating the link between human capital, technology diffusion and total factor productivity growth in this study, a macro panel dataset covering the period of 1990 to 2010 for 13 states was constructed.

Benhabib and Spiegel (2005) specify a model that nests the exponential and logistic functional forms of technology diffusion as below:

$$\Delta a_{i,t} = b + \left(g + \frac{c}{s}\right) h_{i,t} - \left(\frac{c}{s}\right) h_{i,t} \left(\frac{A_i}{A_m}\right)^s + e_t \qquad (4.7)$$

Here $\Delta a_{i,t}$ represents state *i* average annual growth rate of TFP, $h_{i,t}$ represents the log of initial or average human capital in state i, $\frac{A_i}{A_m}$ is the closeness to frontier, and e_t is the error term. Specifically, A_i is the level of state *i* stock of TFP and A_m represents the level of TFP of the leader state, with s ϵ {-1,1}. The above model nests two limiting cases: the exponential diffusion model when s=-1 and the logistic model when s=1 (Messinis & Ahmed 2013).

Benhabib and Spiegel (2005) suggest that countries with smaller capital stock may have slower total factor productivity growth compared to the leader nation, allowing for further divergence in total factor productivity growth rates for some of the follower nations and others which are catching up. Their study found that 22 out of the 27 nations, which were identified as not having the adequate human capital level to achieve faster TFP growth in 1960, registered lower growth as predicted. Essentially, the logistic model allows for the dampening of the diffusion process so that the gap between the leader and a follower can keep growing. They concluded that the level of education will determine the rate of technology spill-over from leaders to followers. In addition, Damsgaard and Krusell (2010) utilised the Nelson and Phelps (1966) specifications for their study on TFP distribution across countries and found that small symmetric idiosyncratic (country-specific) TFP shocks can lead to large long-run differences in TFP levels.

In light of previous research on the logistic technology diffusion model as proposed by Benhabib and Spiegel (2005), this study aims to explore the relationship between human capital, technology diffusion and TFP growth to explain variations of regional economic growth for the 13 states in Malaysia over the period from 1990 to 2010. This study also aims to distinguish the significant role of education as a factor that facilitates technology diffusion and TFP growth. This section will discuss Benhabib and Spiegel (2005) model and the adaptation of the model in this study[21], including references to Benhabib and Spiegel (1994) for earlier empirical works.

The main difference between the confined exponential and logistic models of technology diffusion is that the logistic model contains the extra term $(\frac{A_t}{A_t^{max}})$. This extra term indicates that increases in the closeness to frontier could pose difficulties in adopting distant technologies, which will reduce the rate of diffusion. The catch-up process is slower when the country is very far or very close to the frontier, and this is denoted by the measure of 'backwardness' (Messinis & Ahmed 2013).

In line with this, Benhabib and Spiegel (2005) observe that different functional forms of the technology diffusion process can have very different implications for a nation's growth path towards steady state (a state in which different variables grow at a constant rate), even though the differences among the functional forms are small.

Based on results from Benhabib and Spiegel (2005), this study uses s=1. Therefore, the empirical model for this study is specified as follows:

$$\Delta TFP_{i,t} = \alpha_0 + \beta_1 lnYS_{i,t} + \beta_2 lnECTF_{i,t} + \varepsilon_{i,t} \quad (4.8)$$

(i = 1,…,N; t = 1,…,T)

The above empirical model also generalises the model from equation (4.6), where $\Delta TFP_{i,t}$ represents the growth of total factor productivity, $YS_{i,t}$ represents the log years of schooling (indicates the level of education in state i) and $ECTF_{i,t}$ (in logs) is the interaction between education and closeness to the frontier (the

[21] Benhabib and Spiegel (2005) model adopts the Cobb-Douglas production function.

gap between the technology in the leading state and that in the home state), and $\varepsilon_{i,t}$ represents the error term. The subscript *i* and *t* denote country and time period, respectively.

Going beyond the standard quantitative measure of human capital, the alternative is to consider levels of education. The empirical model can be written as below:

$$\Delta TFP_{i,t} = \alpha_0 + \sum_{j=1}^{3} \beta_j EDU_{i,t} + \sum_{j=1}^{3} \varphi_j ECTF_{i,t} + \varepsilon_{i,t} \qquad (4.9)$$

β_j = (EDU1, EDU2, EDU3)

where EDU represents education level, with EDU_1=primary, EDU_2=secondary and EDU_3=tertiary

In the above equation β_j corresponds with $\left(g + \frac{c}{s}\right)$ and φ_j corresponds with $\left(\frac{c}{s}\right)$.

4.3.2 Human Capital and Economic Growth: Level and Growth Effects Model (Aghion, Howitt and Murtin 2010)

In this section, the theoretical link between human capital and economic growth will be further investigated to determine the effects of differences in level and accumulation of education on state per capita GDP growth. In an empirical study, Kyriacou (1991) found evidence suggesting that without relatively higher level of initial human capital stocks, it would be difficult for laggard countries to converge to more advanced economies. Using the Cobb-Douglas production function with physical capital, labour and human capital on cross-country growth rates for the period of 1970-1985, the study found that the coefficient of human capital is insignificant suggesting that without an initial existent stock economic growth is not possible. These results are puzzling given the substantial evidence in the literature which supports that education contributes significantly to growth. Why it is that only the level and not the growth of human capital affects the GDP growth? As explained earlier, level and growth effects have different connotations for economic growth as the level effect suggests that the level or stock of human capital will enhance economic growth, but the growth effect suggests that it is the accumulation of human capital that affects economic growth.

In explaining this puzzling results, Kyriacou (1991) offered two possible explanations. First, the output elasticity of human capital is positively related to the human capital level, indicating that there are threshold externalities to education. In other words, education cannot make a significant positive contribution to growth in a country unless it has already attained a certain threshold level of human capital stock. Second, it relates to an omitted variable problem, specifically the omitted variable of technological growth. If one considers the initial level of human capital endowments to be a proxy for technological growth, as in Romer (1990), then there is a theoretical justification for introducing the level of human capital in the growth rate regressions.

In achieving this, the study will adapt the unified framework of Aghion, Howitt and Murtin (2010) model that examines the relationship between human capital and growth, embedding both level and accumulation effects of human capital for the period of 1960 to 2000. Using two approaches, first based on Mankiw-Romer-Weil (1992) and Lucas (1988) and second, Nelson and Phelps (1966), AHM study found supportive evidence that a higher initial level and a higher rate of improvement in human capital have significantly positive impact on per capita GDP growth. They suggest that productivity growth should be positively correlated with the level of human capital, in particular with the initial or the average level of human capital in a country or region over a given period. Their findings indicate that both the level and accumulation of human capital have significant positive effects on growth of GDP per capita.

Aghion, Howitt and Murtin (2010) explain that using level and accumulation variable could have a high level of correlation which raises a dilemma. If one variable is omitted from the regression, it may result in omitted variable bias, but using both variables can create multicollinearity problems. Considering the fact that ignoring either of the two (level or accumulation) effects might generate potentially misleading policy conclusions, the model estimation will include both the growth and initial levels in years of schooling as regressors. Therefore, the convergence in human capital can be captured through a linear regression in the form of:

$$\Delta logYS_i = -\frac{1}{\rho} logYS_{i,0} + \nu_i \quad (4.10)$$

where v_{it} is an error term.

Plugging (4.10) into (4.11) yields:

$$\Delta logy_i = a + b\Delta logYS_{i,0} + c(-\rho\Delta logYS_i + \rho v_i) + dlogy_{i,0} + u_i = a + (b - c\rho)\Delta logYS_{i,0} + dlogy_{i,0} + w_i \quad (4.11)$$

The above equation includes not only the effect of education accumulation (b), but also the negative correlation between education accumulation and the initial level of education (Aghion, Howitt & Murtin 2010).

Therefore, using the unified framework proposed by Aghion, Howitt and Murtin (2010), the second theoretical model in this study can be described as below.

Using the production function:

$$Y = A H^{\beta} \quad (4.12)$$

Here, $0<\beta<1$, H represents the current stock of human capital, and A represents the productivity parameter. It is assumed that a higher level of education will enhance labour productivity and efficiency in the economy. The natural logs of the above equation will be:

$$y = a + \beta h \quad (4.13)$$

Equation (4.13) implies that the accumulation of education (h) should have a positive effect on output growth (y) as proposed by Lucas (1988). Based on Nelson-Phelps equation in incorporating that productivity evolves over time, the equation becomes:

$$\dot{a} = \theta(\bar{a} - a) + \alpha h + \delta \quad (4.14)$$

Here ā represents the log of the current world frontier productivity and where θ, α, δ are all constants, with higher h indicating higher level of education that are able to absorb technology and enhance productivity to catch up with the world leader (ȧ). Taking equation (4.13) and (4.14) together, the growth of GDP per capita depends upon both the level and accumulation of human capital, as described below:

$$g = \dot{y} = \theta(\bar{a} - a) + \alpha h + \beta h + \delta \quad (4.15)$$

or similarly can be expressed as:

$$g = \delta + \theta\bar{a} - \theta y + (\alpha + \beta\theta)h + \beta h \quad (4.16)$$

Here, the growth of GDP per capita should depend negatively upon its initial level, positively upon the level and accumulation rate of education, and positively upon current world productivity.

Using the production function, and adapting the empirical model by Aghion, Howitt and Murtin (2010) as well as equation (4.16), the empirical model of growth equation, including both the level and accumulation of human capital, can be formulated as below:

$$Y_{i,t} = \alpha_0 + \beta_1 YS_{i,t} + \beta_2 YS_{i,0} + u_{i,t} \quad (4.17)$$

where $u_{i,t}$ denotes the remainder disturbance.

In line with equation (4.15), the equation estimate is specified as below:

$$\Delta logy_{i,t} = a + b\Delta logYS_{i,t} + clogYS_{i,0} + dlogy_{i,0} + u_{i,t} \quad (4.18)$$

Here, $\Delta logy_{i,t}$ is the change per year in the log of GDP per capita, multiplied by 100; $\Delta logYS_{i,t}$ is the change per year in the log of years of schooling in that state over the same period, also multiplied by 100 and represents the accumulation effect of human capital; log $YS_{i,0}$ is the log of years of schooling at the beginning of the period and represents the stock or level effect of human capital; log $y_{i,0}$ represents initial log of GDP per capita and $u_{i,t}$ is a residual term. The subscript *i* and *t* denote state and time period, respectively. In addition, equation (4.18) will also run estimates on the education levels (primary, secondary and tertiary) and the working-age groups (young, middle and older).

4.3.3 Age structure, Education and Economic Growth

Using the Benhabib and Spiegel (2005) model, the empirical model was extended to include the human capital effect of age structure. Three working-age cohorts are considered: young workers (15-29 years old), middle workers (30-49 years old) and older workers (50-64 years old). The educational levels of the working-age groups are constructed in a panel dataset that uses three years average data, covering the period of 1990 to 2010. The age structure will be estimated using both the adapted Benhabib Spiegel model and the AHM model.

Extending the age structure in the Benhabib and Spiegel (2005) model, the equation becomes:

$$\Delta a_{i,t} = b + \left(g + \frac{c}{w}\right) s_{i,t} h_{i,t} - \left(\frac{c}{s}\right) s_{i,t} h_{i,t} \left(\frac{A_i}{A_m}\right)^s + e_{i,t} \quad (4.19)$$

Here $\Delta a_{i,t}$ represents state *i* average annual growth rate of TFP, $s_{i,t}$ represents the working-age population, $h_{i,t}$ represents the log of initial or average human capital in state i, $\frac{A_i}{A_m}$ is the distance to the frontier, and $e_{i,t}$ is the error term. Specifically, A_i is the level of state *i* stock of TFP and A_m represents the level of TFP of the leader state, with s=1.

Using the measurement on human capital proposed by Barro and Lee (2010), a panel dataset was constructed to represent the number of years of schooling for the working-age groups, as calculated below.

$$ys_t = \sum_{a=1}^{A} l_t^a s_t^a \quad (4.20)$$

where l_t^a is the share of the working-age population, and s_t^a is the number of years of schooling for the working-age groups, with a=1 (15-29 age group), a=2

(30-49 age group) and a=3 (50-64 age group). Specifically, the number of years of schooling of age group *a* in time *t* is:

$$ys_t^a = \sum_j^A h_{j,t}^a Dur_{j,t}^a \quad (4.21)$$

where h_j^a is the portion of group *a* with educational attainment level *j*=primary, secondary, tertiary, and *Dur* indicates the corresponding duration in years.

Meanwhile, extending the age structure in the Aghion, Howitt and Murtin model, the equations can be written as follows:

$$\Delta logy_{i,t} = a + \sum_{j=1}^{3} \beta_j logAGEYS_{i,t} + clogWAYS_{i,0} + dlogy_{i,0} + u_{i,t} \quad (4.22)$$

AGE = (AGE1, AGE2, AGE3)

Here $\Delta logy_{i,t}$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\sum_{j=1}^{3} \mathrm{logAGEYS}_{i,t}$ represents the change per year in the log of years of schooling of each working-age groups in that state over the same period, also multiplied by 100; $logWAYS_{i,0}$ represents the log of years of schooling at the beginning of the period for each working-age groups; log $y_{i,0}$ represents initial log of GDP per capita and $u_{i,t}$ is a residual term.

4.3.4 Variables Definitions and Data Descriptions

The measurement and description of variables used in estimating all the empirical models will be elaborated in this section.

Table 4.1 List of Variables Definitions and Data

Variable	Definition	Source
SGDPpc	Real state gross domestic product divided by state population (constant MYR in 2005 price)	Calculated from DOSM and EPU data

Variable	Definition	Source
ΔTFP	Average annual growth rate of TFP	Calculated from DOSM and EPU data
YS	Average years of schooling of the working-age population (in logs)	Calculated from DOSM data
CTF	Closeness to frontier (TFP gap between the leading state, (A_m) and home state (A_i)).	Calculated from DOSM data
K	Net physical capital stock	Calculated from DOSM data
N	Total population by state	DOSM
n	Average rate of population growth	Calculated from DOSM data
I	Total of state domestic and foreign direct investments	EPU, MIDA
FDIpc	Foreign direct investments divided by the number of state population	Calculated from MIDA and EPU data
EDU	Education level (percentage)	DOSM
AGE	Working age population	DOSM
SciP	Scientific journal article publications in sciences per capita (in logs)	Calculated from SCOPUS

4.3.5 Detailed measurement of key variables

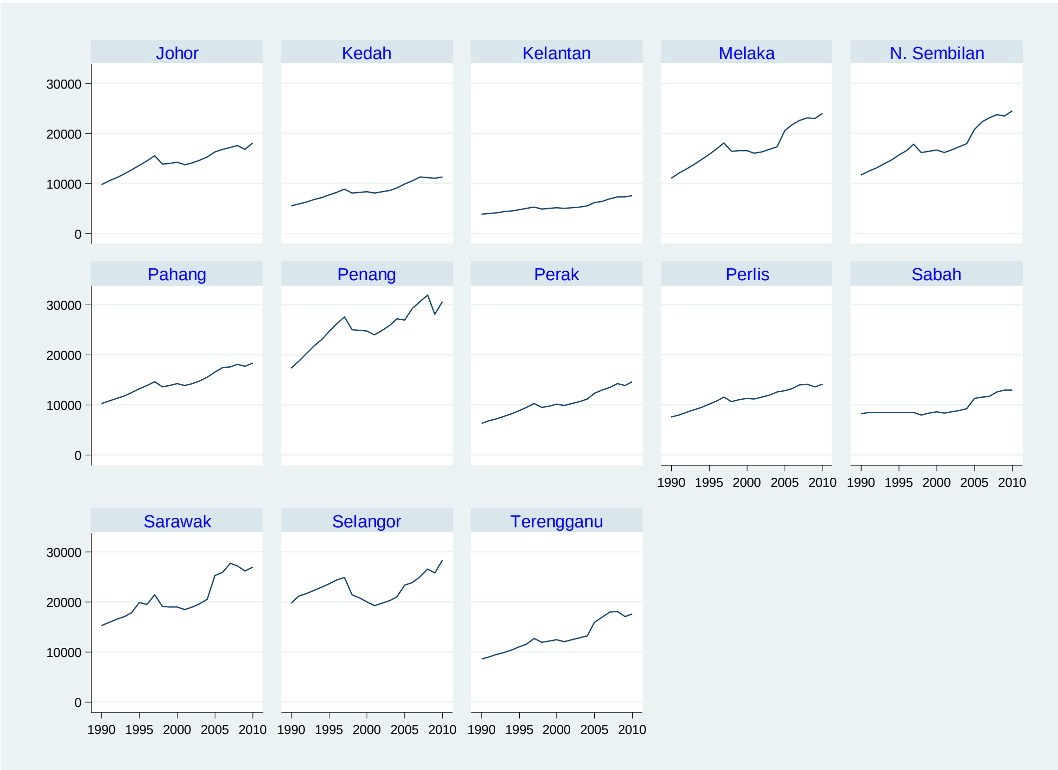
Real state gross domestic product per capita (SGDPpc)

The state gross domestic product (SGDP) measures the total value of all final goods and services produced in a state (i) in a given year (t), which indicates the economic performance of that particular state. Data for the SGDP are obtained from the Economic Planning Unit Malaysia (EPU) and the Department of Statistics Malaysia (DOSM). The data are then calculated using constant Malaysian Ringgit (MYR) in 2005 prices to get the real SGDP. The figures are further divided with state population to generate the real state GDP per capita (SGDPpc) variable. In measuring the state's economic growth, the real state

GDP per capita for each state (in logs) acts as the dependent variable. The SGDP data, represented as $y_{i,t}$ was also used to calculate the value of TFP.

Figure 4.2 below plots the time series data on the real state GDP per capita of the 13 states in Malaysia for the period of 1990 to 2010. In all states, the real GDP per capita indicate an increasing trend, with five states, namely the states of Melaka, Negeri Sembilan[22], Penang, Sarawak and Selangor having real GDP per capita above MYR20,000 in 2010. The state of Kelantan has the lowest real GDP per capita of below MYR10,000 for the whole period of 1990 to 2010. The figure below clearly indicates the uneven level of real GDP per capita among the states.

Figure 4.2 Trends in real state GDP per capita, 1990-2010 (2005=100)



Source: Department of Statistics Malaysia; Author's calculations

The trends in real state GDP per capita growth indicate that all states felt the impact of the 1997 financial crisis and 2008 global financial crisis, although at

[22] In tables and figures, due to limited space, Negeri Sembilan is written as N. Sembilan.

varying degrees (see Figure 4.3), with the state of Penang indicating the highest decline.

Figure 4.3 Real state GDP per capita growth rates, 1990-2010 (2005=100)

Source: Department of Statistics Malaysia; Author's calculations

Total Factor Productivity

In explaining world disparities in per capita income, the total factor productivity approach started to gain attention in the early 1990s (Taylor 2009). In line with this approach, the calculation of total factor productivity in this study will follow Benhabib and Spiegel (2005) adaptation of Klenow and Rodriguez-Clare (1997) calculation of physical capital. The initial capital stocks will be calculated using the equation as below:

$$\left.\frac{K_i}{Y_i}\right|_{1990} = \frac{I/Y}{\gamma+\delta+n} \qquad (i = 1,\ldots,N;\ t = 1,\ldots,T) \qquad (4.23)$$

Here I/Y is the average share of physical investment in output from 1990 to 2010, (γ) represents the average rate of growth of output per capita over that period, (n) represents the average rate of population growth over that period and (δ) represents the rate of depreciation. The rate of depreciation (δ) is fixed at 3%[23]. Given initial capital stock estimates, the capital stock of state *i* in period *t* is as follows:

$$K_{i,t} = \sum_{j=0}^{t}(1-\delta)^{t-j}I_{i,j} + (1-\delta)^{t}K_{1990} \tag{4.24}$$

The TFP was estimated from a constant return to scale Cobb-Douglas production function with the capital share set as 1/3 and the labour share set as 2/3. For state *i* in period *t* :

$$a_{i,t} = y_{i,t} - \frac{1}{3}k_{i,t} - \frac{2}{3}l_{i,t} \tag{4.25}$$

where $a_{i,t}$ represents the log of TFP, $y_{i,t}$ represents the log of real output, $k_{i,t}$ represents the log of the physical capital stock, and $l_{i,t}$ represents the log of the population. Data for the domestic investments in the states, which will be used to calculate the physical capital component of the TFP measurement are sourced from the Malaysian Investment Development Authority (MIDA)[24] database, available online at the Economic Planning Unit Malaysia website. Using the Consumer Price Index (CPI) as the price deflators for the base year 2005 (2005 = 100), the investment data are re-calculated for the period from 1990 to 2010. Meanwhile, data on population are from the Population and Housing Census, downloaded from the Population Quick Info online database provided by the Department of Statistics Malaysia.

