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Education and Growth in Malaysian Knowledge-based Economy

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ABSTRACT

The Malaysian economy of today is in the process of evolving from a production-based economy (P-economy) into a knowledge-based economy (K-economy). In the theory of K-economy, knowledge is recognized a one of the primary factors in sustaining economic growth aside from land, labor and physical capital. In this study, we focus on formal education as a knowledge-based input in the Malaysian production function. The multivariate cointegration test result indicates that education, technical progress, labor, capital and economic growth of the country have a long-run equilibrium relationship, which allows them to elevate together over time. Even though several previous studies show that education might not contribute significantly to the growth of developing countries, our short-run estimated results, based on vector error-correction modeling, show that human capital, with the stock of knowledge accumulated through education, does contribute to Malaysian economic growth. In fact it can be considered as, based on the estimated production elasticities, the second most important input factor, after physical capital, that promotes economic growth. This result provides empirical evidence that education, which is causally linked to the physical capital and technological progress, is an important mechanism to escalate the transformation of Malaysia into a fully-developed K-economy.

Keywords: Education, Economic Growth, Cointegration, Vector-error-correction, Knowledge-based Economy

INTRODUCTION

In the new millennium, technological and information revolutions under the wave of markets globalization have exerted profound impacts on world economic development. Among others, the Malaysian economy is also in the process of evolving from a production-based economy (P-economy) towards a knowledge-based economy (K-economy). It is believed that the knowledge-based factor input can ease the bottleneck of resource-based production in the country. One main characteristic of a K-economy is its increasing reliance on knowledge-based activities such as formal educational trainings, on-the-job trainings and so on. In a K-economy, the diffusion of information and communication technologies (ICT) is rapid, the internationalization of businesses is intense; and the migration of business and employment towards knowledge-based activities are very intense.

Many countries realize the importance of human capital and stock of knowledge in promoting economic growth. The balance between knowledge and ph)".sical resources has shifted towards the former. Knowledge has become one of the most important factors in determining the standard of living of people, as compared to land, physical capital and labor. New ideas, inventions and innovations are the lifeblood of emerging knowledge-based societies. Malaysia, among others, has tried very hard in this regard. The setting up of various strategies and programs under Vision 2020 can be considered as very good efforts by the country to transform itself into a fully-developed K-economy. The vision asserts that the ultimate resource of a nation is its people, and nothing is more important than the development of human capital. It has been pursued, particularly with regards to human capital development, through formal education. In view of this, it is therefore crucial to determine the contribution of formal education, apart from technical progress, physical capital and quantity of workers, as an important knowledge-based factor in economic growth of Malaysia.

The effect of productivity, education and knowledge on economic growth has been investigated both empirically and theoretically. In the study by Mitch (1992), he examined the role of education in technological advancement and commercial development and found that a minimum level of educational attainment in a work force is a prerequisite for economic growth. Kalemli-Ozcan et al. (2000) found that mortality decline may promote economic growth through an increase in educational investment. Benhabib and Spiegel (1994) indicated that the growth of total factor productivity is a function of the level of education or human capital. They show that an educated labor force is better at creating, implementing, and adopting new technologies, thereby generating growth. There are several views concerning the expansion of education and economic growth. The first is to view eduation as an investment in human capital by Krugman (1993). The second is to recognize the role of education in a nation's economic growth through positive externalities by Sen (1999). This Nobel Prize-winning development economist believed that an educated part of the community can benefit the whole of it. The third is to view human capital developed through formal education as a critical input for innovation and R&D activities. This view is shared by Romer (1986), Lucas (1988), and Jones and Manuelli (1990). From this perspective, education is an intentional effort to increase the resources needed in creating new ideas. Thus, any increase in education will directly accelerate technological progress.

Inmost of studies, education is often used as proxy for human capital, as the knowledge-based input. However, education and human capital are not identical, since human capital can be acquired through many means other than formal education. Due to the fact that there are usually no other measures of human capital available, the number of students enrolled in institutions of higher learning is taken as a measure of human capital. According to Schultz (1961), formally organized education at the higher level for adults plays an important role in transmitting knowledge for human resource development. Tilak (1994) argued that the relationship between education and economic growth is referred to as the "chicken and egg relationship". Education makes a positive contribution to a society; literate people and an educated labor force play a significant role in social, economic, demographic, political and cultural development. In turn, economic growth allows further development of education systems by providing higher levels of resources for educational expansion. This hypothesis is supported by the study of Cheng and Hsu (1997). They applied Hsiao's version of the Granger causality method to Japanese data for the period 1952-93 and found that an increase in human capital stock exerts positive effects on economic growth and vice versa.

