THE EFFECT OF HEALTH ON ECONOMIC GROWTH: THRESHOLD EVIDENCE FROM SELECTED ASIAN COUNTRIES

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Abstract

This paper dealing with the role of health in moderating the productivity-growth effect in Asian countries. Panel threshold regression analysis proposed by Hansen (1999) are employ to assess the hypothesis of study. This methodological approach is chosen because it is flexible enough to accommodate the possibility that the impact of TFP "boost up" only after host countries have achieved a certain level of health condition. The result suggests that there is a threshold effect in the TFP-growth relationship such that the positive impact of TFP boost up only after host countries achieve a certain level condition of worker health. This finding is consistent with the view that host countries must have absorptive capacity in order to benefit from TFP. Therefore, policymakers should weigh the cost of policies aimed at ensuring the health of the workers to be taken into account in order for the quality and productivity of the workers to increase as a health has a first-order impact on economic growth.

Keywords: *Health; growth-effect Total factor productivity; threshold.*

INTRODUCTION

For many years, researchers have debated about the economic growth and total factor productivity. Several recent studies reveal that there are more than sixty different variables which are able to improve our understanding of variations in long-term growth performance across countries (Durlauf, Johnson and Temple, 2005; Sala-i-Martin, 1997). Economist have recognized that technological progress appears to be the key explanation for differences in output growth and productivity across countries. According to Grossman and Helpman (1991) and Lucas (1993), countries with high level of technology and those who specialize in technological progressive activity are expected to enjoy high rate of productivity growth compared to others.

In the neo-classical growth models, the long-run rate of growth is exogenously determined by either the savings rate (the Harrod–Domar model) or the rate of technical progress (Solow model). However, the savings rate and rate of technological progress remain unexplained. More specifically, the neo-classical growth model treats productivity improvements as an 'exogenous' variable, they are assumed to be independent of the amount of capital investment. According to

these models, the main factor that promotes output growth is improvement in capital-labour ratio. However, increase in capital investment will not have a permanent impact on the output growth rate.

Recently, several endogenous growth models have been proposed and they provide a novel way in dealing with other important variables. Study by Romer, 1990; Barro and Sala-i-Martin, 1995, among many others, they treat technological progress in their model and emphasize that the creation of new knowledge and technology is the ultimate source of long-run growth. The theory also focuses on positive externalities and spillover effects of a knowledge-based economy which lead to economic development. According to these models, innovation efforts such as investment in research and development (R&D) activity and human capital accumulation will have permanent impacts on productivity growth and this is expected to allow countries to enjoy sustained growth in the long run. Study by Nordin et al. (2017), they study on developing countries and their study used research and development as a proxy of technological progress and finding indicate that R&D enhance the country productivity.

However, empirical evidence suggests that not all countries productivity influenced by technological progress. Whereas the growth literature has highlighted that factor accumulation alone cannot adequately explain differences in growth performance across countries. Past researcher has debated the role of labour on economic growth (i.e. Raleva, 2014; Dimova and Nodman, 2014 among many others), and a few empirical studies identify the labour quality with education level on cross country growth performance (Topel,1999; Hanushek and Wobmann, 2007, Ramos et al 2012). Recent study by Nordin et al. (2019), indicated that regulation of labour market is one of new variable proved to promote economic growth in developing countries.

Based on the past literatures, one of the external factors like health received a little attention from researchers. Health is one essential factor of labour that become crucial factors of productivity and country growth performance. A healthier labour become more productive, because they are physically and mentally more energetic and eager to work. Empirical study by Strauss and Thomas, 1998 and Schultz, 2002; workers with better health condition will increases labor market participation and worker productivity. Past study by Bloom and Canning 2000, 2001, used life expectancy at birth as a proxy of health, where according to Cervellati and Sunde, 2013; Prettner, 2013, Bloom et al. 2014 increasing life expectancy creates incentives to invest in education, innovation, and physical capital and at the end benefited country through increasing the volume of productivity. However labour productivity may influence by other external health factors like poverty, geographical, environmental or biological factor that may cause many disease or illness that may drop the level of labour productivity.