The above calculation of TFP will be used in the estimation models with ($a_{i,t}$) hereafter known as TFP.

[23] Following the rate of depreciation as used in Benhabib and Spiegel (2010) and Messinis and Ahmed (2013) models.
[24] MIDA, among others, provides data on domestic investment, foreign investment and total investment by state and industry. Data from the Economic Census are not used in the TFP measurement because the Economic Census are conducted once in every 5 years and mainly involves collection of information from Small Medium Enterprises (SMEs).

Table 4.2 Total Factor Productivity Estimates (1990-2010)

State	$logTFP_{1990}$	$logTFP_{2010}$	Average annual growth of TFP (1990-2010)
Johor	1.9081	1.9269	1.1035
Kedah	1.7565	1.8406	1.6141
Kelantan	1.9708	1.9141	0.7500
Melaka	1.9386	1.9239	0.9270
N. Sembilan	1.9036	1.9483	1.2647
Pahang	1.9486	1.9497	1.0057
Penang	1.9651	1.9957	1.1685
Perak	1.8834	1.8956	1.0669
Perlis	2.0265	1.8639	0.4483
Sabah	1.9707	1.9483	0.8926
Sarawak	1.9932	1.9813	0.9420
Selangor	1.9739	1.9925	1.0988
Terengganu	1.7475	1.8362	1.6613

Table 4.2 presents the total factor productivity estimates for 1990 and 2010, and the estimates of average annual growth of total factor productivity for the period of 1990 to 2010. All states indicate positive growth, within the range of 0.4483% to 1.6613%. The state of Terengganu has the highest average annual TFP growth at 1.6613%, whilst the state of Perlis has the lowest average annual TFP growth at 0.4483%. Eight states indicate increase in log TFP from 1990 to 2010, while five states show decrease in log TFP. The results at state levels gave a more precise indication of the differences in log TFP and average annual TFP growth in comparison to the findings of Benhabib and Spiegel (2005) that estimated the changes in TFP at the national level. Benhabib and Spiegel (2005) results indicated average annual TFP growth at 0.0266 for Malaysia during the period of 1960 to 1995, with log TFP_{1960} at 0.2549 and log TFP_{1995} at 1.1852.

Data for TFP are derived from equations (4.23) to (4.25). The dependent variable, TFP growth is defined by ΔTFP, which is the average annual growth rate of TFP. Figure 4.4 highlights the correlation between TFP growth and distance to frontier for the year 1990. The negative correlation is in line with Benhabib and Spiegel's model that suggest states that are far from the leader state have higher TFP growth.

Figure 4.4 TFP growth and distance to frontier (1990)

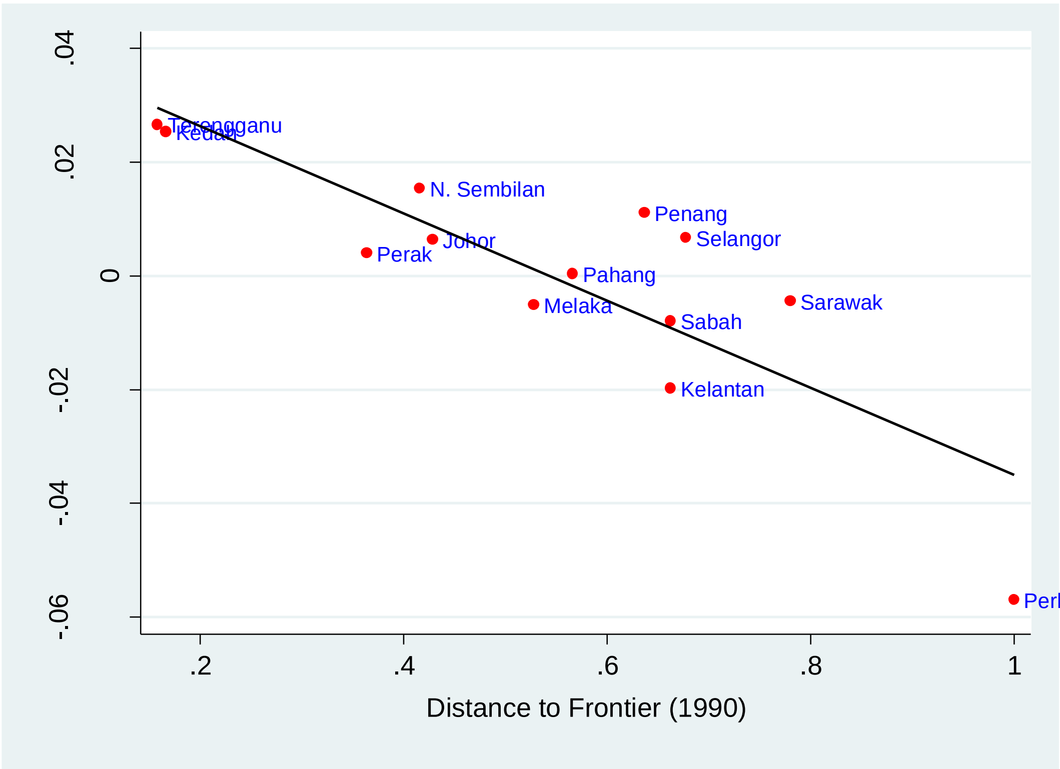
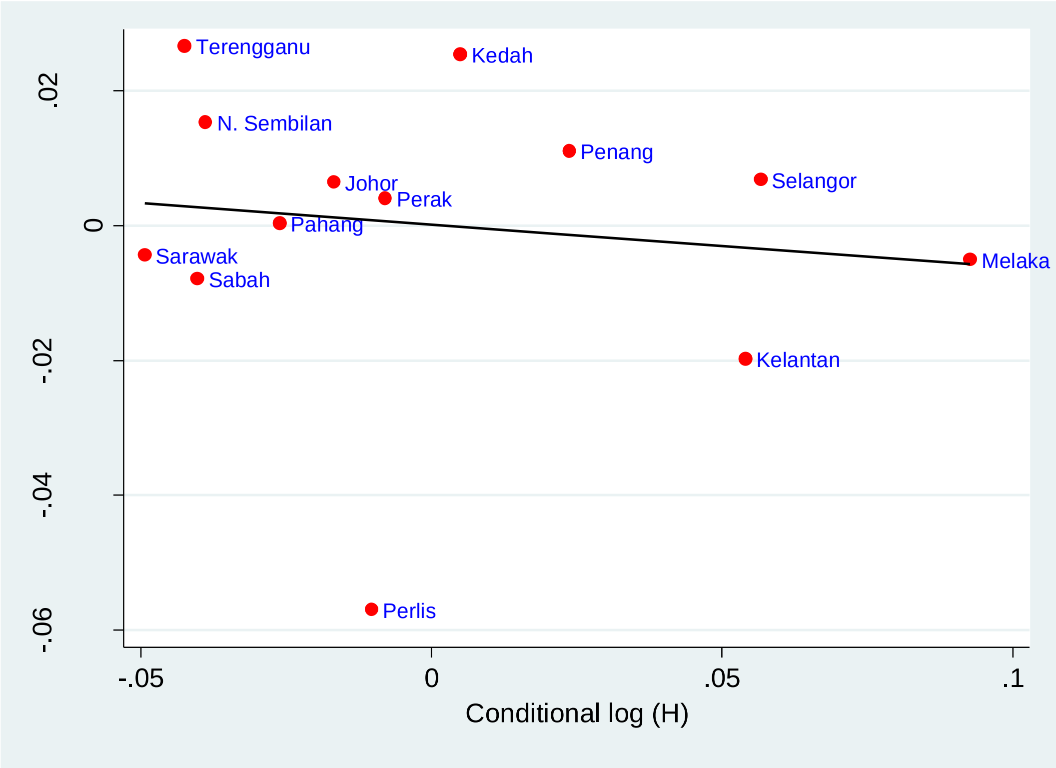


Figure 4.5 presents a scatter plot of the interactions between human capital (H) and the distance to frontier (conditional human capital) against the average TFP growth from 1990 to 2010. The conditional log of human capital represents the direction of the relationship between human capital interacted with distance to frontier on average TFP growth, indicating a slight negative relationship.

Figure 4.5 TFP growth and conditional log (H)



Closeness to Frontier (DTF)

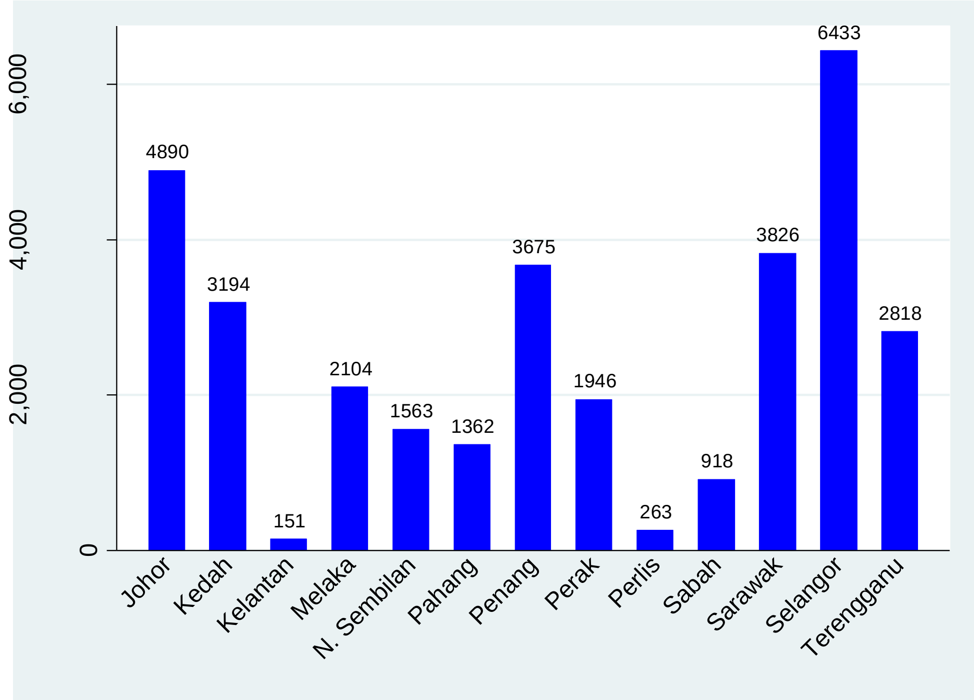
The closeness to frontier is the gap between TFP in the leader state (A_m) and home state (A_i). In the context of technology diffusion, the state leading in TFP represents the technology frontier (Nelson & Phelps 1966). Figure 4.4 above shows that the leader state in TFP growth in 1990 is the state of Perlis, while Figure 4.5 shows that for TFP growth with conditional log of human capital, the state of Melaka is the leader state. States that are near the frontier will focus more on innovation activities, whereas states that are far from frontier will adopt the technologies.

Foreign Direct Investment (FDI)

Data for domestic and foreign direct investments inflow in the states are sourced from the Malaysian Investment Development Authority (MIDA) database, available online at the Economic Planning Unit Malaysia website. The data are used to calculate the physical capital component of the TFP measurement. Figure 4.6 below shows the average investment in the states for the period of 1990 to 2010. Data for FDI are also calculated using constant Malaysian Ringgit (MYR) in 2005 prices to get the real FDI. In addition, the FDI per capita (in logs) has been included as control variable to examine the link between human capital and FDI investments in the states. The FDI per capita (FDIpc) are calculated by dividing FDI with total population in the states. It is also assumed that higher FDI inflows could contribute to more job opportunities and higher economic growth.

There are many factors that affect TFP and economic growth. Although some literature has considered FDI to be a driver of TFP growth, the FDI per capita is selected as a control variable to explain other related factors that may affect TFP growth. The benefits of FDI on growth have been widely researched, although with conflicting results. Lack of absorptive capacity (in terms of gaining benefits from FDI flows) of the host country may contribute to the weak or conflicting FDI-growth relationship (Azman-Saini, Baharumshah & Law 2010). There are also suggestions that since the adoption of new technologies need higher skilled labour, developed countries with higher level of human capital are more likely to gain from FDIs than developing countries (Borensztein et al. 1998). However, for Malaysia the high foreign labour dependence indicates support for FDI labour-intensive manufacturing. Taylor (2009) claims that the 1990s saw a steep rise in capital intensity, but the empirical evidence suggested otherwise as imports of unskilled foreign labour helped sustain labour-intensive manufacturing.

Figure 4.6 Average investment, 1990-2010 (2005=100)



Source: Malaysian Investment Development Authority (MIDA) 2014; Author's calculations

Population

Data on population are downloaded from the Population Quick Info online database provided by the Department of Statistics Malaysia (DOSM). The DOSM conducted the Population and Housing Census every 10 years and yearly population estimates are then calculated. Using the final data on births and deaths, the population data are reviewed every ten years after the Population and Housing Census was conducted for more accurate data estimation. The population growth rates refer to changes in the number of population over a time period and calculated as a percentage of the initial population, while the average rate of population growth is the average annual percentage growth rate divided by the number of years.

In this study, the working-age population are divided into three groups: AGE1 represents young workers (15-29 years), AGE2 represents middle workers (30-49 years) and AGE3 represents older workers (50-64 years). Using the population by age data, the working-age population are calculated and divided into these three groups. Physical labour is assumed homogenous and all qualitative differences are summarised by education variables for each group.

Education (Human Capital)

Years of schooling in logs (YS)

Higher educated labour force is assumed to promote innovation and technology absorption that contributes to higher productivity growth, thus making the working-age population level of education crucial in enhancing economic growth. Education growth represents the growth in educational attainment, with higher educational attainment contributes to higher economic growth. Empirical research on human capital uses various variables as measurement for education, such as average years of schooling, school enrolment rates or student-teacher ratio. The overall human capital stock, measured by average years of schooling is often assumed to affect the growth rate of TFP by acting as a catalyst of technology creation and technology adoption (Nelson & Phelps 1966; Cuaresma, Lutz & Sanderson 2012).

Following Barro and Lee (2010), the average years of schooling is the key explanatory variable in the study model, representing the measurement for human capital. Therefore, the average years of schooling in the working-age population of those aged 15 to 64 years are used as a proxy for human capital, indicated by the variable YS. The first panel data set contains data which covers 13 states for the period of 1990 to 2010 (21 years). The data was derived from the Labour Force Surveys (LFS) conducted by the DOSM throughout the years using the household approach. The LFS macro time series yearly data are downloaded from the DOSM website. Educational attainment categories by levels of schooling indicate the relative importance of primary, secondary and tertiary level that contributes to Malaysia’s economic development. The estimates of educational attainment provide a reasonable proxy for the stock of human capital (Barro & Lee 2010).

Micro data for the year 1990, 1995, 2000, 2005 and 2010 were used to calculate the years of schooling for the working-age population. Since the DOSM only provided data that covers a 5-year time period, between year data estimate was calculated using the normalisation technique. In this case, the ratios of the growth rate from micro data provided by DOSM and the time-series data from the DOSM website was calculated and normalised. Data for the two years that LFS were not conducted (1991 and 1994) were linearly interpolated. Therefore, the second panel dataset contain non-overlapping observations of 3-year time period, totalling 7 observations from 1990 to 2010 for the 13 states. In calculating the years of schooling, the primary level was assumed to represent 6 years of education, secondary level 11 years and tertiary level 15 years. The 15 years for tertiary level is the minimum number of years of schooling to achieve tertiary level education. Following Barro and Lee (2010), the number of years of schooling for the working-age groups is calculated as below.

$$ys_t = \sum_{a=1}^{A} l_{it}^{a} s_{it}^{a} \tag{4.26}$$

where l_t^a is the share of the working-age population, and s_t^a is the number of years of schooling for the working-age groups, with a=1 (15-29 age group), a=2 (30-49 age group) and a=3 (50-64 age group), with t=time. The average years of schooling was also calculated based on the educational level in three categories, namely primary, secondary and tertiary to establish the link between growth and educational level. The average years of schooling was calculated based on highest certificate obtained by each working-age population. Data on the highest certificate obtained are then used to calculate the average years of schooling for each working-age groups. Data based on the highest certificate obtained is considered more precise than the education level because a worker could have finished schooling at the lower secondary or upper secondary level. Specifically, the number of years of schooling of age group *a* in time *t* is:

$$ys_t^a = \sum_{j}^{A} h_{j,t}^{a} Dur_{j,t}^{a} \tag{4.27}$$

where h_j^a is the portion of group *a* with highest certificate obtained of educational attainment level *j*=primary, secondary, tertiary, and $Dur_{j,t}^a$ indicates the corresponding duration of level j in years.

Education Quality

There is a growing debate on the quantity measure of human capital (i.e., the average years of schooling) and whether this can adequately explain the relationship between human capital and growth. The important contribution of education quality on growth was highlighted by the works of, among others, Hanushek (2004), Islam (2010), and Messinis and Ahmed (2013).

Using science and mathematics scores on internationally comparable tests to measure human capital quality, Hanushek and Kimko (2000) and Barro (2001) argue that both educational quality and quantity affect growth positively. Internationally, there are two widely referred international benchmarks on quality of education, namely the Trends in International Mathematics and Science (TIMSS) and the OECD Programme for International Assessment (PISA)[25]. Although the literature on quality education lists indicators such as the teacher quality and teacher-student ratio, presently the assessment by TIMSS and PISA are internationally accepted to provide a clear benchmark on education quality. However, since data on TIMSS and PISA are limited for Malaysia, as an alternative, following Messinis and Ahmed (2013), this study utilises the data on scientific journal article publications in sciences per capita, SciP, sourced from SCOPUS[26] for the 13 states in Malaysia for the period of 1990 to 2010. SciP is a critical component of the latent measure of *applied cognitive skills*. This variable measures research outcomes and quality of education, which provide the foundation for cognitive and research skills. In addition, according to Romer (1990), as the human capital stock are usually fixed, technological change highly depends on human capital that are involved

[25] Students completed an assessment on reading, mathematical and scientific literacy, as well as extensive background questionnaire.
[26] SCOPUS represents the largest abstract and citation database of peer-reviewed literature in scientific journals.

in the research sector. Higher rate of human capital involvement in research will enhance higher rate of technological change.

Therefore, following Messinis and Ahmed (2013) in determining the education quality in this study, data from SCOPUS on the scientific journal article publications in sciences (in logs) will be used, later calculated in per capita terms with one added to the original data, as below. The scientific publications data covers important cities from the 13 states in Malaysia. This variable also indicates the innovation activities, implying higher human capital with higher publications in scientific research.

$$SciP_{i,t} = \frac{1 + Scientific\ Publication_{i,t}}{Population_{i,t}}$$

A research by Jin and Jin (2013) suggests that publication productivity in different subject matter has different effects on economic growth. They examine academic research as a proxy for quality of education at the tertiary level (by assessing the cognitive ability of professors) and concluded that research publications have positive and significant effects on economic growth. Publications in basic science and engineering are found to have bigger effect on growth in comparison with other subject matter (business and economics education has a more indirect effect on technology development). They also highlight that the speed of convergence seems to be faster when the measures for quality of education are included in the growth estimation.

4.4 Estimation Method

The empirical models in this study will be estimated using the dynamic panel system GMM estimator proposed by Arellano and Bover (1995). The system GMM estimator is widely used in empirical analyses for it has a number of advantages, among others, it exploits the time-series properties of the data, controls for firm-specific effects, and can be used to account for endogeneity in explanatory variables (Arellano & Bond 1991; Roodman 2006, 2008). In addition, the GMM estimators can accommodate unbalanced panels, non-linear effects in the error term and more efficient identification of instruments via principal component analysis (Roodman 2008). In the case of years (T) being larger than number of states (N), it is possible for instruments to proliferate, but the number of instruments can be restrict using the principal component analysis. The system GMM estimator is also known to yields less bias and more efficiency than other panel estimators (Hayakawa 2006).