Even though human capital accumulation or education has been considered as an important factor in economic growth by many economists, however, some empirical studies show otherwise. Hoshiono and Rodriguez (2001) studied the case of Latin America and found that high investment in education did not necessarily produce high stocks of human capital that can contribute to economic growth. According to the paper, this is due to severe inefficiencies in the process of investment in human capital. In another study, Haouas and Yagoubi (2005) showed that education did not have the expected growth effect in the MENA countries because of the very poor quality of schools in the countries.

The main contribution we seek from this study is to determine the possible gains from education and technical progress to economic growth during the transitional period to K-economy. To achieve this objective, an augmented growth model, which emphasizes the specific roles of education and technical progress, is estimated via the robust multivariate cointegration and vector error-correction analysis. The paper is structured as follows: Section 2 describes the three-factor growth model employed; section 3 explains the econometric methodology; Section 4 reports the estimated results, and the last section presents the concluding remarks.

THREE-FACTOR GROWTH MODEL

This empirical study is conducted based on the theoretical three-factor growth framework to estimate the possible contribution of education, as a formal means of accumulating knowledge-based human capital, to economic growth (see Lau et al., 1993). The model suggests that the economy accumulates three factors of production, namely, labor input, capital input and human capital, to generate a possibility of long-run sustainable growth. The model can be represented by $Y = f(Lt\ Kt\ ED)$, where L is labor input, K is capital input; and ED is the human capital development via education. The equation states that the quantities of L, K and ED employed affect output, Y, in accordance with the process specified by the functional operator,f This model is further augmented into *Yt :;: f(Lf Kf EDf TE),*where an additional term, *TE,*is included as an exogenous variable to capture the effect of disembodied technical and other structural changes that might occur over time.

ECONOMETRIC METHODOLOGY

In this study, the widely used multivariate cointegration analysis and the Granger-causality test within the environment of vector error-correction modeling (VECM) are used to determine the 'long-run and short-run relationship between education, or human capital development, technical progress and economic growth in Malaysia. Before these analyses, the time-series data was tested for its deterministic and stochastic trends, seasonality and degree of integration. The multicollinearity test is also conducted to clear concerns about multiple regression analysis with regards to the linear relationship between the independent variables. In this case, the correlation between labor input and human capital via education is the concern.

Multivariate Cointegration

The long-run relationship between the variables is analyzed by the Johansen-Juselius (1990) multivariate cointegration method. However, the short run relationship is analyzed by using Granger-causality within the vector error-correction model (VECM). Before conducting the cointegration analysis, the order of integration of each series is determined by both Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests. The maximum likelihood multivariate cointegration test is then employed to determine the number of linearly independent cointegrating vectors in the system. The multivariate cointegration procedure based on the least square estimating regressions is as follows:

$$\Delta X_t = \alpha_1 + \sum_{i=1}^{p-1} \Gamma_1 \Delta X_{t-i} + w_{1t} \quad (1)$$

$$X_{t-p} = \alpha_2 + \sum_{i=1}^{p-1} \Gamma_1 \Delta X_{t-i} + w_{2t} \quad (2)$$

T

While the product moment matrices of the residuals as $S_{ij} = T^{-1} \sum_{t=1}^{T} w_{it} w_{jt}$; (i, j