The empirical model will be estimated using two macro panel datasets of annual observations for 21 years and 3 year averages for the 13 states in Malaysia. The use of panel data, not only will allows better models to be estimated, but will also improves efficiency (Mirestean & Tsangarides 2016). The empirical models will be estimated using the Stata 13 software (xtabond2 command) and applying the one-step and two-step system GMM. The one-step GMM estimator assumes independent error terms and homoskedastic error variances across countries and times. Meanwhile, the two-step GMM utilises the consistent variance-covariance matrix that was constructed from the residuals of the one-step estimation when the assumptions of independence and homoscedasticity do not hold.

The models estimation using Stata 13 ‘xtabond2’ procedure will include various commands, such as principal components analysis (pca) that runs on the correlation (not covariance) matrix of the GMM-style instruments. It instructs the program to replace the GMM-style instruments with their principal components to reduce the instrument count in a minimally arbitrary way. Other command options include: collapse, robust and small. The command ‘level’ controls the size of the reported confidence intervals, with the default being 95% and the command ‘small’ generates small-sample corrections to the covariance matrix estimate, resulting in a t statistics (Roodman 2006).

In terms of consistency of the GMM estimator, it depends on two specification tests. The first test, AR(2) examines the hypothesis of no second-order serial correlation in the error term of the differences equations. Meanwhile, the second is the Hansen test for over-identifying restrictions. Under the null of joint validity of all instruments, the empirical moments have zero expectation (Arellano &

Bond 1991). Failure to reject the null of both tests provides support to the estimated model.

4.5 Chapter Summary

This chapter has focussed on explaining the theoretical frameworks and empirical models of this study. Following works on endogenous growth theory that have been established in the literature, two baseline empirical models were derived to establish the link between age structure, human capital, technology diffusion and TFP or economic growth. This chapter also describes the variables definitions, data descriptions and estimation method. The next chapter will discuss the empirical specifications, model estimation and findings of the two empirical models on education and economic growth in Malaysia.

CHAPTER 5
EDUCATION AND GROWTH IN MALAYSIA: THE EVIDENCE

5.1 Introduction

This chapter presents the empirical specifications and findings for the two empirical models on education and economic growth in regional Malaysia. Applying the endogenous growth model framework, the first baseline empirical model examines the relationship between human capital, technology diffusion and TFP growth in terms of level effects (i.e., the stock of human capital). The second model examines the relationship between human capital and economic growth in terms of level and growth effects (i.e., the stock and accumulation of human capital). Empirical estimations will also include extended interaction models, specifically the link between education level (primary, secondary and tertiary) and TFP or economic growth, as well as estimation to examine the effect of FDI (as control variable) on TFP growth.

This chapter is divided into two sections, with the first section explaining the empirical specifications and model estimations. The second section discusses the findings, beginning with descriptive statistics and followed by the discussion on the empirical findings of the two baseline models, as well as the extended model on FDI. The dynamic panel data Generalised Method of Moments (GMM) analysis was used for all model estimations and for comparison, the models will be estimated using the one-step and two-step standard errors system GMM. The difference between the standard errors is that the two-step GMM utilises the consistent variance-covariance matrix which is constructed from the residuals of the one-step estimation when the assumptions of independence error terms and homoscedastic error variances across countries and times do not hold. In earlier literatures, inferences were usually made on the results of the one-step standard errors because the two-step standard errors were biased downwards. However, Windmeijer (2005) suggests a correction procedure to resolve the biasness in the two-step standard errors. The model estimations on the relationship between human capital, technology diffusion and TFP or economic growth in this study utilised data of annual observations for 21 years and 3 year averages from 1990 to 2010, covering all the 13 states in Malaysia.

5.2 Empirical Specifications

In examining the links between human capital and economic growth, two empirical models were adapted, namely the human capital and technology diffusion model proposed by Benhabib and Spiegel (2005), and the model of economic growth proposed by Aghion, Howitt and Murtin (2010), hereafter known as AHM, as explained in detailed in Chapter 4. These two models will be examined to test their capacity to explain economic growth in regional Malaysia. Following this, the empirical specifications will define (i) links between human capital, technology diffusion and TFP growth, with additional specifications on education level and (ii) links between human capital and economic growth, with additional specifications on education level. Since Malaysia is a federation with a centralised governance structure, the concentration of authority at the national level enables education policies to be standardised throughout the country. Although the centralisation of authority in education raises questions on the efficiency of the delivery of services, the centralisation does contribute in ensuring the standard of education as well as access to education are equal for every student.

Additional estimation related to FDI as controlled variable and education quality were also performed for both baseline models. However, details of the extended interaction models on education level and education quality will be discussed in Chapter 6. The interaction models in improving empirical analyses were adapted from Brambor, Clark and Golder (2006). In all models, the state dummies and year dummies are also estimated. Summary of the empirical specifications as adapted from Benhabib and Spiegel (2005) and Aghion, Howitt and Murtin (2010) models are discussed below.

5.2.1 Empirical Model of Human Capital, Technology Diffusion and TFP Growth

Following Benhabib and Spiegel (2005), this study's baseline empirical specification on the link between education and TFP growth is written as follows:

$$\Delta a_{i,t} = b + (g + m)s_{i,t}h_{i,t} - (m)s_{i,t}h_{i,t}\left(\frac{A_i}{A_m}\right)^s + \varepsilon_{i,t} \quad (5.1)$$

or can be re-written as:

$$\Delta TFP_{i,t} = \alpha_0 + \beta_1 lnYS_{i,t} + \beta_2 lnECTF_{i,t} + \varepsilon_{i,t} \quad (5.2)$$

(i = 1,…,N; t = 1,…,T)

where the dependent variable, $\Delta TFP_{i,t}$ represents the average annual growth rate of total factor productivity. The independent variables, $YS_{i,t}$ represents the log years of schooling (indicates the education level in state i) and $ECTF_{i,t}$ (in logs) represents the interaction between education and closeness to frontier (EDU x CTF). The coefficient β_1 represents the combined effect of YS (h) on ΔTFP from (a) innovation, and (b) the exponential component of the distance to frontier (A_{max} – A)/A, with higher level of YS having a positive effect on TFP growth. As in equation (4.7), β_1 = (g+m) and g (pure innovation effect) = (β_1 – β_2). Lastly, the $\varepsilon_{i,t}$ represents the error term. The subscript *i* and *t* denote state and time period, respectively and this denotation of *i* and *t* also applies to other sets of specification described hereafter. The coefficient β_1 is expected to have a positive sign, while β_2 is expected to have a negative sign. The coefficient β_2 indicates the effect of the gap in frontier technology between leader state and followers. States that are near the frontier will focus more on innovation activities, whereas states that are far from the frontier will adopt technologies from the frontier country, thus represented by the negative sign.

Previous research findings have found a positive link between productivity growth and level of human capital and that a higher initial level of human capital has significantly positive impact on per capita GDP growth (Nelson & Phelps 1966). Kyriacou (1991) suggests that without relatively higher level of initial human capital stocks, it would be difficult for laggard countries to converge to more advanced economies. Therefore, the estimates for the empirical model as specified in equation (5.2) will examine the evidence on the contribution of human capital for productivity growth in Malaysia. From the estimation model, TFP growth depends on two factors, that is (i) the innovation capability of that country, which depends on the human capital stock (lnYS); and (ii) the interactive component (lnECTF), that should capture the process of catch-up described by the Nelson–Phelps hypothesis, in which the rate of technology diffusion depends on the existing technology gap and on the stock of human capital.

In addition to estimating the baseline model given by the above equation, estimation was also performed to examine the effect of FDI (as control variable) on TFP growth, using the model specification as in equation (5.3) below.

$$\Delta TFP_{i,t} = \beta_0 + \beta_1 YS_{i,t} + \beta_2 EDTF_{i,t} + \beta_3 FDI_{i,t} + \varepsilon_{i,t} \qquad (5.3)$$

(i = 1,…,N; t = 1,…,T)

The FDI per capita is selected as a control variable to explain other related factors that may affect TFP growth. Islam, Ang and Madsen (2014) propose that FDI embodies new technology, know-how and knowledge that contribute to economic growth. FDI could provide new inputs and foreign technologies in the production process of the host country and will also provide knowledge enhancement through skills training and more effective management structures. Borensztein et al. (1998) and Xu (2000) claim that the adoption of new technologies needs higher skilled labour and developed countries with higher level of human capital are more likely to gain from FDIs than developing countries. However, past empirical studies have also found positive relationship between FDI and economic growth in developing countries as well (Wang 2003). The underlying assumption here is that FDI is treated as an exogenous variable, and from the equation model above, the coefficient β_3 is expected to have a positive sign. Similarly, the coefficient β_1 is expected to have a positive sign, while β_2 is expected to have a negative sign.

5.2.2 Empirical Model of Human Capital and Economic Growth

Next, the link between education and economic growth will be defined. Using the production function and adapting the empirical model by Aghion, Howitt and Murtin (2010), the empirical model of growth equation in this study, which includes both the level and accumulation of human capital, as previously discussed in Chapter 4, is defined as below:

$$\Delta logy_{i,t} = a + b\Delta logYS_{i,t} + \ clogYS_{i,0} + \ dlogy_{i,0} + \ u_{i,t} \qquad (5.4)$$

or can be re-written as:

$$\Delta GDP_{i,t} = a + b\Delta EDU_{i,t} + \ cEDU_{i,0} + \ dGDP_{i,0} + \ u_{i,t} \qquad (5.5)$$

Following the AHM model, the dependent variable $\Delta GDP_{i,t}$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\Delta EDU_{i,t}$ represents the change per year in the log of years of schooling in the respective states over the same period, also multiplied by 100; log $EDU_{i,0}$ represents the log of years of schooling at the beginning of the period; log $GDP_{i,0}$ represents initial log of GDP per capita and $u_{i,t}$ is a residual term. The subscript *i* and *t* denote state and time period, respectively.

The coefficient (b) from the above equation model represents the accumulation of human capital that affects economic growth. Higher growth or accumulation of human capital will have a positive effect on economic growth and thus, the coefficient is expected to have a positive sign. In addition, coefficient (c) on initial years of schooling is also expected to have a positive sign as higher initial level of human capital will contribute towards higher growth. Meanwhile, coefficient (d) for initial level of per capita GDP is predicted to have a negative sign, which suggests that growth of per capita GDP should depend negatively upon its initial level. In earlier estimation FDI was included as explanatory variable, however the results are not significant and the variable was dropped.

5.3 Descriptive Statistics Results

All the above empirical models are estimated using Arellano and Bover (1995) dynamic panel system GMM, as discussed in the model estimation section in Chapter 4. The results of the descriptive statistics are presented in Table 5.1.

Table 5.1 Descriptive statistics

Variable	Mean	Std. Deviation	Min	Max
Real SGDPpc	9.493	0.462	8.252	10.368
Growth of TFP (ΔTFP)	0.000	0.118	-0.924	0.217
Years of schooling (YS)	2.311	0.069	2.119	2.481
Distance to frontier (DTF)	0.582	0.214	0.157	1.000
Population	1.681	1.042	0.187	5.502
Scientific publication (SciP)	2.775	1.576	-0.760	6.967
FDI per capita (FDIpc)	1008.48	1445.12	0	11,851.85

(No. of observations (N*T) = 273)

Table 5.1 highlights the distribution of the panel data constructed for this study, which covers the 13 states for the period of 1990 to 2010 (21 years). The real state GDP per capita (in logs) indicates a minimum of 8.2 and the maximum of 10.3, with an average of 9.4. TFP growth indicates a minimum negative growth of -0.9% and the maximum growth being 0.2%. The years of schooling (YS) in logs show an average of 2.3 years, with a minimum of 2.1 years and the maximum of 2.4 years. The distance to frontier (DTF), which indicates the gap between the technology in the leading country (A_m) and the home country (A_i) have the maximum value of 1.0 and average value of 0.5.

The states' population average is at 1.6 million, with the minimum state population being 0.2 million and the maximum state population of 5.5 million people during the same period. The scientific publication (SciP), represents the per capita scientific journal article publications in sciences in logs. SciP, which also implies higher human capital with higher publications in scientific research show an average of 2.7 publications, with a maximum of 6.9 publications. The figure for FDI per capita indicates the presence of wide gaps between the minimum and maximum investment values, with certain states having zero FDI investments in certain years during the study period. FDI inflows are mostly in the manufacturing industry and located in the more-developed states in Malaysia.

5.3.1 Panel Unit Root Tests

The panel unit root tests were run to determine the order of integration of the series in the panel datasets. Economic variables tend to be non-stationary over time, but the series can become stationary by differencing the variables, in which probability distributions are stable over time (Wooldridge 2013). There are a few panel data non-stationary or unit root tests available in STATA, such as Im, Pesaran and Shin (IPS) (2003), Levin, Lin and Chu (2002) and Maddala and Wu (1999) Fisher combination test. These tests, which are commonly used, were based from the panel unit root tests introduced by Levin and Lin in 1993 (Hoang & McNown 2006).

In this study, the IPS unit root test will be used to test the panel datasets. The IPS null hypothesis proposes that all series contain a unit root, but with alternative hypothesis that allows for some, but not all series contain a unit root. The data is considered stationary if the null hypothesis of assuming that all series in the panel are nonstationary processes is rejected. Under the assumption that there are no cross-sectional correlations in panels and through the Monte-Carlo simulations, the IPS test was found to be more powerful than the Levin Lin test (Im, Pesaran & Shin 2003; Maddala-Wu 1999).

In addition, Pesaran (2007) suggests a cross-sectional augmented Dickey-Fuller (CADF) test for testing unit roots in a dynamic panel, in terms of cross-sectional dependency as well as serially correlated errors. In this test, the standard Dickey-Fuller regressions are augmented with cross-sectional averages of lagged levels and first differences of the individual series. Pesaran (2007) also proposes a cross-sectional augmented IPS (CIPS) test, which is a simple average of the individual CADF-tests. The IPS test involves data generating process using a simple dynamic linear heterogenous panel data model. In this procedure, the error term is assumed to have an unobserved one-common-factor structure accounting for cross-sectional correlation and an idiosyncratic component.

The results of the unit root tests are shown in Table 5.2. IPS test [W-t-bar] in level indicates that YS (in logs) are non-stationary when using one lag and indicates stationary when two lags are used. The null hypothesis is that all panels contain a unit root. From the results, we reject the null hypothesis at 1% level of statistical significant and concluded that there are no unit roots in the panels. The second IPS test using first difference indicates all variables are stationary when both lags are used. The Pesaran (2007) CADF test statistic [Z-t-bar] indicates similar results in both one and two lags for all variables, except for the variable YS when using two lags.

Table 5.2 Panel unit root tests

	IPS Test [W-t-bar]		CADF Test [Z-t-bar]	
Variable	Lag (1)	Lag (2)	Lag (1)	Lag (2)
In levels				
ΔSGDPpc	-2.818***	-1.234	-2.807***	0.272
ΔTFP	-6.810***	-5.204***	-8.864***	-4.993***
YS	-0.409	-1.836**	-0.448	0.664
DTF	-5.208***	-5.042***	-7.949***	-4.261***
In first difference				
ΔYS	-4.066***	-3.328***	-7.791***	-2.839***

Notes: *** and ** indicate significance at 1% and 5% levels respectively. The null hypothesis is panels containing unit roots. The tests control for the cross-sectional effects and include a time trend. Overall, all relevant variables are considered to be I(0).

5.4 Estimation Results

5.4.1 Level Effects: Human Capital, Technology Diffusion and TFP Growth

The human capital and technology diffusion level effects model was empirically tested to estimate the relationship between the independent variable ΔTFP (average annual growth rate of total factor productivity) and the independent variables of YS (average years of schooling, which proxies for education) and ECTF (interaction between education and closeness to the frontier). In addition, the baseline model was also estimated with an extended interaction model on FDIpc (foreign direct investment per capita) as control variable. The data used for estimation represents annual observations for 21 years and 3 year averages from 1990 to 2010. As comparison, the models were estimated using both the one-step and two-step estimation techniques.

The first empirical model (equation 5.2), which is also the baseline model, investigates the linkages between human capital, technology diffusion and TFP growth. As discussed in Chapter 4, the divergence in TFP growth depends on the human capital stock which represents the capability to innovate and absorb frontier technology. The estimation results using 21 years of data are shown in Table 5.3 below, which indicate that the coefficients for human capital (YS) has the expected positive sign (columns I to IV) and statistically significant at 5% level (columns I to III), both when estimated with, or without FDI (equation 5.3) as the control variable. The higher level of human capital will have a positive effect on TFP growth.

The coefficient for ECTF has the expected negative sign and statistically significant at 5% level (columns I and IV), confirming the TFP catch-up or convergence process between the follower and leader states and in line with Benhabib and Spiegel (2005) and Papageorgiou (2002) findings in their study. The negative sign indicates that states that are near the frontier will focus more on innovation activities, whereas states that are far from the frontier will adopt technologies from the frontier country. However, Benhabib and Spiegel (2005) also point out on the need for countries to further attract physical capital in ensuring convergence in per capita income as well. Regarding the estimation of human capital and FDI per capita, the findings show a negative (column III and IV) and statistically significant relationship at 5% level (column III), indicating that FDI has an adverse (negative) effects on TFP growth in regional Malaysia.

Table 5.3 Total factor productivity growth: System GMM (21 years)

Variables	I	II	III	IV
	One step	Two step	One step	Two step
Constant	-13.940* (4.979)	7.046 (15.829)	6.122 (9.930)	-20.481 (9.834)
YS	0.660* (0.280)	2.241* (1.020)	1.942* (0.826)	0.289 (0.760)
ECTF (YS*CTF)	-0.231* (0.095)	-0.290 (0.171)	-0.007 (0.128)	-0.298* (0.114)
ln (FDIpc)			-0.035* (0.016)	-0.003 (0.020)
Observations	260	260	253	253
N states	13	13	13	13
N instruments	20	18	23	21
AR(2)	0.343	0.376	0.233	0.485
Hansen test	0.674	0.527	0.793	0.902

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Table 5.3 also provides the number of panel units, the total number of instruments used, the AR(2) test for autocorrelation and the Hansen test for over-identifying restrictions. The Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation, while the Hansen test is used to test for over-identifying restrictions. The Hansen test shows the validity of the instruments used in the analysis, by determining whether any correlation between instruments and errors exists. For an instrument to be valid there should be no correlation between instruments and error. From the results, the null hypothesis cannot be rejected, thus providing evidence of the validity of lagged levels dated t-2 and earlier lags as instruments in the first difference equations. The diagnostic tests are reported at the bottom of Table 5.3, with the

AR(2) test for autocorrelation and the Hansen test for over-identifying restrictions indicating validity of the instruments used in the analysis.

The model was also estimated using the 3 year averages dataset and the findings are as shown in Table 5.4 below. The coefficients for YS show negative signs (columns I and II) and statistically significant at 5% level (column I), while coefficients for ECTF, although they have the negative signs but are not significant. The results of YS and ECTF are better when estimated with FDI as the control variable. The coefficients for YS and ECTF have the expected sign, with YS statistically significant at 5% level (columns III and IV) and ECTF statistically significant at 1% level when using one-step estimation (column III). The coefficients for FDI indicate negative signs (columns III and IV) and statistically significant at 5% level (column III), indicating that FDI has an adverse effect on TFP growth in Malaysia during the period from 1990 to 2010. The negative effect of FDI may be due to the low absorptive capacity (i.e., the quality of human capital) whereby countries may not be able to fully benefit from FDI (Azman-Saini, Baharumshah & Law 2009, 2010). The low absorptive capacities also explain why some countries experience rapid economic growth through FDI inflows, while others are still lagging behind. Another possible explanation of the negative effect can be due to FDI being endogenous via (a) reverse effects from TFP growth or (b) YS or ECTF affecting FDI but are not fully controlled since FDI is not instrumented.

The diagnostic tests are reported at the bottom of Table 5.4, with the AR(2) test for autocorrelation and the Hansen test for over-identifying restrictions indicating validity of the instruments used in the analysis. In summary, the results using 21 years dataset are better compared to using 3 year averages dataset, possibly due to the longer time frame and more data variability.

Table 5.4 Total factor productivity growth: System GMM (3 year averages)

Variables	I	II	III	IV
	One step	Two step	One step	Two step
Constant	5.041* (2.023)	4.823 (3.262)	-2.616* (1.055)	-1.762* (0.779)

Variables	I	II	III	IV
	One step	Two step	One step	Two step
YS	-2.289* (0.902)	-2.193 (1.455)	1.207* (0.482)	0.805* (0.358)
ECTF (YS*CTF)	-0.044 (0.114)	-0.038 (0.231)	-0.110** (0.035)	-0.072 (0.065)
ln (FDIpc)			-0.014* (0.006)	-0.017 (0.009)
Observations	91	91	91	91
N states	13	13	13	13
N instruments	9	9	19	19
AR(2)	0.930	0.929	0.087	0.073
Hansen test	0.087	0.087	0.553	0.553

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

Innovation and technology development are among the main drivers of economic growth. The creation of technology and adoption of these new technologies depend on greater human capital knowledge and capability to absorb these technologies. Therefore, the educational level of the working-age population is important and is one of the key factors in enhancing technology diffusion that contributes to more rapid economic growth. The overall human capital stock, measured by average years of schooling is often assumed to affect the growth rate of TFP by acting as a catalyst of technology creation and adoption, as well as absorption of new technology (Nelson & Phelps 1966; Cuaresma, Lutz & Sanderson 2012). In addition, Romer (1990) states that increase in the stock of human capital will increase the steady state growth rate.

The model specification as in equation (5.2) measures the human capital capacity for innovation activities and technology adoption from abroad, which contribute towards TFP growth. The above estimation results provide some support for the model showing that human capital (YS) has a positive sign and the coefficient for ECTF has the expected negative sign, both statistically significant at 5% level (Table 5.3, column I). The coefficient for ECTF is expected to have a negative sign based on the adverse effects of convergence in which states that are near the frontier will focus more on innovation activities, whereas states that are far from the frontier will adopt technologies from the frontier country. However, when FDI is used as a control variable, there is less evidence of the ECTF effect with yearly data which suggests that diffusion may be a longer-term phenomenon and most studies do indeed focus on lower frequency data than annual.

The equation (5.2) model results are similar to those in Benhabib and Spiegel (2005) finding a positive role of human capital as an engine of innovation. The findings indicate that average years of schooling have a direct and indirect effect on TFP growth in Malaysia, which validates the importance of education in enhancing TFP growth in Malaysia. In addition, Wei et al. (2001) observe that when there is a high level of human capital, tangible inputs could be used more effectively and thus contributes to higher ability in learning and absorbing new technology. Education enhances labour productivity that contributes towards economic growth, as well as increases the innovation capacity of the country (Lucas 1988). World Bank (2013) also stresses on the importance of education for Malaysia's growth, describing it as an essential element in achieving the goal of becoming a high-income nation.

Since high TFP growth is linked with high economic growth, higher education level will lead to the deepening of human capital and rapid adoption of new technologies. This will lead to higher labour productivity, which is one of the important traits of a develop country. In the Eleventh Malaysia Plan (2016-2020), further efforts will be taken to attain productivity target of RM92,300 per worker by 2020, compared to the productivity level of RM77,100 in 2015. In achieving this target, growth needs to be accelerated for the next 5 years. Therefore, in moving towards becoming a high-income and developed nation, Malaysia needs to be able to match the research and innovation intensity of world leaders, thus having a higher human capital is crucial for future growth.

The ECTF result confirms the presence of TFP catch-up or convergence process in Malaysia. The convergence theory suggests that states that are near the frontier will incline towards innovation activities, whereas states that are far from the frontier will adopt the technology from the frontier country. In addition, Benhabib and Spiegel (2005) also point out on the need for countries to further attract physical capital in ensuring convergence in per capita income as well. The results also indicate that the education level as suggested by Nelson and Phelps (1966) play an important role in technology adoption that contributes to convergence and reducing development gap among the states in Malaysia.

There are many factors that affect TFP and economic growth. Following earlier research literatures, the FDI per capita was selected as a control variable to explain other related factors that may affect TFP growth. Wei et al. (2001) suggest that besides capital and managerial skills, FDI also transfers embodied and tacit technologies. Embodied technologies refer to improvements in the design or quality of new capital goods or intermediate inputs (OECD 2001). Host countries benefit from successful FDI transfers through technology transfer that improves the recipient countries technological capability (Abdullah, Bakar & Hassan 2014). In addition, FDI has also been identified as an important source of financing that will further enhance growth, especially in developing countries, where capital for investment are limited. Therefore, the first baseline empirical model was also extended to investigate the relationship between human capital, technology diffusion, FDI per capita and TFP growth. The findings show a negative relationship between FDI per capita and TFP growth, indicating that FDI has an adverse effect on TFP growth in Malaysia.

The benefits of FDI on growth have been widely researched, although with conflicting results. Azman-Saini, Baharumshah and Law (2010) observe that the deficiency of absorptive capacity (in terms of gaining benefits from FDI flows) of the host country may contribute to the weak or conflicting FDI-growth relationship. The intervening factors, among others, include the quality of human capital and freedom of economic activities. Countries with low absorptive capacity may not be able to benefit from FDI. The low absorptive capacities also explain why some countries experience rapid economic growth through FDI inflows, while others are still lagging behind. In addition, Azman-Saini, Baharumshah and Law (2010) also claim that FDI, if examined by itself, has no direct impact on economic growth, but if it is examined through the index of economic freedom[27], the results indicate a positive correlation with growth. There is also likelihood that real FDI is not measured well due to CPI deflators may not be appropriate to calculate real FDI.

In this study, the finding of an adverse FDI effect on TFP growth may indicate that FDI inflows are mainly observable in labour intensive and low-skilled industries. Taylor (2009) claims that although the 1990s saw a steep rise in capital intensity in Malaysia, the imports of unskilled foreign labour helped sustain labour-intensive manufacturing in Malaysia. In addition, data on foreign labour participation in economic sectors in Malaysia also show higher concentration of foreign workers in low-skilled jobs, particularly in the manufacturing and agriculture sector (Economic Planning Unit 2015). Another possible explanation may relate to FDI being endogenous or correlated with YS or ECTF. FDI could be endogenous via (a) reverse effects from TFP growth or (b) YS or ECTF affecting FDI but are not fully controlled since FDI is not instrumented.

5.4.2 Level and Growth Effects: Human Capital and Economic Growth

In earlier chapters, the important role of human capital in economic development was highlighted with the understanding that higher level of human capital will enhance the absorptive capacity of new technologies. For example, Dowrick (2003) suggests that having more educated workforce contributes in adapting and utilising technological advances, therefore investment in human capital in terms of skills and ideas are important to promote economic growth. In addition, Lucas (1988) highlights that human capital is the engine of economic growth, assuming individuals invest in education to accumulate new skills and knowledge. Therefore, the accumulation of human capital or the growth effects may contribute to further enhance economic growth.

[27] This index provides insight into the characteristics of an environment conducive to prosperity by measuring the institutional quality that includes variables, among others, free and competitive market, protection of property rights and freedom of exchange across borders.

Next, the estimation of the empirical model of AHM, equation (5.4) and the findings are shown in Table 5.5. These indicate that growth in years of schooling have the expected positive signs (columns I and II) when estimated using the 21 years dataset. However, the same coefficients have the negative signs when estimated using the 3 year averages dataset (columns III and IV) and statistically significant at 5% level when using one-step GMM (column III). As for the initial years of schooling, all coefficients have, as expected, negative signs but are not statistically significant (columns I to IV). Meanwhile, the results for initial per capita GDP show the predictive negative signs when estimated using the 21 years dataset, with the coefficients statistically significant at 5% level when estimated using two-step GMM.

Table 5.5 GDP Growth: System GMM

Variables	21 years		3 year averages	
	I	II	III	IV
	One step	Two step	One step	Two step
ΔEDU	0.547** (0.173)	0.672** (0.183)	-1.923* (0.753)	-1.820 (1.151)
EDU_{1990}	-539.460 (535.737)	-711.412 (600.970)	-1.162 (1.362)	-0.708 (0.962)
GDP_{1990}	-251.989 (142.062)	-308.751* (137.596)	2.320* (1.022)	1.717 (1.365)
Observations	260	260	78	78
N states	13	13	13	13
N instruments	20	13	12	13
AR(2)	0.566	0.525	0.045	0.038
Hansen test	0.634	0.634	0.437	0.329

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

Previous research findings based on the Mincer wage equation (Mincer 1974) have found positive return to schooling, with higher educational accumulation contributing to higher wages. Barro and Lee (2010) also claim that higher years of schooling will enhance growth of GDP per capita. Earlier researches have also found positive links between productivity growth and human capital and that a higher initial level as well as a higher rate of improvement in human capital have significantly positive impact on per capita GDP growth (Mankiw, Romer and Weil 1992; Lucas 1988; Nelson & Phelps 1966). In addition, there are research findings that indicate human capital has a positive effect on regional productivity and income growth, implying that differences in human capital promote these variances (Brunow & Hirte 2009).

The model specification in equation (5.4) measures the link between education and economic growth. The estimation results provide some support for the model, showing that human capital accumulation (ΔEDU) has a positive effect on economic growth. The positive coefficients indicate that higher educational accumulation will enhance growth of GDP. However, the coefficient for EDU levels show negative signs, indicating that education level did not have direct effect on economic growth. Lutz, Cuaresma and Sanderson (2008) argue that although the literature has widely recognised that higher level of educational attainment or more years of schooling will positively affect income for individuals, at the macroeconomic level however, the empirical evidence has been ambiguous. This indicates the weak assumption on the empirical basis that education will contribute positively towards economic growth.

Nevertheless, higher level of education has always been an important determinant of human capital and economic growth. Even though the benefits of investment in education take a longer time to show results, investments in education are crucial to support children to become more knowledgeable workers, with higher skills in the future. Therefore, despite the unclear link between education and economic growth in the long-term, investment in education is still one of the best investment options that countries can make for a better future. Therefore, countries need to evaluate the expected benefits of human capital accumulation towards economic growth and allocate adequate development budgets, as well as formulate policies that support growth.

5.5 Summary of Empirical Signs for Human Capital and Technology Diffusion Model

This section will summarise the above results. The expected coefficient signs based from the literature and actual signs that were derived from the GMM panel data estimations for each variable in the model are shown in Table 5.6 below. The actual results are discussed in various sections in this chapter. In summary, the two baseline models examined here have estimation coefficients for years of schooling with the expected positive sign, confirming the important role of years of schooling (education) for TFP and economic growth. In comparison, model estimations using the 21 years dataset gave better results that the 3 year averages dataset possibly due to the longer time frame and more data variability.

Predicted and actual signs for Benhabib and Spiegel model are better compared to AHM model, indicating the direct link between human capital and TFP growth (level effects). The coefficients for the ECTF variable also have the expected signs for equation models 5.2 to 5.3. Both the ln(FDIpc) signs, when estimated using one-step and two-step system GMM, as in equation (5.3) was different from the expected sign, indicating that FDI has an adverse effect on TFP growth in Malaysia.

Table 5.6 Expected and estimated coefficient signs in GMM estimation

Variables	**Expected**	**Estimated 21 years**		**Estimated 3 year averages**	
		One-step	Two-step	One-step	Two-step
Equation 5.2					
YS	+	+	+	-	-
ECTF	-	-	-	-	-
Equation 5.3					
YS	+	+	+	+	+
ECTF	-	-	-	-	-
ln (FDIpc)	+	-	-	-	-
Equation 5.4					
ΔEDU	+	+	+	-	-
EDU_{1990}	+	-	-	-	-

Variables	Expected	Estimated 21 years		Estimated 3 year averages	
		One-step	Two-step	One-step	Two-step
GDP_{1990}	-	-	-	+	+

Source: Author's estimations. Note: The sign (+/-) refers to positive and negative expectation.

The human capital variable in the models was expected to have a positive relationship with TFP and economic growth. This relationship indicates that when human capital increases, productivity will increase and contribute to higher TFP and economic growth, as supported in the literature and as proposed by Nelson and Phelps (1966). Meanwhile, Aghion, Howitt and Murtin (2010) found supportive evidence for both the initial level (i.e., stock effect) and accumulation of human capital (i.e., growth effect) having a significantly positive impact on per capita GDP growth. Similarly, Krueger and Lindahl (2001) also found that both levels of schooling and changes in years of schooling have a positive link with economic growth, as well as Cohen and Soto (2001) studies that found robust evidence of a positive association between changes in education and economic growth, particularly, as a result of higher investment in education.

However, sustaining economic growth momentum in the long term is a challenge to all countries. Middle-income countries, such as Malaysia faces various challenges in terms of rising wages and loss of comparative advantage in labour intensive industries. In maintaining economic growth, a country needs to enhance knowledge and innovation through more investment in human capital. In addition, governments need to expand higher education to support the growing demand for higher skilled and knowledgeable workers. In a condition when the growth momentum slows down in a middle-income country, focus on education that creates the right skills to increase productivity could be the solution in enhancing growth (Jimenex, Nguyen & Patrinos 2012). Even though education boosts productivity, education needs to be relevant with quality and accessible to society (Jimenex, Nguyen & Patrinos 2012). In the next chapter, estimations on education levels and quality will give better insights on the relationship between education and TFP or economic growth.

5.6 Chapter Summary

In examining the links between human capital and economic growth, two baseline empirical models were adapted from the human capital and technology diffusion model by Benhabib and Spiegel (2005), and the model of economic growth by Aghion, Howitt and Murtin (2010). In this context, the empirical specifications define links between human capital, technology diffusion and TFP growth, with additional specification on education level, as well as links between human capital and economic growth with additional specification on education level. The empirical analysis examines and estimate the relationships between the variables described earlier for the period of 1990 to 2010. In this chapter the focus of discussion was based on the effects of education in enhancing TFP and economic growth. The findings show that the human capital level effects model have better results compared to the growth effects model, indicating the positive link between human capital and TFP as well as economic growth. The next chapter will discuss the links and effects of education levels and education quality on TFP and economic growth, using extensions to the Benhabib and Spiegel (2005) and AHM (2010) models. The models are estimated and the results of these empirical estimations will be presented and discussed in details in Chapter 6.

CHAPTER 6
EDUCATION LEVELS AND QUALITY: THE EVIDENCE

6.1 Introduction

This chapter presents the empirical specifications and findings for the empirical models on education level and quality. The baseline empirical model on the relationship between human capital, technology diffusion and TFP or economic growth in terms of level and growth effects have been discussed in Chapter 5. This chapter will examine the empirical estimations of the extended interaction models, specifically the link between education level (primary, secondary and tertiary) and TFP or economic growth. In addition, the relationship between education quality and TFP growth will be estimated.

The findings of the empirical estimations as discussed in Chapter 5 indicates that human capital level effects model have better results compared to the growth effects model, indicating the positive link between human capital and TFP as well as economic growth. However, the effect of human capital on economic growth assumes that the effect is independent of education levels and quality, assuming that one extra year of education or a higher share of the population completing a higher level of education has the same impact on technology diffusion or economic growth. Applying the endogenous growth model framework, the effect of education levels and quality on human capital will be examined through the empirical specifications and findings for the two empirical models on (a) the nexus between human capital, technology diffusion and TFP growth in terms of level effects and (b) the nexus between human capital and economic growth in terms of level and growth effects. The discussion on education quality as in earlier chapters has established that education quality (i.e., the cognitive skills of the population) plays an important role in enhancing income and economic growth. The education quantity, through educational attainment has not guaranteed improved economic conditions (Hanushek & Wößmann 2007).

This chapter is divided into two sections, with the first section explaining the empirical specifications and model estimations. The second section discusses on the findings followed by a discussion on the empirical findings of the extended models on education levels and quality. The models will be estimated using the dynamic panel data system Generalised Method of Moments (GMM) analysis and for comparison, the one-step and two-step standard errors system GMM were applied for all model estimations. This study utilised data of annual observations for 21 years and 3 year averages from 1990 to 2010, covering all the 13 states in Malaysia to estimate the relationship between human capital, technology diffusion and TFP or economic growth.

6.2 Empirical Specifications

As explained in Chapters 4 and 5, the Benhabib and Spiegel (2005) and the Aghion, Howitt and Murtin (2010), hereafter AHM, empirical models were adapted to test their capacity to explain on economic growth in Malaysia. In examining the link, the empirical specifications will define (a) links between education level, technology diffusion and TFP growth, and (b) links between education level and economic growth. Therefore, this section will examine the extended empirical models of equation (5.2) and (5.4) on the education levels. In all models, the state dummies and year dummies are also estimated. Details of the extended interaction models on education levels and education quality as adapted from Benhabib and Spiegel (2005) and AHM (2010) models are discussed below.

6.2.1 Empirical Model of Education Level and TFP Growth

In estimating the link between education level and TFP growth, and following Benhabib and Spiegel (2005), the empirical specifications for this study can be written as below.

$$\Delta TFP_{i,t} = \beta_0 + \sum_{j=1}^{3} \beta_j EDU_{j,i,t} + \sum_{j=1}^{3} \varphi_j ECTF_{j,i,t} + \varepsilon_{i,t} \tag{6.1}$$

where j = (1, 2, 3)

Here $TFP_{i,t}$ represents the average annual growth rate of total factor productivity, $EDU_{j,i,t}$ represents the education level, denotes by the three variables - EDU_1 (primary), EDU_2 (secondary) and EDU_3 (tertiary) in percentage. $ECTF_{i.t}$ represents the interaction between each education level and its closeness to the frontier (i.e., EDU x CTF) and $\varepsilon_{i.t}$ represents the error term. The coefficient β_j is predicted to have a positive sign, whereas the coefficient φ_j is predicted to have a negative sign. The coefficient φ_j indicates the effect of the gap in frontier technology between leader state and followers. States that are near the frontier will focus more on innovation activities, whereas states that are far from frontier will adopt technologies from the frontier country, thus the negative sign. The model estimation used both panel datasets, which comprise annual observations for 21 years and the 3 year averages, from 1990 to 2010.

The relationship between TFP growth and education quality will be estimated to establish the effects of cognitive ability of the working-age population on TFP growth. The empirical specifications are as specified in equation (6.2). Hanushek and Wößmann (2007) claim that economic growth were the results of education quality, rather than mere access to education. Therefore, higher level of education quality will contribute to better knowledge absorption and adaptation among the working-age population. The empirical estimation on EDU (education quantity) and SciP (education quality) was done separately to compare the effects of education with existing literature. Following the literature, the EDU and SciP are expected to highly correlate[28].

6.2.2 Empirical Model of Education Quality

Hanushek and Kimko (2000) and Barro (2001) argue that both, education quantity and quality affect growth positively. There is a growing debate on the quantity measure of human capital (i.e., the average years of schooling) and whether this can adequately explain the relationship between human capital and growth. The important contribution of education quality on growth was

[28] The estimation on correlation of the variables shows a correlation of 0.72 and significant at 1%.

highlighted by the works of, among others, Hanushek (2004), Islam (2010), and Messinis and Ahmed (2013). In examining the relationship between TFP growth and education quality, the empirical specification is defined as below.

$$\Delta TFP_{i,t} = \beta_0 + \beta_1 SciP_{i,t} + \beta_2 SpCTF_{i,t} + \varepsilon_{i,t} \tag{6.2}$$

where $TFP_{i,t}$ represents the average annual growth rate of total factor productivity, $SciP_{i,t}$ represents the per capita scientific journal article publications in sciences, and $SpCTF_{i,t}$ represents the interaction between education quality and closeness to the frontier (SciP x CTF) and $\varepsilon_{i.t}$ represents the error term. The model estimation used panel datasets for the 21 years period, from 1990 to 2010, as well as 3 year averages from the same period. The interaction term between SciP and CTF refers to the indirect effect of SciP on ΔTFP. The estimation results from this model will also enable comparison between education quantity and education quality to be made.