= 1, 2) is used to construct two likelihood ratio test statistics in order to determine the number of unique cointegrating vectors in X_t. The likelihood ratio test statistic for the hypothesis of at most r cointegrating relationship is as follows:

$$-2 \ In \ Qr = -T \sum_{i=r+1}^{p} In \ (1 - \lambda_l) \quad (3)$$

Where $\lambda_1 > \lambda_2 > \ldots \lambda p$ are the eigenvalues that solve the equations as $/\lambda S_{22} S_{21} S_{11} S_{12}/ = 0$. Equation (3) is referred to as the trace test statistic which can be written as:

$$r_{trace} = -T \sum_{i=r+1}^{p} In \ (1 - \lambda_l) \quad (4)$$

Where l+1, … lp denotes the p-r smallest squared canonical correlation or eigenvalue. The null hypothesis for the Trace test is at most r cointegrating vectors where r=0, …p. So, the null hypothesis of r ≥ 0 is tested against the alternative hypothesis of r ≤ 1, …, r ≤ p. The second likelihood ratio test which is more powerful and robust than the trace test is the MaximumEigenvalue Test. The maximal eigenvalue test statistic is as follows:

$$r_{max} = -T . In \ (1 - \lambda_r + 1) \quad (5)$$

where $\lambda_{r+1}$is the (r + t) th largest squared canonical correlation or eigenvalue. The null hypothesiss is r cointegrating vectors, against the alternative of r + 1 cointegrating vectors. As a result, test the null of r = 0 versus the alternative hypothesis of r = 1.

VECM and Causality Analysis

After determining the number of cointegrating vectors, the residuals generated from the Johansen Cointegration Equation can be applied into VECM. The Granger Causality Test must be conducted in the VECM by requirement of the Vector Auto Regression (VAR) analysis. The purpose of obtaining the relevant error correction terms from the Johansen Multivariate Cointegration equation must be included to avoid omission of important constraints and misspecification. Then, determine the optimal lag structure by using the criterion of maximum likelihood ratio test. In this study, the VECM for the system equation is as follows:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p1} \alpha_1 \Delta Y_{t-i} + \sum_{j=1}^{p2} \alpha_2 \Delta ED_{t-j} + \sum_{k=1}^{p3} \alpha_3 \Delta L_{t-k} + \sum_{l=1}^{p4} \alpha_4 \Delta K_{t-l} + \sum_{m=1}^{p5} \alpha_5 TE_{t-i} + \alpha_5 Z_{t-l} + \varepsilon_{1t}$$

$$\Delta ED_t = \beta_0 + \sum_{i=1}^{q1} \beta_1 \Delta ED_{t-i} + \sum_{j=1}^{q2} \beta_2 \Delta Y_{t-j} + \sum_{k=1}^{q3} \beta_3 \Delta L_{t-k} + \sum_{l=1}^{q4} \beta_4 \Delta K_{t-l} + \sum_{m=1}^{q5} \beta_5 TE_{t-i} + \beta_5 Z_{t-l} + \varepsilon_{2t}$$

$$\Delta L_t = \delta_0 + + \sum_{i=1}^{r1} \delta_1 \Delta L_{t-i} + \sum_{j=1}^{r2} \delta_2 \Delta Y_{t-j} + \sum_{k=1}^{r3} \delta_3 \Delta ED_{t-i} + \sum_{l=1}^{r4} \delta_4 \Delta K_{t-l} + \sum_{m=1}^{r5} \delta_5 TE_{t-i} + \delta_5 Z_{t-l} + \varepsilon_{3t}$$

$$\Delta K_t = \rho_0 + \sum_{i=1}^{s1} \rho_1 \Delta K_{t-i} + \sum_{j=1}^{s2} \rho_2 \Delta Y_{t-j} + \sum_{k=1}^{s3} \rho_1 \Delta ED_{t-i} + \sum_{l=1}^{s4} \rho_4 \Delta L_{t-l} + \sum_{m=1}^{s5} \rho_5 TE_{t-i} + \rho_5 Z_{t-l} + \varepsilon_{4t} \quad (6)$$

where *Y is* the aggregate domestic product, *ED* is the human capital accumulated through education, *L* is the labor input, K is the capital input, TE is the exogenous technical progress, and Z_{t-l} is the error-correction term lagged one and ε_{it}, where *i*=1, …, 4, are the residuals of the VECM regression. The significance of both t-statistics and F-statistic in the model implies the Granger-endogeneity of the dependent variable, while the non-significance of the test implies the Granger-exogeneity of the dependent variables in the system. The significant coefficients of the first-differenced independent variables imply short-run causal effects running from the variables to the dependent variable, whereas the significant error-correction terms in each of the equation indicates the adjustment to the short-run deviation from the long-run equilibrium.

Data

The annual data expanded from 1969 - 2003 were collected from the Social Statistics Bulletin, Quarterly Bulletin, Economic Report and International Financial Statistics Yearbook. The real gross domestic product (GDP) at factor cost is taken as a measure for economic growth. The total gross capital formation was utilized as a proxy for capital stock. On the other hand, the number of workers employed was measured as the labor input. Tertiary formal education is considered as the principal mechanism to accumulate human capital. Due to the fact that the average number of years of tertiary formal education per person in the labor force is not available, thus the number of student enrolments in tertiary learning institutions is used as a proxy for human capital. Studies that used similar proxies are those of Barro (1991), Mankiw et al. (1992) and Levine and Renelt (1992). All the data employed in the analysis are in logarithm form.

ESTIMATION RESULTS

The results of unit root test, Johansen multivariate cointegration, and causality tests in VAR/VECM are sensitive to the presence of a deterministic trend, thus it is crucial to test for such trends, particularly for data gathered from a fast growing economy like Malaysia. The test indicates that all variables appear to have a constant term and a deterministic time trend. Hence, a constant and time trend are included for the unit root test and other related equations of the series. The test for deterministic seasonality, on the other hand, shows that seasonality is irrelevant in these series. In the case of collinearity diagnostics, there is no multicollinearity problem detected among the variables based on the low correlation, in particular that computed between education (ED) and labor input (L).

Unit Root Test

Informing models for time series data, it is crucial to know whether or not the underlying stochastic process that generated the series can be assumed to be stationary. Ifthe stochastic process is non-stationary over time, it will often be hard to represent the series over past and future intervals of time by a simple algebraic model. Unit root test is an alternative test of stationarity for time series. In this paper, two asymptotically equivalent procedures, namely the Augmented Dickey Fuller (ADF) test and the Phillips and Perron (PP) test were used for detecting a unit root in the series. The results of these test, as shown in Table 1, indicate that the series of *Y, K, L* and *ED* are integrated of order one, or they are I(l), while *TE* is integrated of order zero, or it is I(O). These results show that all the variables are stationary at their first-differences, except *TE*,which has no stochastic trend and is stationary at that level. The *TE* thus will be treated as an exogenous variable in the cointegration analysis and vector error-correction model.

Table 1 Unit Root Tests

	ADF Test	PP Test
Levels		
y	-1.6814	-1.6306
K	-1.8570	-2.3958
L	-1.4389	-1.4386
ED	1.3330	1.3744
TE	-13.346*	-10.123*
First Differences		
y	-3.9523*	-4.7950*
K	-3.3605*	-3.7985
L	-5.0032*	-26.0218*
ED	-5.7210*	-9.3340*
TE	-17.463*	-24.593*

Notes: The asterisk (*) indicates rejection of the null hypothesis at the 5% level of significance. This test is conducted using the model without a linear trend. The critical value for rejection is -3.41. These critical values are based on MacKinnon (1991).

Multivariate Cointegration Analysis

In this study, two test statistics, the trace and maximum eigenvalue (max) statistics, are employed to identify the number of cointegrating vectors in the system. The critical values for these tests are tabulated in the Johansen and Juselius (1990). The estimated result, as reported in Table 2, indicates that only the null hypothesis of r equals to 0, or no cointegrating vector is rejected at the 95% critical value. The trace and max statistics are 44.599 and 32.216, which are greater than their respective critical values of 40.175 and 24.159. This result implies that the variables are tied together in the long-run through one adjustment vector.

Table 2 Johansen's Test for Multiple Cointegrating Vectors

Variables: Y, K, L, ED (p=2)				
Ho	Amax	Amax (95%)	Trace	Trace (95%)
r = 0	32.216*	24.159	44.599*	40.175
r 1	10.392	17.797	12.383	24.276
r 2	1.987	11.225	1.990	12.321
r 3	0.003	4.130	0.003	4.130

Notes: r indicates the number of cointegrating vectors. The asterisk (*) indicates rejection at the 95% critical values. The technical progress *(TE)* is treated as an exogenous variable in this test.