6.2.3 Empirical Model of Human Capital and Economic Growth

Next, the link between education levels and economic growth will be defined. Using the production function and adapting the empirical model by AHM (2010), the empirical model of growth equation in this study, which includes both the level and accumulation of human capital, as discussed in Chapter 4, is defined as below:

$$\Delta logy_{i,t} = a + b\Delta logYS_{i,t} + c logYS_{i,0} + d logy_{i,0} + u_{i,t} \tag{6.3}$$

Following the AHM model, the dependent variable $\Delta logy_{i,t}$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\Delta logYS_{i,t}$ represents the change per year in the log of years of schooling in that state over the same period, also multiplied by 100; log $YS_{i,0}$ represents the log of years of schooling at the beginning of the period; log $y_{i,0}$ represents initial log of GDP per capita and $u_{i,t}$ is a residual term. The subscript *i* and *t* denote state and time period, respectively.

The coefficient (b) from the above equation model represents the accumulation of human capital that affects economic growth. Higher growth or accumulation of human capital will have a positive effect on economic growth and thus, the coefficient is expected to have a positive sign. In addition, coefficient (c) on initial years of schooling is also expected to have a positive sign as higher initial level of human capital will contribute towards higher growth. Meanwhile, coefficient (d) for initial level of per capita GDP is predicted to have a negative sign, which suggests that growth of per capita GDP should depend negatively upon its initial level.

The baseline model was extended to estimate the education levels (primary, secondary and tertiary) relationship with growth, as defined in equation (6.4) below.

$$\Delta logy_{i,t} = a + \sum_{j=1}^{3} b_j log\Delta YS_{j,i,t} + \sum_{j=1}^{3} c_j logYS_{j,i,0} + dlogy_{i,0} + \varepsilon_{i,t} \qquad (6.4)$$

where j = (1, 2, 3)

Similarly, $\Delta logy_{i,t}$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\sum_{j=1}^{3} bjlog\Delta YS_{j,i,t}$ represents the change per year in the log of years of schooling of each education level in that state over the same period, also multiplied by 100; $\sum_{j=1}^{3} cjlogYS_{j,i,0}$ represents the log of years of schooling at the beginning of the period of each education level; log $y_{i,0}$ represents initial log of GDP per capita and $\varepsilon_{i,t}$ is a residual term.

The coefficient (b) above represents the combined effect of each education level on economic growth that relates to growth in human capital. Higher growth or accumulation of human capital will have a positive effect on economic growth and thus, the coefficient is predicted with a positive sign. Likewise, coefficient (c) for the initial years of schooling is also expected to have a positive sign as higher initial level of human capital will contribute positively on economic growth. Lastly, coefficient (d) for initial level of per capita GDP is predicted to have a negative sign, which suggests that growth of per capita GDP should depend negatively upon its initial level. The subscripts *i* and *t* denote state and time period, respectively.

6.3 Estimation Results

6.3.1 Education Level and TFP Growth

Education could affect economic growth through years of schooling as well as through educational attainment. The decomposition of the education level enables a better understanding of the different roles the education level exhibits for growth, with indications that education level is relatively higher when countries are closer to the frontier (Liberto, Pigliaru & Chelucci 2010). However, education quantity treats extra one year of education as the same, irrespective of the content and level of education. Therefore, the estimation by education levels could give a better understanding of the link between education and TFP growth.

The findings of the equation (6.1) model, as depicted in Table 6.1 (columns I to VI) below, show that primary, secondary and tertiary education level coefficients have a positive sign, with the coefficient estimates for primary and secondary education levels being statistically significant at 5% level when estimated using the one-step system GMM for the 21 years dataset (columns I and III). The results on closeness to frontier show the expected negative signs (columns I to VI), with the coefficient estimates for ECTF1 (primary) statistically significant at 1% level. $ECTF_{j,i.t}$ represents the interaction between each education levels and their closeness to the frontier (i.e: EDU_j x CTF, with j = 1, 2, 3), indicating the technology diffusion between the follower and leader states. The negative coefficients indicate that states that are near the frontier focus more on innovation activities, whereas states that are far from the frontier adopt frontier technologies. The closeness to frontier also indicates that as states gets closer to the frontier, TFP growth will be lower. Details of the results are as below (Table 6.1).

The Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation and the Hansen test shows the validity of the instruments used in the analysis. The former test indicates there is no misspecification, while the latter suggests that the instruments used in the analysis are valid, as presented at the bottom of Table 6.1.

Table 6.1 TFP growth and education level: System GMM (yearly data)

Variables	I	II	III	IV	V	VI
	One step	Two step	One step	Two step	One step	Two step
Constant	-12.488** (3.858)	-12.333* (4.459)	-19.232* (5.409)	-10.480* (4.109)	7.844 (18.430)	12.390 (22.280)
EDU_1 (primary)	0.004* (0.002)	0.005 (0.002)				
EDU_2 (secondary)			0.008* (0.003)	0.006 (0.005)		
EDU_3 (tertiary)					0.032 (0.023)	0.039 (0.029)
ECTF1 (EDU_1*CTF)	-0.014** (0.0014)	-0.015* (0.006)				
ECTF2 (EDU_2*CTF)			-0.009 (0.007)	-0.002 (0.007)		
ECTF3 (EDU_3*CTF)					-0.021 (0.017)	-0.026 (0.021)
Observations	260	260	260	260	260	260
N states	13	13	13	13	13	13
N instruments	13	13	13	13	13	13
AR(2)	0.416	0.188	0.370	0.298	0.217	0.292
Hansen test	0.127	0.196	0.854	0.760	0.151	0.151

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

The equation (6.1) model was also estimated using the 3 year averages dataset and the findings are as shown in Table 6.2 below. The findings indicate that the coefficient estimates for all three education levels (i.e., primary, secondary and tertiary) have a positive sign, when estimated using the one-step and two-step system GMM, but are not significant (columns I to VI). Meanwhile, the coefficient estimates for closeness to frontier ($ECTF_j$) have the expected negative signs, with ECTF1 (primary) and ECTF2 (secondary) statistically significant at 5% level (columns I to IV). These results indicate the indirect effect of the primary and secondary education levels on TFP growth. The negative coefficients also indicate that states that are far from the frontier will adopt frontier technologies, whereas states that are near the frontier will innovate. Meanwhile, the Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation and the Hansen test suggests the instruments used in the analysis are valid, as presented below.

Table 6.2 TFP growth and education level: System GMM (3 year averages)

Variables	I	II	III	IV	V	VI
	One step	Two step	One step	Two step	One step	Two step
Constant	-2.025 (1.357)	-1.965 (1.315)	-0.257 (0.336)	-3.207 (3.898)	-0.155** (0.042)	-0.158** (0.051)
EDU_1 (primary)	0.859 (0.584)	0.857 (0.572)				
EDU_2 (secondary)			0.120 (0.155)	1.519 (1.780)		
EDU_3 (tertiary)					0.009 (0.008)	0.009 (0.010)
EDTF1 (EDU_1*CTF)	-0.097* (0.035)	-0.141* (0.062)				
EDTF2 (EDU_2*CTF)			-0.124* (0.056)	-0.202* (0.073)		
EDTF3 (EDU_3*CTF)					-0.009 (0.004)	-0.010 (0.006)
Observations	91	91	91	91	91	91
N states	13	13	13	13	13	13
N instruments	13	14	14	14	13	11
AR(2)	0.131	0.168	0.158	0.291	0.102	0.118
Hansen test	0.215	0.214	0.249	0.225	0.228	0.105

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

Past research findings have found evidence that differences in the structure of education or the composition of human capital did play an important role for economic growth. Tertiary education was found to have a positive and significant effect on economic growth in developed economies (Jin & Jin 2013; Zhang & Zhuang 2011) and that investments in education can lead to more highly educated human capital in the country (Liberto, Pigliaru & Chelucci 2010). The results on the link between education levels and TFP growth in regional Malaysia indicate that coefficient estimates for education levels have a positive sign, with the coefficient estimates for primary and secondary education levels being statistically significant at 5% level when estimated using the one-step system GMM for the 21 years dataset. The findings also indicate that the tertiary education level has no direct effect on TFP growth. These results may be due to the facts that about 75% of the Malaysian workers only have secondary and lower level of education, as discussed in Chapter 2.

Meanwhile, the results on closeness to frontier show the expected negative signs, with the coefficient estimates for ECTF1 statistically significant at 1% level when estimated using the 21 year and 3 year averages datasets. In addition, the coefficient estimates for ECTF2 is statistically significant at 5% level when estimated using the 3 year averages dataset. The negative coefficients indicate that states that are near the frontier focus more on innovation activities, whereas states that are far from frontier adopt frontier technologies. The results on $ECTF_j$ also indicate the indirect and significant effects of primary and secondary schooling on TFP growth.

The post-primary education contributes in enhancing innovation as well as imitation of technology. In developing countries, the production process is still heavily dependent on lower technology and low-skilled labour. The increase in higher education is also associated with the increase in labour productivity and efficiency in production. Vandenbussche, Aghion and Meghir (2006) suggest that skilled labour closer to the technological frontier contribute to higher growth rate. In other words, the different levels of development require a different composition of human capital, with lower education levels usually linked with lower economic development, whereas higher levels of development require higher levels of education as to absorb new knowledge and foster frontier research and innovation. The education level plays an important role in promoting innovation activities in the country. As innovation is usually linked with higher education level, efforts need to be enhanced to increase the composition of tertiary level education among the Malaysian workforce. In line with this need, the aim of Malaysia's national blueprint for a more advanced education system[29] should be given greater emphasis.

Lacopetta (2010) observes that the industrialisation process increases the demand for human capital and this demand motivates individuals to invest in education, which eventually further enhances technology advancement. These observations are similar with previous findings on the linkage between education and growth, validating the idea that efficiency in the production process requires not only investments in new technologies but also enhanced skills and the specialisation of human capital. Past research also shows that higher earnings are closely related to skill sets and education levels, with lower income countries showing higher returns to education, as based from Mincer model of private returns to schooling (Hanushek & Wößmann 2007). The literature also suggests that investing in tertiary level could provide higher return and enhance innovation activities (Vandenbussche, Aghion & Meghir 2006).

Similarly, even within a country, variations in education levels may contribute to variations in economic growth across regions. In a study by Zhang and Zhuang (2011) they found that developed provinces in China benefited more from an increase in tertiary educated workers, while the underdeveloped provinces depended more on workers with lower levels of education. Similarly, Cuaresma, Lutz and Sanderson (2009) also propose that education could affect economic growth through years of schooling as well as through educational attainment. The decomposition of the education level enables a better understanding of the different roles the education level exhibits for growth, with indications that education level is relatively higher when countries are closer to the frontier (Liberto, Pigliaru & Chelucci 2010).

Therefore, it can be concluded from the findings and discussion above that the level effects (i.e., human capital stock) of education levels, either direct or indirectly contributes towards TFP growth. As Malaysia advances in terms of economic growth and moving towards becoming a developed nation,

[29] The Education Blueprints represents the Government of Malaysia's initiatives to enhance the education system, with special focus on increasing the potentials of higher learning institutions.

sustainability in growth will rely more on the level of innovation, thus increasing the need for higher educational level, as well as skilled labour among the workforce.

6.3.2 Education Quality

Previous literature has shown that education level plays an important role in generating long-term economic growth (Barro & Lee 2010; Bloom 2010; Becker 1994; Lucas 1988) and that most countries have formulated policies to further enhance the education level of their population (Hanushek & Wößmann 2007). However, Lutz, Cuaresma and Sanderson (2008) argue that the empirical evidence for education level has been ambiguous at the macroeconomic level. This ambiguity indicates the weak assumption on the empirical basis that education will contribute positively towards economic growth, thus, leading to discussions in the literature on whether it is the education quantity or quality that is important for growth. These arguments are based upon the findings that although most countries have increased their development expenditures in providing more education, there are gaps between developed and developing countries, with some developing countries still not achieving remarkable catch-up in terms of their economic well-being.

Hanushek and Wößmann (2007) claim that education quality measured through cognitive skills has strong impact on individual earnings and economic growth. This raised the questions on how various investments could enhance the education quality and how the quality contributes to economic growth. In the Malaysian context, the World Bank (2015) has reported that constraints in enhancing the education quality in Malaysia relate more to the institutions and not on the quality of inputs. Hanushek and Wößmann (2007) also highlight that investments in resources for schools may not reliably contributes to better school outcomes, although these resources are important. One of the findings on school outcome relates to teacher quality. Although teacher quality was found to have strong effects on student outcomes, there are limited data and research on teacher education or certification.

Data on education quality are scarce and internationally, there are two widely referred international benchmarks on quality of education, namely the Trends in International Mathematics and Science (TIMSS) and the OECD Programme for International Assessment (PISA). However, data on TIMSS and PISA are limited for Malaysia and as discussed in Chapter 4, this study adapted the model proposed by Messinis and Ahmed (2013) that utilises the data on scientific journal article publications in sciences per capita (SciP), sourced from SCOPUS for the 13 states in Malaysia for the period of 1990 to 2010. SciP is a critical component of the latent measure of *applied cognitive skills*. This variable measures research outcomes and quality of education, which provides the foundation for cognitive and research skills.

Next, this section will discuss the findings of the empirical estimations on education quality. Table 6.3 below reports the estimation of the extended model on the link between quality of human capital and TFP growth (equation 6.2). The coefficient for per capita scientific journal article publications in SCOPUS (SciP), have the expected positive signs, but are not statistically significant (columns I and II), indicating that per capita scientific publications do not have direct effect on TFP growth, when estimated using one-step and two-step system GMM. The interaction between education quality and the closeness to frontier (SpCTF) shows that the coefficient estimates for SpCTF have the expected negative sign and statistically significant at 1% level (columns I and II). The diagnostic tests are reported at the bottom of Table 6.3, with the AR(2) test for autocorrelation indicating the absence of second order serial correlation and the Hansen test for over-identifying restrictions indicating validity of the instruments used in the analysis. The former test indicates there is no misspecification, while the latter suggests that the instruments used in the analysis are valid.

Table 6.3 TFP growth and education quality

Variables	21 years		3 year averages	
	I	II	I	II
	One step	Two step	One step	Two step
Constant	-21.433* (7.423)	-19.532* (7.948)	-18.508* (7.503)	-26.841** (7.841)
SciP	0.068 (0.043)	0.072 (0.055)	-0.042* (0.018)	-0.051 (0.029)
SpCTF (SciP*CTF)	-0.126** (0.041)	-0.128* (0.055)	-0.001 (0.019)	0.009 (0.026)
Observations	260	260	91	91
N states	13	13	13	13
N instruments	16	16	15	13
AR(2)	0.807	0.373	0.010	0.874
Hansen test	0.343	0.378	0.352	0.177

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

The equation (6.2) model was also estimated using the 3 year averages dataset. Table 6.3 also reports the summary of system GMM panel data estimation results as proposed by Arellano and Bond (1991).

The coefficient estimate for per capita scientific journal article publications in SCOPUS (SciP) have the negative signs (columns I and II), but only statistically significant at 5% level when using one-step system GMM (column I), indicating that the number of scientific publications have negative effect on TFP growth. The interaction between education quality and closeness to frontier (SpCTF) showed the expected negative sign (column I) when estimated using one-step system GMM and have a positive sign when estimated using two-step system GMM. However, both estimates are not statistically significant. The diagnostic tests are reported at the bottom of Table 6.3, with the AR(2) test for autocorrelation and the Hansen test for over-identifying restrictions. The former test indicates there is no misspecification, while the latter suggests that the instruments used in the analysis are valid.

Discussions of Findings

The measurement of education through years of schooling creates a gap in explaining the difference in economic growth. The assumption that average student in developing country will gain the same amount of acquired knowledge through one year of schooling as in a developed country lead to the argument on the important role of education quality. Hanushek and Wößmann (2007) suggest that additional resources alone may not improve education quality; it is when schooling fosters cognitive skills and facilitates the acquisition of professional skills that matters for development. They claim that quality of education contributes more to individual earnings and economic growth, compared to access to education. As shown by the PISA survey, disparities in secondary education between developing countries and OECD countries are even larger when one considers not only access but also learning achievements.

The estimation coefficients for education quality as shown in Table 6.3, although have the expected positive signs but are not statistically significant. This suggests that education quality did not contribute to TFP growth. The lack of scientific research activity compared to other types of research activities might contribute to the lack of domestic innovation, thus the not significant contribution to TFP growth. Solow (2007) argues that much of productive innovation is realised through ‘learning by doing’ and not necessary via scientific research activity. The interaction between education quality and closeness to frontier (SpCTF) show the coefficient estimates for SpCTF have the expected negative sign and statistically significant at 1% level (columns I and II). The result indicates that education quality and closeness to frontier contribute to better knowledge absorption and adaptation among the working-age population.

In Malaysia, access to education has increased with higher school enrolment rates. However, the PISA 2009 results caused concerns as Malaysian students performed way below the OECD average in all three categories (i.e., reading, mathematics and science). Malaysia attained a mean score of 414 on reading literacy, 404 on mathematical literacy and 422 on scientific literacy scale. Meanwhile, the PISA/OECD average mean score are 493 on reading literacy, 496 on mathematical literacy and 501 on scientific literacy scale. The findings of education quality model as discussed above indicate that although Malaysia has extensive educational infrastructure, there are still gaps in terms of student's performances in regional Malaysia.

6.3.3 Level and Growth Effects: Human Capital and Economic Growth

In earlier chapters, the important role of human capital in economic development was highlighted with the understanding that higher level of human capital will enhance the absorptive capacity of new technologies. For example, Dowrick (2003) suggests that having more educated workforce contributes in adapting and utilising technological advances, therefore investment in human capital in terms of skills and ideas are important to promote economic growth. In addition, Lucas (1988) highlights that human capital is the engine of economic growth, assuming individuals invest in education to accumulate new skills and knowledge. Therefore, the accumulation of human capital or the growth effects may contribute to further enhance economic growth.

Next, adapting the AHM model, equation (6.4) was estimated and the findings are shown in Table 6.4 (column I to VI) below. The coefficients of growth in years of schooling of the secondary and tertiary level show the predictive positive signs (columns III to VI) and statistically significant at 1% level. However, the primary level coefficients (columns I and II) have a negative sign and also statistically significant at 1% level when estimated using the one-step and two-step system GMM for the 21 years dataset. As for initial years of schooling, the primary level has the predictive positive sign but it is not statistically significant. However, both secondary and tertiary initial coefficients show negative signs, with only the tertiary level is statistically significant at 5% level (columns V and VI). Meanwhile, the results of initial per capita GDP show the predictive negative signs for secondary and tertiary levels but only the tertiary level is statistically significant at 1% level.

The Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation, while the Hansen test is used to test for over-identifying restrictions. The former test indicates there is no misspecification, while the latter suggests that the instruments used in the analysis are valid, as presented at the bottom of Table 6.4. The Hansen test shows the validity of the instruments used in the analysis by determining whether any correlation between instruments and errors exists. For an instrument to be valid there should be no correlation between instruments and error.

Table 6.4 GDP growth and education: System GMM (yearly data)

Variables	I	II	III	IV	V	VI
	One step	Two step	One step	Two step	One step	Two step
ΔEDU_1 (primary)	-1.585** (0.427)	-1.244** (0.385)				
ΔEDU_2 (secondary)			0.212** (0.029)	0.217** (0.030)		
ΔEDU_3 (tertiary)					0.047** (0.008)	0.046** (0.008)
$YS_{1, 1990}$	0.602 (3.146)	1.372 (3.313)				
$YS_{2, 1990}$			-523.847 (478.750)	-542.273 (332.805)		
$YS_{3, 1990}$					-196.093* (81.606)	-216.044* (89.092)
GDP_{1990}	1.365 (3.135)	0.950 (4.464)	-203.559 (330.315)	-265.414 (269.852)	-149.185** (34.706)	-160.830** (41.677)
Observations	260	260	260	260	260	260
N states	13	13	13	13	13	13
N instruments	12	13	12	12	12	12
AR(2)	0.722	0.807	0.358	0.330	0.784	0.795
Hansen test	0.333	0.397	0.352	0.352	0.337	0.337

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

In addition, estimations using the one-step and two-step system GMM for the 3 year averages dataset were also performed, with findings as shown in Table 6.5. The results indicate that growth in the years of schooling for all three education level coefficients show negative signs and statistically significant at 1% level (columns I to VI), indicating that growth at all levels of education did not contribute to economic growth. These results did not support the growth effect as proposed by Lucas (1988) that assumes individuals invest in the education sector to accumulate new skills and knowledge. Meanwhile, the initial years of schooling for both secondary and tertiary level coefficients have the predictive positive sign and statistically significant at 1% level (columns III to VI). The results for initial GDP per capita coefficient has a positive sign and statistically significant at 5% level for primary and tertiary education level (column I, II, V and VI). As presented at the bottom of Table 6.5, the Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation and the Hansen test shows the validity of the instruments used in the analysis. The former test indicates there is no misspecification, while the latter suggests that the instruments used in the analysis are valid.

Table 6.5 GDP growth and education: System GMM (3 year averages)

Variables	I	II	III	IV	V	VI
	One step	Two step	One step	Two step	One step	Two step
ΔEDU_1 (primary)	-8.764* (3.595)	-8.862* (3.969)				
ΔEDU_2 (secondary)			-0.881** (0.261)	-0.877** (0.237)		
ΔEDU_3 (tertiary)					-0.393** (0.067)	-0.397** (0.068)
$YS_{1,\ 1990}$	-4.131 (6.925)	-4.190 (3.612)				
$YS_{2,\ 1990}$			0.737** (0.198)	0.685* (0.249)		
$YS_{3,\ 1990}$					0.883** (0.261)	0.775** (0.233)
GDP_{1990}	1.881* (0.695)	1.687* (0.657)	-0.050 (0.415)	-0.070 (0.416)	1.210* (0.511)	0.950* (0.395)
Observations	78	78	78	78	78	78
N states	13	13	13	13	13	13
N instruments	11	12	9	9	9	9
AR(2)	0.350	0.337	0.264	0.228	0.267	0.293
Hansen test	0.379	0.354	0.170	0.170	0.118	0.118

Notes: AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

The findings in this section indicate that growth in human capital has mixed results for Malaysia when education levels are incorporated. More precisely, these findings indicate that growth of the primary level education has a negative effect on economic growth, while secondary and tertiary levels relate positively when using yearly data (i.e., 21 years) but negatively when using the 3 year averages. The positive relationship of educational attainment and economic growth is consistent with past research findings that higher years of schooling will enhance growth of GDP per capita. Past studies have suggested that education is important in facilitating research and development as well as diffusion of technologies, with initial phases of education more important for imitation, and higher education more essential for innovation.

Previous research findings based on the Mincer wage equation (Mincer 1974) have found positive return to schooling, with higher educational accumulation contributing to higher wages. Barro and Lee (2010) also claim that higher years of schooling will enhance growth of GDP per capita. Earlier researches have also found positive links between productivity growth and human capital and that a higher initial level as well as a higher rate of improvement in human capital have significantly positive impact on per capita GDP growth (Mankiw, Romer and Weil 1992; Lucas 1988; Nelson & Phelps 1966). In addition, there are research findings that indicate human capital has a positive effect on regional productivity and income growth, implying that differences in human capital promote these variances (Brunow & Hirte 2009).

Lutz, Cuaresma and Sanderson (2008) argue that although in the literature has widely recognised that higher level of educational attainment or more years of schooling will positively affect income for individuals, at the macroeconomic level however, the empirical evidence has been ambiguous. This indicates the weak assumption on the empirical basis that education will contribute positively towards economic growth. Better and higher level of education has always been an important determinant and element in economic growth. Even though the benefits of investment in education take a longer time to show results, investments in education are crucial to support children to become more knowledgeable workers, with higher skills in the future. Therefore, despite the unclear link between education and economic growth in the long-term, investment in education is still one of the best investment options that countries can make for a better future. Therefore, countries need to evaluate the expected benefits of human capital accumulation towards economic growth and allocate adequate development budgets, as well as formulate policies that support growth.

In addition, Jin and Jin (2013) examine academic research as a proxy for quality of education at the tertiary level (by assessing the cognitive ability of professors) and found that research publications have positive and significant effects on economic growth; with publications in basic science and engineering having greater effect than other subject matters (business and economics education was found to have a more indirect effect on technology development). Meanwhile, Messinis and Ahmed (2013) in their study on international cognitive skills suggest that the increase of applied cognitive skills for Malaysia could be attributed to the relatively strong performance in scientific research output and trade in IT equipment.

The initial years of schooling should relate positively to economic growth. However, only the measure of primary schooling has the expected sign when using the 21 years dataset, and the secondary and tertiary schooling when using the 3 year averages dataset. Meanwhile, the per capita GDP, even at its initial level should have a negative correlation with economic growth, indicating that the per capita GDP should be higher than its initial level.

6.4 **Summary of Empirical Signs**

Table 6.6 below compares the coefficient signs based from the literature and actual signs that were derived from the system GMM panel data estimations for each variable in the equation models. The actual results of the empirical estimations are discussed in various sections in this chapter. The empirical results for equation (6.1) model indicate that all education levels actual signs were the same as the expected positive signs, for both data estimation using the 21 years and 3 year averages datasets. The coefficients for the ECTF variable also have the expected negative signs for all, indicating the technology diffusion between the follower and leader states. The closeness to the frontier also indicates that as states get closer to the frontier, the focus are more on innovation activities, whereas states that are far from frontier adopt frontier technologies.

In addition, education quality also has the same actual and predicted positive signs when the equation model was estimated using the 21 years dataset, but showed different signs when using the 3 years averages datasets. Although the coefficient for per capita scientific journal article publications in SCOPUS (SciP) has the expected positive signs, it is not statistically significant, indicating that SciP do not have direct effect on TFP growth, when estimated using one-step and two-step system GMM. Meanwhile, the coefficient estimates for SpCTF, which represents the interaction between education quality and closeness to frontier, have the expected negative signs and statistically significant at 1% level (columns I and II).

The empirical results for equation (6.4) model indicate mixed results for both data estimation using the 21 years and 3 year averages datasets. The coefficients for growth in ΔEDU_2 (secondary level education) and ΔEDU_2 (tertiary level education) have the expected positive signs when estimated using the 21 years dataset and one-step system GMM. In summary, predicted and actual signs for Benhabib and Spiegel model are better, compared to AHM model, indicating the direct link between human capital and TFP growth (level effects). Findings for the education level models also confirm the important role of years of schooling (education quantity) for TFP and economic growth. In comparison, model estimations using the 21 years dataset gave better results than the 3 year averages dataset.

Table 6.6 Expected and estimated coefficient signs in GMM estimation

Variables	Expected	Estimated 21 years		Estimated 3 year averages	
		One step	Two step	One step	Two step
Equation 6.1					
EDU_1	+	+	+	+	+
ECTF1	-	-	-	-	-
EDU_2	+	+	+	+	+
ECTF2	-	-	-	-	-
EDU_3	+	+	+	+	+
ECTF3	-	-	-	-	-
Equation 6.2					
SciP	+	+	+	-	-
SpCTF	-	-	-	-	+
Equation 6.4					
ΔEDU_1	+	-	-	-	-
$EDU_{1,\ 1990}$	+	+	+	-	-
GDP_{1990}	-	+	+	+	+
ΔEDU_2	+	+	+	-	-
$EDU_{2,\ 1990}$	+	-	-	+	+
GDP_{1990}	-	-	-	-	-
ΔEDU_3	+	+	+	-	-
$EDU_{3,\ 1990}$	+	-	-	+	+
GDP_{1990}	-	-	-	+	+

Source: Author's estimations.
Note: The sign (+/-) refers to positive and negative expectation.

6.5 Chapter Summary

This chapter examines the empirical estimations of the extended interaction models, specifically the link between education level (primary, secondary and tertiary) and TFP or economic growth. In addition, estimation of the relationship between education quality and TFP growth was also performed. Although the growth effects have the expected positive signs for the secondary and tertiary levels, overall the estimation results of the levels effects model are better compared to the growth effects model. These results indicate that both, levels of schooling and changes in years of schooling have a positive link with economic growth. The next chapter will examine the effects of changes in the working-age structure on TFP and economic growth.

CHAPTER 7
AGEING, EDUCATION AND ECONOMIC GROWTH: NEW EVIDENCE

7.1 Introduction

The trend analysis presented in Chapter 2 indicates the occurrence of structural and numerical ageing in all states in Malaysia. The stylised facts confirm a trend towards an ageing population and a steady rise of human capital, particularly among younger workers. However, these changes of population age structure due to declining population growth have resulted in the decrease of labour supply, thus raising concerns of slower economic growth in the future. There is a need to re-examine the human capital level to meet labour demands and promote economic growth. Diversification of the economy will need workers with higher and multiple-skill sets. Therefore, it is important to examine the effects of changes in the working-age structure on TFP and economic growth for future economic planning

Chapters 5 and 6 have examined the effect of human capital on economic growth assuming that the effect is independent of the ageing structure, which assumed that one extra year of education or a higher share of the population completing a higher level of education has the same impact on technology diffusion or economic growth irrespective of whether the people undertaking more education are young or old. This chapter accounts for the effect of age structure on human capital. It presents the empirical specifications and findings for two empirical models on (a) the nexus between age structure, human capital, technology diffusion and TFP growth in terms of level effects and (b) the nexus between age structure, human capital and economic growth in terms of level and growth effects. All empirical models are estimated using dynamic panel data Generalised Method of Moments (GMM) and for comparison, the models will be estimated using the one-step and two-step standard errors system GMM. The chapter begins with a description of the empirical specifications, followed by the empirical results and a discussion of the results.

The findings for the first model on the level effects indicate that the coefficient for the working-age groups and human capital has the predicted positive coefficient sign, but are not significant. Meanwhile, the coefficient for closeness to frontier has the predicted negative sign and statistically significant at 5% and 1% level, both when estimated using the one-step and two-step system GMM estimation. These results confirm that TFP convergence has occurred between laggards and the leader state. The second model on the level and growth effects indicates that growth in the working-age group and human capital has negative signs and statistically significant at 5% and 1% level. The results of initial per capita GDP indicate positive sign and statistically significant at 5% level for the young and older working-age group, with the middle working-age group indicating not significant and negative coefficient sign. As for initial human capital, the middle and older working-age groups exhibit the predicted positive coefficients and are statistically significant at 5% and 1% level. Details of the findings will be elaborated in this chapter.

7.2 Empirical Specifications

Malaysia is on the path of becoming an ageing nation. As higher educated worker may promote innovation and technology absorption that contributes to higher total factor productivity and economic growth, the changes in the age structure could have significant effect on future growth. Therefore, in examining the effect of age structure on TFP and economic growth, two empirical models were specified to examine (a) the nexus between age structure, human capital, technology diffusion and TFP growth and (b) the nexus between age structure, human capital and economic growth. Parallel to previous empirical specifications, two empirical models were adapted to test the model's capacity in explaining the economic growth, namely the Benhabib and Spiegel (2005) model and the Aghion, Howitt and Murtin (2010) model, henceforth AHM. Summary of the adapted models are discussed below.

The age structure in both models will be based on three working-age groups, namely the young workers (15-29 years old), middle-aged workers (30-49 years old) and older workers (50-64 years old). The average years of schooling for the working-age groups are constructed in a panel dataset that consists of 3 year averages data, covering the period of 1990 to 2010. As discussed in Chapter 4, there are limitations regarding the availability of data on age structure and years of schooling in Malaysia. Therefore, the panel dataset used for estimating both empirical models consists of non-overlapping observations of 3 years period, from 1990 to 2010 for the 13 states. In addition, the state dummies and year dummies are also estimated in both models.

7.2.1 Empirical Model of Age Structure, Human Capital, Technology Diffusion and TFP Growth

Following Benhabib and Spiegel (2005), the empirical model with specifications on changes in working-age structure is defined as follows:

$$\Delta TFP_{i,t} = \beta_0 + \sum_{j=1}^{3} \beta_j logYS_{j,i,t} + \sum_{j=1}^{3} \varphi_j ACTF_{j,i,t} + \varepsilon_{i,t} \qquad (7.1)$$

where j = (1, 2, 3)

In this empirical model, $\Delta TFP_{i,t}$ represents the growth rate of total factor productivity. The independent variable, $YS_{j,i,t}$ represents the human capital of the three working-age groups; i.e., YS_1 = young workers, YS_2 = middle workers and YS_3 = older workers; and $ACTF_{i,t}$ represents the interaction between each working-age group human capital and closeness to frontier (YS x CTF). Meanwhile, $\varepsilon_{i,t}$ represents the error term. The empirical model will examine the link between each working-age group's human capital and TFP growth.

The coefficient β_j represents the combined effect of each working-age group and human capital on TFP growth that relates to the innovation capability, with higher level of human capital having a positive effect on TFP growth. Meanwhile, the coefficient φ_j indicates the effect of the gap in frontier technology between leader state and followers. If the states are closer to frontier, the effects on TFP growth will be lower. Therefore, the coefficient β_j is predicted to have a positive sign, whereas the coefficient φ_j is predicted to have a negative sign. The subscripts *i* and *t* denote state and time period, respectively, and these denotations of *i* and *t* also apply to other sets of specification described hereafter. As mentioned earlier, there are limitations on the availability of data on the working-age groups and years of schooling, therefore the empirical model will only be estimated using the 3 year averages dataset, from 1990 to 2010.

7.2.2 Empirical Model of Age Structure, Human Capital and Economic Growth

In this empirical model, which was based on the production function and adaptation of the empirical model by Aghion, Howitt and Murtin (2010), the growth equation which includes both the level and accumulation of human capital is specified as below:

$$\Delta logy_i = a + b\Delta logYS_i + clogYS_{i,0} + dlogy_{i,0} + u_i \qquad (7.2)$$

Here $\Delta logy_i$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\Delta logYS_i$ represents the change per year in the log of years of schooling in that state over the same period, also multiplied by 100; log $YS_{i,0}$ represents the log of years of schooling at the beginning of the period; log $y_{i,0}$ represents initial log of GDP per capita and u_i is a residual term.

The extended model on working-age population structure aims to examine the effects of age structure and human capital on economic growth, based on the endogenous growth theory. Based on equation (7.2), the empirical model specifying the estimates for the three working-age population as defined earlier, can be re-written as below:

$$\Delta logy_{i,t} = a + \sum_{j=1}^{3} b_j log\Delta YS_{j,i,t} + \sum_{j=1}^{3} c_j logYS_{j,i,0} + dlogy_{i,0} + \varepsilon_{i,t} \qquad (7.3)$$

where j = (1, 2, 3)

Similarly, $\Delta \log y_{i,t}$ represents the change per year in the log of GDP per capita in state *i* over a given time period, multiplied by 100; $\sum_{j=1}^{3} b_j \log\Delta YS_{j,i,t}$ represents the change per year in the log of years of schooling of each working-age groups in that state over the same period, also multiplied by 100; $\sum_{j=1}^{3} c_j \log YS_{j,i,0}$ represents the log of years of schooling at the beginning of the period for each working-age groups; log $y_{i,0}$ represents initial log of GDP per capita and ε_{it} is a residual term.

The coefficient (b) above represents the combined effect of each working-age group and human capital on economic growth that relates to growth in human capital. Higher growth or accumulation of human capital will have a positive effect on economic growth, thus the coefficient is predicted with a positive sign. Meanwhile, coefficient (c) for the initial years of schooling is also predicted to have a positive sign as higher initial level of human capital will contribute positively on economic growth. Lastly, coefficient (d) for initial level of per capita GDP is predicted to have a negative sign, which suggests that growth of per capita GDP should depend negatively upon its initial level. The subscripts *i* and *t* denote state and time period, respectively. As mentioned earlier, there are limitations regarding the availability of data on the working-age groups and years of schooling, therefore the empirical model will only be estimated using the 3 year averages dataset, from 1990 to 2010.

7.3 Descriptive Statistics Results

Table 7.1 described the distribution of the panel data constructed for this study, which covers 13 states for the period of 1990 to 2010. Descriptive statistics for other variables, such as the real state GDP per capita (in logs), TFP growth, closeness to frontier (CTF) and state population are as shown in Chapter 5 (Table 5.1). As shown below, Table 7.1 only highlights the average years of schooling for each working-age groups. The average years of schooling are relatively high, with young workers having the highest average years of schooling, followed by middle-aged workers and older workers.

Table 7.1 Descriptive statistics

Variable	Mean	Std. Deviation	Min	Max
YS_1	10.9	0.5	9.4	12.3
YS_2	10.1	0.8	8.2	11.9
YS_3	8.0	0.9	6.3	11.0

(No. of observations (N*T) = 273)

7.4 Estimation Results

7.4.1 Level Effects: Age Structure, Human Capital, Technology Diffusion and TFP Growth

Earlier studies on the nexus between age structure and economic growth suggest that population ageing may impact on national or regional income growth (Bloom 2010; Brunow & Hirte 2009). A higher educated labour force is assumed to promote technology absorption and diffusion, which will contribute to higher productivity growth. This assumption accentuates that the working-age population's level of education is a crucial factor in economic growth. Therefore, the link between age-structure, human capital and technology diffusion was empirically tested to estimate such potential relationship. As stated earlier, divergence in TFP growth depends on the human capital stock which represents the capability to innovate and absorb frontier technology.

The findings for equation model (7.1), as shown in Table 7.2 below, indicate that all working-age groups (YS_1, YS_2 and YS_3) coefficient estimates have positive signs, but are not statistically significant, indicating that age-specific human capital did not have a significant effect on TFP growth. Positive coefficient estimate for education level indicates that when human capital increases, productivity rises and contributes to higher TFP growth, as proposed by Nelson and Phelps (1966). However, the results for equation model (7.1) are not significant. The findings also show that the coefficient estimates for ACTF has the predicted negative sign and statistically significant at 5% level (columns I to VI), indicating a convergence process between the follower and leader states. These negative coefficients indicate that states that are near the frontier focus more on innovation activities, whereas states that are far from the frontier adopt frontier technologies. The closeness to the frontier also indicates that as states gets closer to the frontier, TFP growth will be lower.

When all the age-specific variables for human capital are combined, most of the coefficient estimates have the expected positive sign but are not statistically significant (columns VII and VIII). The results for the combined age-specific ACTF series indicate that the one-step system GGM coefficient estimates (column VII) for ACTF1 (the young) and ACTF3 (the older) have the expected negative signs, but are also not statistically significant. The two-step system GMM estimates for ACTF1 also indicate a similar result (column VIII). These results suggest that age-structure, in this model, does not have a significant effect on TFP growth. Details of the results are as below.

Table 7.2 also reports on the number of panel units, the number of instruments used, the AR(2) test for autocorrelation and the Hansen test for over-identifying restrictions. The Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation, while the Hansen test is used to test for over-identifying restrictions. The former test indicates there is no misspecification while the latter suggests that the instruments used in the analysis are valid.