Granger-Causality Tests

Since the variables are cointegrated, the Granger-causality test is conducted in the environment of VECM. In this modeling, a lagged error-correction term (ECT) is included in each of the equations to capture adjustments that ensure the variables at their long-run equilibrium path. The estimated results of the Granger-causality test with uniform lag lengths are reported in Table 3.

Table 3 Results of Granger Causality Test based on VECM

Dependent Variable	Independent Variable (Uniform lag-length)					
	tiY	Af(	*M*	*MD*	ti*TE*	*ECT* []t-1
	F-statistics (Significance Levels)					!statistics
tiY	2.2072 (0.1338)	2.7614* (0.0851)	4.3714* (0.0252)	5.2597* (0.0136)	28.1064* (0.0001)	-1.0604* (-5.3134)
Af(	1.5048 (0.2441)	0.5366 (0.5922)	0.3159 (0.7324)	2.6859** (0.0904)	4.6974* (0.0413)	-1.3906* (-2.2448)
M	2.6955** (0.0897)	1.5277 (0.2392)	0.1742 (0.8413)	1.8845 (0.1756)	9.3167* (0.0058)	-0.2227* (-2.9809)
MD	1.6563 (0.2138)	0.0485 (0.9527)	2.4584 (0.1087)	0.4514 (0.6425)	3.2682** (0.0843)	-2.4205 (-1.5583)

Notes : The F-statistic tests the joint significance of the lagged values of the independent variables, and!statistics test the significance of the error correction terms (ECT). The optimal lag length is 2, based on the AIC criterion. The asterisks indicate the following levels of significance: * 5% and ** 10%. The technical progress *(TE)* is treated as an exogenous variable in this analysis.

The significance of f -statistic for the joint test on the lags of each of the independent variable implies the presence of a unidirectional short-run causal effect running from the independent variable to the dependent variable. The F-statistics in Table 3 indicate that there is a unidirectional short-run causal effect running from *K* to *Y*,*ED* to *Y*, *TE* to *Y*,*ED* to *K*, *TE* to *K*, *TE* to *L*, and *TE* to *ED*, and bi-directional feedback relationship between L and *Y*. The significant t-statistics of error-correction terms presented in the last column of the table show that the burden of short-run endogenous adjustments to bring the system back to its long-run equilibrium is through physical capital and labor, and not education or human capital. This indicates that the adjustment of education is not a short-run phenomenon.

Besides the VECM, a single-equation regression is also estimated to analyze the elasticity of production based on the four input factors. The elasticity coefficient between growth and education is 0.27; between growth and physical capital is 0.32; between growth and labor is 0.15; and lastly between growth and technical is 0.04. This elasticity estimated from the regression shows that the economic growth of the country is most contributed by the increase in physical capital. The formal educational training of workers appears to be the second important factor. The labor input and technical progress, even though not as important as physical capital and human capital, also contribute significantly to economic growth.

CONCLUSIONS AND IMPLICATIONS

The empirical results obtained from this study confirm the importance of human capital accumulation via formal education in sustaining economic growth in Malaysia. When education, or human capital, is introduced into the Malaysian production function as a knowledge-based factor input, it is significant in causing physical capital and output growth. This is consistent with the finding of Blackbum et al. (2000), which suggested that the accumulation of skills and knowledge by a nation's citizens is ultimate for economic growth. This finding also shares the view of Katz (1996) that an increase in educational investment has the potential to produce a "win-win" situation of a strong economic growth and equitable distribution of economic resources. Many others, for example, Young et al. (2004), Mankiw (2000), Laitner (1993) also found that education exerts significant positive effects on economic growth, in particular in developed nations.

In this study, the multivariate cointegration test result indicates that education, technical progress, labor, capital and economic growth of the country have a long-term equilibrium relationship, which allows them to elevate together over time. Even though several previous studies show that education might not contribute significantly to the growth of underdeveloped and developing countries, our short-run estimated results, based on the vector error-correction model, show that human capital with the stock of knowledge accumulated through education does contribute to Malaysian economic growth. In fact it can be considered as, based on the estimated production elasticities, the second most important input factor, after physical capital, that promotes economic growth. This result provides the empirical evidence that education, which is causally linked to physical capital and technological progress, is an important mechanism to escalate the transformation of Malaysia into a fully-developed K-economy.

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