Table 7.2: TFP growth and age: System GMM (3 year averages)

Variables	I	II	III	IV	V	VI	VII	VIII
	One step	Two step	One step	Two step	One step	Two step	One step	Two step
Constant	-2.025 (1.357)	-1.965 (1.315)	-0.257 (0.336)	-3.207 (3.898)	-0.072 (0.756)	-0.161 (1.029)	-0.930 (1.277)	0.562 (1.924)
YS_1 (young)	0.859 (0.584)	0.857 (0.572)					0.575 (1.687)	0.062 (5.294)
YS_2 (middle)			0.120 (0.155)	1.519 (1.780)			-0.971 (2.675)	0.386 (7.898)
YS_3 (older)					0.139 (0.402)	0.196 (0.525)	0.845 (1.460)	-0.811 (3.628)
ACTF1 (YS_1*CTF)	-0.097* (0.035)	-0.141* (0.062)					-0.284 (3.727)	-1.695 (8.480
ACTF2 (YS_2*CTF)			-0.124* (0.056)	-0.202* (0.073)			1.763 (5.872)	1.377 (14.419)

Variables	I	II	III	IV	V	VI	VII	VIII
	One step	Two step	One step	Two step	One step	Two step	One step	Two step
ACTF3 (YS_3*CTF)					-0.374** (0.116)	-0.399* (0.157)	-1.689 (2.979)	0.411 (6.673)
Observations	91	91	91	91	91	91	91	91
N states	13	13	13	13	13	13	13	13
N instruments	13	14	14	14	13	13	15	15
AR(2)	0.131	0.168	0.158	0.291	0.992	0.980	0.963	0.850
Hansen test	0.215	0.214	0.249	0.225	0.195	0.195	0.715	0.662

Notes: The young are between 15-29 years old, the middle-aged are between 30-49 years old and the older workers are between 50-64 years old. AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

The educational level of the working-age population is one of the main factors that enhance technology diffusion and, thus, TFP and economic growth. A highly educated labour force may assist in technology absorption and diffusion that contributes to higher productivity growth. Cuaresma and Mishra (2011) suggest that the education level of the adult population represents productive ability to contribute to economic growth. They claim that education at earlier stages of adulthood will contributes more towards economic growth, compared to education at later stages of working years. This is because workers will gain efficiency through education at an earlier stage of working, accumulate experiences and will be able to innovate at a later stage, suggesting that there's also faster diffusion of new idea and technology through the adaptability and adoptability process.

The model specification in equation (7.1) measures the working-age group capacity for innovation activities and technology diffusion that will effect TFP growth. The estimation results from equation (7.1) indicate that all age groups have positive coefficients but these are not statistically significant. However, the closeness to frontier (ACTF) coefficients have the predicted negative sign and are statistically significant at 1% level (columns I to VI). The negative coefficients indicate that states that are near the frontier will focus more on innovation activities, whereas states that are far from the frontier will adopt technologies from the frontier state. This makes intuitive sense since closeness to the frontier indicates the gap of technology diffusion between home state and frontier state.

Changes in the population age structure in moving towards population ageing could promote higher investment in human capital and positive impact on per capita growth. As life expectancy increases, workers have an opportunity to extend their working life and further accumulate relevant skills that can foster further growth (Prettner 2013). However, when comparing the effects of human capital on TFP growth, equation (5.1), to those of changes in the age structure via human capital, equation (7.1), the latter has yet to have a significant effect on TFP growth in Malaysia. These results may be due to the fact that, despite a transition towards population ageing, the current working-age population in Malaysia is still relatively young compared to other high- and middle-income countries (World Bank 2012), with about 52.6% of the workforce being under 35 years old or about 85.8% of workers under 50 years old in 2010, as discussed in Chapter 2.

In addition, the results for the combined age-specific variable show that most of the coefficient estimates for the working-age groups are not statistically significant, which does not provide empirical support for the model prediction of age-structure effects on economic growth. These age-structure estimation results indicate that the Benhabib and Spiegel (2005) model may not be the most appropriate framework to examine the relationship between age-structure and economic growth. Previous studies have found that age-structure data enhances the estimation results for economic growth and that changes in the working-age population's education levels are positively linked to changes in aggregate productivity (Cuaresma, Lutz & Sanderson 2009; Cuaresma & Mishra 2009, 2011). Alternatively, the results may be due to a mismeasurement in factor shares and TFP in general.

7.4.2 Level and Growth Effects: Age Structure and Economic Growth

A highly educated workforce is able to adapt to changes and utilise technological advances more intensively (Dowrick 2003). In addition, developing countries could benefit more from higher human capital because as a country develops and invests in human capital, the higher skills among the working-age population could better meet industry demand for higher productivity and thus promote economic growth. In addition, Lucas (1988) highlights that human capital is the engine of economic growth, assuming individuals invest in the education sectors to accumulate new skills and knowledge. Therefore, the accumulation of human capital or the growth effects may further enhance economic growth. Even retired workers that have accumulated expertise over their working years could still contribute to growth by encouraging life-long learning and knowledge sharing. Higher education among the young workers will contribute towards a more skilled older workforce in the future.

The empirical estimates of the equation (7.3) model are shown in Table 7.3 and indicate that the coefficients of growth in years of schooling of the working-age groups (YS_1, YS_2 and YS_3) have negative signs for all working-age groups (columns I to VI) and statistically significant at 5% and 1% level. Meanwhile, the coefficients for initial per capita GDP have positive signs and statistically significant at 5% level for the young and older working-age groups. However, the middle working-age groups, although it has the predicted negative signs, it is not statistically significant. Coefficients for the initial years of schooling indicate the predicted positive signs and statistically significant at 5% and 1% level for the middle and older working-age groups (columns III to VI). The Arellano and Bond (1991) autocorrelation test indicates the absence of second order serial correlation and the Hansen test shows the validity of the instruments used in the analysis, as presented at the bottom of Table 7.3.

The results for the combined variables show that only the coefficient estimates for growth in years of schooling of the older workers have the expected positive signs and statistically significant at 5% level (columns VII and VIII), when estimated using the one-step and two-step system GMM. The coefficient estimates for middle working-age groups, although statistically significant, do not have the expected positive signs. Meanwhile, the estimate of the combined initial years of schooling show that the young and older workers have the expected positive signs (column VII), as well as for the middle working-age group (column VIII), but all are not statistically significant.

Table 7.3: GDP growth and age: System GMM (3 year averages)

Variables	I	II	III	IV	V	VI	VII	VIII
	One step	Two step	One step	Two step	One step	Two step	One step	Two step
ΔYS_1	-8.764* (3.595)	-8.862* (3.969)					-3.016 (2.862)	-1.775 (1.996)
ΔYS_2			-0.881** (0.261)	-0.877** (0.237)			-2.318* (0.970)	-2.724* (1.078)
ΔYS_3					-0.393** (0.067)	-0.397** (0.068)	1.172* (0.497)	1.370* (0.540)
$YS_{1,1990}$ (young)	-4.131 (6.925)	-4.190 (3.612)					7.085 (13.093)	-13.949 (31.428)
$YS_{2,1990}$ (middle)			0.737** (0.198)	0.685* (0.249)			-0.967 (1.796)	4.821 (3.210)
$YS_{3,1990}$ (older)					0.883** (0.261)	0.775** (0.233)	0.885 (1.054)	-1.905 (2.467)
GDP_{1990}	1.881* (0.695)	1.687* (0.657)	-0.050 (0.415)	-0.070 (0.416)	1.210* (0.511)	0.950* (0.395)	0.563 (1.019)	1.483 (1.038)
Observations	78	78	78	78	78	78	78	78
N states	13	13	13	13	13	13	13	13
N instruments	11	12	9	9	9	9	16	15
AR(2)	0.350	0.337	0.264	0.228	0.267	0.293	0.543	0.477
Hansen test	0.379	0.354	0.170	0.170	0.118	0.118	0.144	0.116

Notes: The young are between 15-29 years old, the middle-aged are between 30-49 years old and the older workers are between 50-64 years old. AR(2) represents Arellano-Bond tests for autocorrelation, and the values reported are the p-values for second order auto correlated disturbances in the first differences equations. Hansen test reports the p-values for the null hypothesis of instrument validity. Robust standard errors are shown in parentheses. Statistical significance by the t-statistics at 1% and 5% levels are denoted by ** and *, respectively.

Discussion of Findings

Education has been identified as one of the most important component of human capital, which enhances labour productivity and contributes in long-term economic growth (Barro & Lee 2010; Bloom 2010; Dowrick 2003; Becker 1994; Lucas 1988). Higher education levels of the working-age population could enhance labour productivity and absorption of new technology. However, sustaining economic growth momentum in the long term is a challenge to all countries. Middle-income countries, such as Malaysia is confronted with various challenges in maintaining economic growth. In addressing these challenges, countries need to enhance knowledge and innovation by increasing investments in human capital, whereby, education that focuses on the skills that enhance productivity could be the answer to boost growth (Jimenex, Nguyen & Patrinos 2012).

The empirical results for equation (7.3) model as above indicate that the coefficients for growth in years of schooling of the age-specific groups (YS_1, YS_2 and YS_3) have negative signs for all working-age groups (columns I to VI) and statistically significant at 5% and 1% level. These results indicate that the age composition is not an important factor for economic growth in Malaysia. The coefficients for the initial years of schooling show the predicted positive signs and statistically significant at 5% and 1% level for the middle and older age groups (columns III to VI). Although the coefficient estimate for initial per capita GDP has the predicted negative sign for the middle-age group, it is not statistically significant.

Aghion, Howitt and Murtin (2010) found supportive evidence of a positive effect of both the initial level and the accumulation of human capital on per capita GDP growth. They ascertain that productivity growth is positively correlated with the level of human capital, in particular with the initial or the average level of human capital in a country or region over a given period. In addition, Krueger and Lindahl (2001) suggest that both the level of and the change in schooling years have a positive impact on economic growth. This is consistent with Cohen and Soto (2001) who also find robust evidence of a positive association between changes in education and economic growth. However, the estimates in relation to equation (7.3) here indicate a statistically significant positive effect for only the initial level of schooling. This may be due to the fact that Malaysia's states are still in transition towards ageing population. Another factor may be that the expected effects of changes in the age structure and the accumulation of human capital on economic growth have yet to be realised since the estimation only based on averaged data, which is usually regarded as not quite long-term.

The results for the combined variables show that only the coefficient estimates for growth in years of schooling for the older working-age groups have the expected positive sign and statistically significant at 5% level. The coefficients for middle-aged workers although are statistically significant, have the wrong signs. Meanwhile, the combined initial years of schooling show that the young and older workers have the expected positive signs but are not statistically significant. These results fail to support the particular model of economic growth examined here. However, the significant results of the older working-age group suggest that older workers make a significant contribution to economic growth. As Malaysia progresses towards becoming an ageing nation, empirical research is crucial for evidence-based insights on the implications of shifts in the age structure for economic growth in Malaysia.

7.5 Summary of Empirical Signs

Table 7.4 below compares the coefficient signs predicted by theory and the actual signs derived from the system GMM panel data estimations. Equation (7.1) model has the same expected and actual signs. However, equation (7.3) model has mixed expected and actual signs. These will be further discussed below.

Table 7.4 Expected and estimated coefficient signs in GMM estimation

	Variables	Expected	Estimated	Variables	Expected	Estimated
Age Groups	**Equation 7.1: Benhabib and Spiegel (2005)**			**Equation 7.3: AHM (2010)**		
	One step			**One step**		
Young	YS_1 ACTF1	+ -	+ -	ΔYS_1 $YS_{1,1990}$ GDP_{1990}	+ + -	- - +
Middle-aged	YS_2 ACTF2	+ -	+ -	ΔYS_2 $YS_{2,1990}$ GDP_{1990}	+ + -	- + -
Older	YS_3 ACTF3	+ -	+ -	ΔYS_3 $YS_{3,\ 1990}$ GDP_{1990}	+ + -	- + +
	Two step			**Two step**		
Young	YS_1 ACTF1	+ -	+ -	YS_1 $YS_{1,1990}$ GDP_{1990}	+ + -	- - +
Middle-aged	YS_2 ACTF2	+ -	+ -	YS_2 $YS_{2,1990}$ GDP_{1990}	+ + -	- + -
Older	YS_3 ACTF3	+ -	+ -	YS_3 $YS_{3,1990}$ GDP_{1990}	+ + -	- + +

Source: Author's estimations
Note: Summary of selected variables

The actual results are as discussed in the earlier two sections of this chapter. The empirical results for equation (7.1) model indicate that the coefficients for age-specific human capital are the same as the predictive positive sign, indicating the important role of the variable to TFP and economic growth. In addition, the coefficients for ACTF also have the expected signs (i.e., the negative coefficients indicate that states that are near the frontier will focus more on innovation activities, whereas states that are far from frontier will adopt technologies from the frontier state). In summary, the predicted and the estimated coefficient signs seem more consistent with the Benhabib and Spiegel (2005) model than the AHM (2010) model, casting doubt on the significance of the link between age-specific human capital accumulation and economic growth (i.e., the growth effects). In addition, the results for most variables in the combined estimation also did not show significant results.

7.6 Chapter Summary

This chapter presents the findings of the model specifications for age-specific human capital and provide evidence of TFP growth and economic convergence in Malaysia. The divergence in TFP growth depends on the human capital stock which represents the capability to innovate and absorb frontier technology. However, when comparing the effects of human capital on TFP growth, equation (5.1) to those of changes in the age structure via human capital, equation (7.1), the latter has yet to have a significant effect on TFP growth in Malaysia. The current working-age population in Malaysia, which are still relatively young compared to other high and middle-income countries could be among the factors that contribute to the estimation results being not significant. Meanwhile, the empirical findings validate the significant effect of economic convergence to TFP and economic growth in Malaysia, in line with other developing countries that have also gained benefits from economic convergence. The next and final chapter will discuss the conclusions and recommend some policy options.

The empirical results in this chapter do not fully support the theoretical model predictions regarding the ageing structure effects on the two growth models considered here. Before dismissing ageing effects altogether, we acknowledge the possibility that the results here may be due to limitations in the two theoretical models or in the measurement of human capital and TFP growth. Thus, it is worth considering alternative and more flexible theoretical models with respect to production technology and the functional relationship between ageing, human capital and growth. It is now common knowledge that skills may be complementary to physical capital or may be consistently favoured by new technology. In this case, the Cobb-Douglas technology assumed here would be unable to capture these relationships and thus other more flexible forms should be explored, see Messinis and Ahmed (2013). Further, the measurement of TFP growth here relied heavily on the assumption of fixed factor shares favouring labour by a factor of three. Again, this assumption may be unrealistic.

CHAPTER 8
CONCLUSIONS AND POLICY RECOMMENDATIONS

8.1 Introduction

This empirical study examined the implications of population dynamics, in particular population ageing on human capital and, thus, on the economic growth in Malaysia, within the endogenous growth model framework. The study has focused on two core objectives: (i) to examine the nexus between human capital, technology diffusion and TFP growth, and (ii) to examine the nexus between human capital and economic growth. The empirical models were tested using dynamic panel data Generalised Method of Moments (GMM). Model estimates applied both the one-step and two-step standard errors system GMM as to explain variation in economic growth for the 13 states in Malaysia over the period 1990 to 2010. The findings of the study are presented in Chapters 5, 6 and 7.

This chapter is divided into three sections. The first section summarises the research details, discusses the empirical results and highlights the implications of the study. The discussion on the empirical results is divided into four main segments; first, discussion on the level effects of human capital and technology diffusion on TFP growth; second, regarding the level and growth effects of human capital and economic growth; third, discussion on the education quality; and fourth, regarding the effects of changes in the age structure on both level and growth effects. The second section recommends policy options related to population ageing, human capital and economic growth in Malaysia. The third section highlights the limitations of this research and provides suggestions for future research.

In brief, this study’s findings confirm the view that human capital is one of the key determinants of TFP and economic growth. However, age structure does not seem to have significant effects on TFP growth. Using yearly data, the level or the stock of human capital has a positive effect on TFP and growth. In addition, the analysis on total economic growth also relates to the accumulation of human capital, as suggested by Aghion, Howitt and Murtin (2010) and Lucas (1988). These findings also confirm the role of the level and accumulation of human capital for states' economic convergence. Kyriacou (1991) elaborates that a country cannot have a significant positive contribution of education to growth unless it has already attained a certain threshold level of human capital stock. The findings of the closeness to frontier confirm the findings of previous literatures that countries with relatively higher levels of human capital focus more on innovation as it becomes nearer to the economically more advanced countries.

8.2 Research Summary and Implications of the Study

Malaysia aims to become a high-income and advanced nation by the year 2020, with higher quality of life and income per capita rising above US$15,000. Since 1980s, the country has experienced rapid and continuous economic growth. However, progress has slowed and economic growth prospects have weakened (NEAC 2010), particularly, after the Asian and global financial crisis. The rapid economic growth has contributed to the increase of labour and capital costs, thus making Malaysia less competitive with other lower-income countries producing low-cost manufactured exports. At the same time, the country also faces competition with higher skilled producers in the advanced economies which have the competitive advantage in knowledge and innovation-based products and services. These factors have contributed to Malaysia being in a middle-income trap, as defined by World Bank (2010). The Malaysian economy, as previously discussed in Chapters 1 and 3, has shifted from being highly dependent on primary commodities, to manufacturing and services industries. In moving forward, focus has been given on achieving a knowledge intensive and innovation-driven economy, with emphasis on productivity and innovation activities. However, Malaysia still faces the challenges of weak technological dynamism, low-skilled workforce and migration of talented Malaysian to other countries (Thiruchelvam et al. 2013).

In addition, economic progress also brings changes in the population age structure and Malaysia is projected to become an ageing nation by the year 2035. Given this inevitable demographic shift, empirical research is vital to provide evidence based research insights on the implications of population ageing in Malaysia and to propose compatible policies to ensure sustainable economic growth. The change in the age structure, as discussed in Chapter 2, will lead to declining labour force participation, increasing older population and decelerating economic growth.

In this study, endogenous growth theory forms the theoretical framework, incorporating two theoretical models, namely the endogenous technological change (Romer 1990) and human capital accumulation (Lucas 1988). Romer (1990) assumes technological change as an endogenous input factor that provides incentives to enhance capital accumulation and contribute towards higher economic growth. Meanwhile, Lucas (1988) emphasises that human capital is the engine of economic growth, assuming individuals invest in education to accumulate new skills and knowledge.

Therefore, applying the endogenous growth model framework, the first baseline empirical model examines the relationship between human capital, technology diffusion and TFP growth focusing on level effects (i.e., the stock of human capital). The second model examines the relationship between human capital and economic growth, accounting for both level and growth effects (i.e., the stock and accumulation of human capital). Empirical estimations also include extended interaction models, specifically the link between education levels (primary, secondary and tertiary) and TFP or economic growth. Then, these models are further extended to include scientific research as a measure of educational quality, as well as the human capital effect of changes in the population age structure (young, middle and older) on TFP or economic growth.

In this context, the Benhabib and Spiegel (2005) model of logistic diffusion and the Aghion, Howitt and Murtin (2010), hereafter AHM, model of human capital and economic growth, will be re-examined to test the capacity of these models to explain economic growth in regional Malaysia. This study has compared both models to assess the role of level and growth effects on economic growth in Malaysia, for the two may have different effect on economic growth. The level effect suggests that the level or stock of human capital will enhance economic growth, but the growth effect suggests that it is the accumulation of human capital that affects economic growth.

Level Effects

In examining the relationship between human capital, technology diffusion and TFP growth in Malaysia, as well as addressing the second research question of this study, an empirical model (Equation 5.2) was specified. The econometric results of the empirical model indicate that the level of human capital contributes towards TFP growth, confirming previous evidence that the human capital stock positively relates to TFP growth.

The estimation results for the model (5.2) on the link between human capital, technology diffusion and TFP growth indicate that both human capital and ECTF (interaction between education level and the closeness to frontier) have the expected signs when tested using the 21 years dataset. That is, human capital has a positive effect, while ECTF has a negative impact, with both coefficients being statistically significant at 5% level. This indicates that the stock of human capital will positively contribute to the adoption and absorption of new technology and, thus, it will positively affect TFP growth, as proposed by Nelson and Phelps (1966). Also, Romer (1990) remarks that a higher stock of human capital may raise the steady state growth rate. The findings here lead to the conclusion that Malaysia needs to further enhance human capital development and technology diffusion to promote TFP growth. In line with this, efforts to enhance educational standards and performance, as well as educational infrastructures, particularly in the states, should be given priority and support. The importance of human capital for TFP and economic growth was highlighted in Chapter 3.

The positive coefficient for human capital indicates the importance of education in enhancing TFP growth in Malaysia and the closeness to frontier indicate that as states are nearer the frontier, the states will focus more on innovation and thus, TFP growth is smaller. The results are similar to those in Benhabib and Spiegel (2005) that find a positive role of human capital as an engine of innovation. The availability of higher level of human capital also indicates that tangible inputs could be used more effectively and thus contributes to higher ability in learning and absorbing new technology. Since TFP growth is linked to economic growth, higher education levels will lead to the deepening of human capital and rapid adoption of new technologies. This will lead to higher labour productivity, which is one of the important traits of a developed country.

Evidently, the ECTF effect here confirms the presence of TFP catch-up or convergence process in Malaysia. The convergence theory suggests that states that are near the frontier will incline towards innovation activities, whereas states that are far from the frontier will tend to adopt the technology from the frontier country. The results also indicate that the education level as suggested by Nelson and Phelps (1966) play an important role in technology adoption that contributes to convergence and reduces development gaps among the states in Malaysia. In addition, following earlier research literatures, the FDI per capita was selected as a control variable to explain other related factors that may affect TFP growth. However, the findings show a negative relationship between FDI per capita and TFP growth, indicating that FDI has an adverse effect in TFP growth. The adverse effect may be due to the shift in FDI type of investment for Malaysia, which is moving away from labour intensive FDI towards investment that focuses on increasing productivity through higher level of human capital.

The finding of adverse FDI effect on TFP growth may indicate that FDI inflows are mainly in labour intensive and lower skilled industries that may not contribute to higher TFP growth in Malaysia. The constraints in human capital may limit the absorptive capacity to fully gain benefits from FDI flows (Azman-Saini, Baharumshah & Law 2010). The low absorptive capacities also explain why some countries experience rapid economic growth through FDI inflows, while others are still lagging behind. An alternative explanation may relate to the potential correlation of FDI and human capital or ECTF, or the endogeneity of FDI.

Therefore, based on the empirical findings above, human capital can be considered as one of the important enablers for continuous economic growth. As for Malaysia, although the government continues to prioritise human capital development and training, focus should also be given in understanding and meeting the demands of the labour markets. The country needs to enhance the ability to undertake innovation and promote higher productivity growth that could pave the way for Malaysia to escape from the middle-income trap and move towards an advanced nation.

Next, the empirical findings for model (6.1) on the link between education level and TFP growth show that primary, secondary and tertiary education levels have made their contribution to growth, with the primary and secondary levels being statistically significant at 5% level when estimated using the 21 years dataset. Meanwhile, the results on the closeness to frontier show the expected negative signs and significant effect of primary schooling on TFP convergence. The literature has reported that tertiary education does have a positive and significant impact on economic growth in developed economies, as compared to primary and secondary education (Petrakis & Stamatakis 2002; Zhang & Zhuang 2011). These findings indicate that education level could affect TFP and economic growth through years of schooling as well as through educational attainment (Cuaresma, Lutz & Sanderson 2009). Meanwhile, Papageorgiou (2003) finds that the contribution of primary education to output production is substantial, particularly in developing countries. In addition, developing countries that are closer to the frontier possess sufficient know-how that will help them to grow faster by adopting existing innovation, and therefore enabling them to converge to the income level of the technology leader.

Level and Growth Effects

In previous chapters, the important role of human capital in economic development was established, with the understanding that the effective use of capital investment depends highly on human capital. This section will discuss the level and growth effects of human capital on economic growth, which is also the fourth research question of this study. The empirical model examines the effects of both human capital level and educational attainment on economic growth, with claims that higher human capital accumulation could contribute to faster growth (Zhang & Zhuang 2011; Jin & Jin 2013) and that higher level of human capital could enhance the absorptive capacity of new technologies. In addition, Lucas (1988) also proposes that individuals invest in education to accumulate new skills and knowledge. Aghion, Howitt and Murtin (2010) found supportive evidence for both the initial level and accumulation of human capital having a significantly positive impact on per capita GDP growth. They proposed that productivity growth should be positively correlated with the level of human capital, in particular with the initial or the average level of human capital in a country or region over a given period. Their findings indicate that both the level and accumulation of human capital have significant positive effects on growth of GDP per capita.

In this study, the findings for the empirical model on level and growth effects indicate that the growth of human capital also contributes to higher economic growth. This positive relationship is consistent with the literature that longer years of schooling will enhance growth of GDP per capita. The positive return to schooling indicates that with higher educational accumulation, the workers are able to received higher wages. According to Chung (2003), returns to education in Malaysia, particularly at the higher education levels, remain high and positive. Since human capital is embodied knowledge and skills, and economic development depends on advances in technological and scientific knowledge, development presumably depend on the accumulation of human capital (Becker and Murphy 1980).

The evidence with respect to the empirical model (5.5) indicates that growth in years of schooling has the expected positive effect when estimated using the 21 years dataset. The positive relationship of educational attainment and economic growth is consistent with past research findings that longer years of schooling will enhance growth of GDP per capita. Meanwhile, the initial per capita GDP, as expected, has a negative impact on GDP growth. As for initial years of schooling, the results show the expected negative impact but this is not statistically significant.

Differences in the structure or composition of education may play an important role for economic growth, with claims that higher educated human capital could contribute to faster growth (Zhang & Zhuang 2011; Jin & Jin 2013). The results indicate that growth in human capital has mixed results for Malaysia when education levels are employed in the empirical model (6.5). The findings show that the growth of the primary level education has a negative effect on economic growth, while secondary and tertiary levels have the expected positive effects indicating a positive link with economic growth when using yearly data. However, the education level indicates negative effect when using the 3 year averages dataset. The findings on this adapted AHM model show that in Malaysia, growth effect contributes more towards the economic growth compares with the level effects.

Therefore, the Malaysian education policy should emphasise on the expansion of higher levels education to accelerate the process of becoming an advanced nation. Among others, efforts should be taken to further increase the intake of students into tertiary education institutions, broaden access to quality vocational and technical skills programs, up-skill the workforce through lifelong learning and improve education delivery through better access and quality. Although in the past there has been some mismatch in terms of skills demand from the industry and skills supply from the workers (Economic Planning Unit 2010), particularly during the transitional process of moving from growth based on labour-intensive exports to greater skill intensity through expanded higher education (Lucas 1996), the present policies are now more focussed on meeting the industrial demands and needs to reduce skills mismatch. Therefore, to further enhance economic growth, the expansion of higher education needs to be supported by industrial growth in terms of better employment opportunities, as well as higher income level.

Education Quality

There has been a growing debate on whether it is the quality of human capital or the quantity of human capital that contributes to long-run economic growth. Therefore, for a more comprehensive understanding of the education-growth nexus, the next section will discuss on the empirical estimation results for the two models when using education quality as a measure of human capital. The proxy for education quality (SciP) represents the per capita scientific journal article publications in SCOPUS. The evidence on the quality of human capital shows mixed results, but SciP has the expected positive effect when using yearly data. However, the results indicate that education quality has an adverse effect on TFP growth when estimated using the 3 year averages dataset. The lack of scientific research activity might contribute to the lack of domestic innovation, thus, the insignificant contribution to TFP growth. Hanushek and Wößmann (2007) suggest that education quality could be improved when schooling develops cognitive skills and facilitates the acquisition of professional skills that matters for development. However, Solow (2007) also argues that much of productive innovation is realised through 'learning by doing' and not necessarily via scientific research activities.

Meanwhile, the interaction between education quality and closeness to frontier (SpCTF) has the expected negative effect and is statistically significant at 1% level. The education quality measure used in this study reflects research outcomes, indicating higher research and innovation activities with higher quality of education. Since R&D has been identified as one of the main component of productivity growth, more fiscal investment should be allocated to provide support for more extensive R&D activities. Efforts should also be taken to increase scientific research activities to enhance further domestic innovation and the commercialisation of new products. Although various achievements have been recorded, such as the increase in public universities research citations that marked an increase of 155% between 2010 and 2013, Malaysia continues to face challenges in further enhancing the quality of education and curbing the brain drain.

The Malaysia Education Blueprint (Higher Education) 2015-2025 also outline the need to improve systems outcome, among others through access and quality higher education to develop graduates that meet the industry's requirements and standards, as well as internationally competitive. Education quality also involves entrepreneurial skills, critical thinking, communication and leadership skills. These skills can enable the graduates to stimulate creativity and innovation and able to contribute to a growing economy.

In Malaysia, the government has started to focus on science and technology, including research and development activities (R&D) since the Fifth Malaysia Plan (1986-1990). The support given by the government for R&D activities has contributed towards a faster development of technological capability, along with diversification of various industry-related technologies. Efforts to enhance and promote wider utilisation of science and technology require huge investment in research and development. However, despite huge government expenditures and a sound institutional framework, innovation performance has been gradual due to poor linkages among the researchers and industry. According to Thiruchelvam et al. (2013), there seems to exist imbalances in the allocation of national R&D expenditure whereby nearly 45% of the national R&D budget mostly covers developed regions of the country.

The gross expenditure on research and development (GERD) activities as a share of GDP in Malaysia have increased from 0.8% in 1990 to 1.13 % in 2012. The number of researchers per 10,000 labour force has increased from 18 per 10,000 labour force in 2001 to 53.1 in 2010. The academic personnel with doctorate qualifications in public universities also has increased from 30% in 2010 to 36.5% in 2013 (Economic Planning Unit 2015), which indicates the commitment of the government in supporting human capital development in R&D related activities. In terms of international rankings in 2014, Malaysia was ranked 33rd out of 143 countries in the Global Innovation Index and 20th out of 144 countries in the Global Competitiveness Index (Economic Planning Unit 2015). In the Eleventh Malaysia Plan, which covers the period from 2015 to 2020, R&D activities, as well as commercialisation and innovation (C&I) activities will be expanded to increase return on investment. In line with this, strategic partnerships between the industries and researchers need to be strengthened to accelerate innovative ideas and demand-driven research.

Age Structure: Level and Growth Effects

Next is a summary on the findings of the empirical models on the nexus between age structure, human capital, technology diffusion and TFP or economic growth in terms of level and growth effects. The findings relate to the third and fifth research questions of this study, which examine the links between population age structure and human capital on the one hand, and TFP and economic growth on the other. The findings for the first model on the level effects indicate that the working-age groups and human capital have the estimated positive effects, but are not significant. Meanwhile the coefficient for closeness to frontier has the estimated negative effect. These results confirmed Nelson & Phelps (1966) idea of TFP convergence via human capital for follower states. The second model on the level and growth effects indicates that growth in the working-age groups and human capital have negative effects, while the results of initial per capita GDP indicate positive effect and statistically significant at 5% level for the young and older working-age groups, with the middle working-age group indicating insignificant and negative effect. As for initial human capital, the middle and older working-age group indicates the estimated positive effect.

The expected decline in labour force participation and labour supply due to population ageing may affect economic growth in the long-run (Bloom, Canning & Fink 2010). Studies have found that as population aged, economic growth tends to be slower, therefore increasing the need to support productivity growth through investment in skills and education (Intergenerational Report Australia 2010). The education trends among the working-age population, as discussed in Chapter 2, show that the average years of schooling among younger workers has increased and this trend is likely to continue in the future. Future labour force is expected to be more educated and healthier, which may contribute to higher productivity.

Older workers in the future may also benefit from higher living standards and quality of life (Hamid 2015) and thus, able to extend their working life. Advances in medical and healthcare will also help more workers to remain in the labour force and for people to live longer and healthier. Population ageing may also bring economic benefits in terms of higher human capital investment (Lee & Mason 2010), thus leading to higher accumulation of human capital, which leads to higher labour productivity in the future (Becker & Barro 2001; Lee & Mason 2010). Although the findings of the empirical models examined here did not show significant age structure effects, there is little known about the precise mechanism by which population ageing impacts on the wider economy and economic growth in particular. Hence, the possibility that our specific theoretical models examined here may not be the most appropriate functional form of the nexus between ageing and economic growth. Uncertainty about the functional form this relationship may take also extends to the production technology. Here, the standard production technology of Cobb-Douglas was assumed, the validity of which can be questionable (more detail in section 8.4 below).

8.3 Policy Recommendations

Issues and concerns regarding population ageing have paved the way for this research, as government policies play a crucial role in determining the effect of ageing on economic growth (Bloom, Canning & Fink 2011; Hamid 2015). It is crucial for Malaysia to conduct studies and used the empirical evidence for planning of policies that will better manage the changes of the population age structure and simultaneously able to sustain economic growth. The impact of the transition towards an ageing society could be cushioned if policymakers take appropriate actions, particularly in balancing the needs of an ageing population and the needs to allocate resources to further promote economic growth. Population ageing will affect all levels of society and in striving towards becoming an advanced nation, policies on ageing need to address these issues at all levels of government, whether at federal or states level (Hamid 2015).

Despite taking various efforts, the expected shortage in the supply of human capital, particularly, highly skilled human capital still persists and Malaysia nevertheless faces a middle-income trap challenge. In moving forward, as ageing is a lifelong process, there is a need for a continuous learning process. The lifelong learning is important in the process of up-skilling and re-skilling the workforce to better adapt to the continuous technological change. Workers should be able to have access and opportunities to attend training and mitigate the gap between the needs of technological knowledge and their skills.

However, among the challenges for human capital development in Malaysia is to equip the workforce with the relevant skills set and the ability to absorb technological changes. In building technological capability among the population, Malaysia needs to nurture interests and foster wider focus on science and technology related subjects in schools, as well as enhancing technical and vocational training (Economic Planning Unit 2015). These efforts will enable workers to meet market demands and employer’s expectation. The understanding of science and technology is crucial and steps need to be taken to inculcate and nurture interests in science and technology, not only for schools but also for the general public. Therefore, the strategies for transformation of the human capital need to address the issues as discussed above. These issues are also discussed in the Malaysian Education Blueprint 2013-2025 (preschool to post-secondary education), the Malaysian Education Blueprint (higher education) 2015-2025, and the Talent Roadmap 2020 (Economic Planning Unit 2015) and they should be given priority to ensure the success of its implementation to meet the human capital set objectives.

In addition, the government should also play an important role in encouraging human capital development, both in public and private sector. Creating a supportive environment and the availability of funds for trainings could provide the platform to encourage workers to keep abreast with technology and upgrade technological capabilities. At the same time, innovation should also be supported through the development of better public and private sector linkages as well as between universities and other research institutions locally and internationally. The facilities for research in universities should be made available to other researchers and research outputs should be assessable and further developed for commercialisation. Efforts should be heightened to develop a pool of experts through closer collaboration between government, university and industry. Intuitively, this is with the aim to follow from the fact that higher human capital will further enhance economic growth.

Continuous efforts should be taken to improve productive ageing. The government should review taxes, earnings and pension systems to motivate older people to continue working. Employers should be given incentives to employ older workers and to provide older persons with training, environment friendly working conditions, and a wage structure that is better aligned with productivity. More flexible working hours and part time job should be made available to older workers to encourage them to actively participate in the economy. Beyond retirement age, older workers should be more adaptable to wage flexibility and willing to accept lower wages. In addition, the increase of population ageing will require new technologies being introduced to compensate declines in sensory and physical capabilities for older workers, as well as providing opportunities for them to work from home, retrain and continue working in diverse work places (Skirbekk 2008).

Although the future labour force may be healthier and more educated, which will contribute to higher labour market participation rates and productivity from the current old (Productivity Commission Australia 2005), the increasing number of the elderly are expected to pull down the total labour force participation. Bloom (2009) suggests that economic consequences of an ageing population could be mitigated through behavioural responses, in terms of greater female labour participation, and policy reforms, such as an increase in the legal age of retirement. Longer life expectancy and better health conditions will contribute to more people willing to work longer and this will have significant effects on labour force participation and human capital accumulation. Therefore, the economic consequences of population ageing could be alleviated not only through people wellbeing and larger female labour force participation, but also through policy reforms such as an increase in the legal age of retirement. Higher education attainment of young women today tends to result in higher labour participation of older women in the future (Day & Dowrick 2004).

In addition, various efforts should be made to encourage higher women labour force participation. These include, among others, more flexible working arrangements, better child-care facilities at the work place, equal opportunities as well as training support to enhance relevant skills. Women will also benefit from the higher retirement age, in terms of longer working life as well as increase in savings. Efforts should also be intensified to encourage more women who have left the workforce due to various previous commitments to return to work.

Further, extending the working life is a popular response to population ageing. Flexible retirement and part-time positions, improved career planning and more internal mobility could increase work productivity of the elderly. A longer proposed working life implies that individuals should invest more in enhancing their skills. Older workers usually have comparative advantages when performing tasks, particularly where experience, management and communication skills are important, rather than performing tasks that requires more physical and lots of processing speed (Skirbekk 2008).

Lastly, the government needs to review the current social-linked programmes to provide a more all-inclusive assistance to the low income households, such as providing a safety net programme for old age. This could complement the existing programme, which will not only help to increase income of the poor and low income households but also to ensure that programme participants did not fall back to poverty in their old age. Coordinated efforts need to be taken among relevant ministries to ensure better planning of income generating activities that also include programmes for old age financial sustainability.

8.4 Limitations of this research and suggestions for future research

In the process of this study, there were few circumstances that are unforeseen and uncontrollable that may slightly affect the outcomes of the study. These limitations clearly set the need for future research in this subject area. The first common constraint in any study is data availability and this study faces similar problem. Data collection and information in Malaysia are within the purview of the Department of Statistics Malaysia (DOSM). This centralised system of data management constructs readily available data at national level, with limitations on access to state level data, although more detailed data are available upon request. Since DOSM only provided data that covers a 5-year time period, between year data estimate was calculated using the normalisation technique and interpolation. These time consuming data processes indicate the need for a more integrated data sharing system or a more readily available data at the state levels.

Second, the study did not apply the multi-dimensional aspects of measuring human capital. Although the education quantity and quality variables are part of the empirical models, the quantitative measure of human capital did not factor in other forms of non-formal education that might have complemented and contributed to higher human capital. In addition, the endogenous growth model, which forms the theoretical framework for this study proposed that the rates of growth of productivity and income are endogenously explained. However, the model neglects the effects of sectoral shifts in output and labour utilisation. Hence, as a result of data limitations, this study was not able to account for sectoral variation in human capital and economic growth. The study also did not comprehensively treat other factors that may impact on the nexus between human capital and economic growth. For example, foreign direct investment (FDI) was only used as a control variable in the baseline human capital models, as discussed in Chapter 5 and not on other extension models (i.e., education levels). This variable may also have been endogenous but was only treated as exogenous.

Third, this study only examines the 13 states in Malaysia, excluding the 3 federal territories. The exclusion of the federal territories is due to the facts that the federal territories have relatively low population and are directly managed under the federal government administration. Fourth, the measurement of TFP growth in our diffusion model may be limiting as it assumes (a) fixed factor shares, and (b) a Cobb-Douglas production technology. The latter may also be a limitation for the Aghion, Howitt and Murtin (2010) model as there is much evidence in favour of more flexible technologies that can account for capital-skill complementarities or skill biased technology (Messinis and Ahmed 2013).

Thus, future research ought to explore alternative models of economic growth and TFP growth in order to better understand the role ageing plays in transforming human capital and economic growth. Further, it more attention to the measurement of quality of education as a potentially important factor in the ageing-growth nexus.

8.5 Chapter Summary

Specifically, this study aims to fill a gap in the literature of population dynamics by studying the implications of population ageing for human capital and economic growth in Malaysia. Although the Malaysian economy has continued to grow despite external shocks and challenges such as low commodity prices and climate change, these challenges need to be addressed persistently to further develop human capital, productivity, innovation and economic growth. However, as Malaysia has strong policy emphasis on human capital, this put the nation on the right path of human capital development and in moving forward to become an advanced nation by the year 2020.

In addition, investment in education contributes to human capital, enhances research and development, absorbs new technologies, and enables innovations at the state level. The evidence here seems to suggest that for countries closer to the technology frontier, innovation has been more important than imitation (Vandenbussche, Aghion & Meghir 2006; Benhabib & Spiegel 2005; Kyriacou 1991). Thus, the composition of human capital between basic and higher education seems important, with the initial phases of education linked to imitation and higher education contributing to innovation. Consequently, countries that are far away from the frontier can benefit from technology diffusion and grow rapidly (Benhabib & Spiegel 2005; Papageorgiou 2002).

In conclusion, the education system in Malaysia needs to focus on both the quantity and quality of education. Therefore, attention should be given to the types of subjects that students are taught and the quality of their education, both at entry and upper levels, with focus on specific and relevant skills compatible with the labour market demand for high-skilled workers.

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