Model Specification

The main objective of this study is to examine the role that health plays in moderating the impact of labour productivity on output growth in selected Asian countries. More specifically, this study intends to test whether health makes a difference to the way TFP affects output growth. Our hypothesis is labour with better health condition are able to increase productivity. Thus, this study will employ threshold estimation method that is difference with other past empirical study. i.e study by Bloom and Canning 2001 that used regression estimation method to find the significant role of health on economic growth.

This paper uses a panel threshold regression modelling proposed by Hansen (1999) to assess the hypothesis that health plays an important role in moderating the impact of productivity on growth. The threshold estimation analysis is employed because this methodology is more flexible to accommodate the possible contingency effect of health in the TFP-growth link. This procedure allows the data to endogenously determine the numbers and locations of the threshold points. We argue that a model particularly well suited to capture the presence of contingency effects and to offer a rich way of modelling the influence of health on the link between TFP and output growth is the following threshold specification:

$$\mathrm{GROWTH}_{it} = \alpha X_{it} + \begin{cases} \beta_1 \mathrm{TFP}_{it} + \varepsilon_{it}; & \mathrm{HEALTH} \leq \gamma \\ \beta_2 \mathrm{TFP}_{it} + \varepsilon_{it}; & \mathrm{HEALTH} > \gamma \end{cases} \quad (1)$$

where GROWTH is a growth rates of real GDP, TFP is TFP level at current purchasing power parities, Health is measure based on life expectancy at birth, and X is a vector of variables hypothesized to affect output growth which includes employment, schooling rate, gross fixed capital formation, regulatory quality, rule of law. In this model, HEALTH acts as sample splitting (or threshold) variable. The above specification allows the effects of TFP on growth to take two different values depending on whether the level of health is smaller or larger than a threshold level γ. The impact of FDI on growth will be $\beta_1(\beta_2)$ for countries in low (high) regime.

Data Descriptions

The data set consists of observations for 10 selected Asian countries over the 2000-2018 periods. The dependent variable of the growth was defined as the per capita real GDP in US$ at time t. This definition was used in Ranis, Stewart and Ramirez (2000), Butkiewicz and Yanikkaya (2006) and Batuo and Fabro (2009). Productivity is measure by total factor productivity provided in Penn World Table. Health is measured based on life expectancy at birth as proposed by Bloom et al. (2001). Higher life expectancy is generally thought to be associated with better health status and further study by Bloom et al. (2019) of 116 countries show that this situation able to increase labour productivity.

Endogenous growth theory discussed the relationship of physical capital and human capital on economic growth. In this study, gross fixed capital formations to GDP as a proxy of physical capital as used in Zhang (2008). Human capital is measured based on employment to population ratio. The data were extracted from the World Development Indicators database (WDI). Mankiw et al. (1992), proved the importance of physical and human capital on economic growth.

The other independent variable used in the model is schooling rate that measure based on ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. The secondary education chosen because secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers. The level of schooling rate is expected to raised worker productivity.

Other variables like regulatory quality and rule of law. Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that

permit and promote private sector development. Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The data were extracted from the World Development Indicators database (WDI). Table 1 provides a summary of all data.

Table 1: Summary of Data

Variable	Measurement	Source of data
Growth	Growth rate of real GDP per capita.	World Development Indicator (WDI)
Productivity	Total factor productivity	Penn World Table 9.1
Health	Life Expectancy at birth.	WDI
Physical Capital	Ratio of Gross fixed capital formation to GDP.	WDI
Human Capital	Employment to population ratio	WDI
Schooling rate	Total secondary school enrolment	WDI
Regulatory Quality	Regulatory Quality	WDI
Rule of Law	Rule of Law	WDI

Results and Discussion

This section discusses estimation results which examine the health plays in moderating the impact of total factor productivity on economic growth. The analysis is based on 11 selected Asian countries over the 2000-2018 periods. Most of the studies that have examined the role of absorptive capacity in the TFP-growth link have relied on the use of a linear interaction model. One major limitation of this type of modelling strategy is that they impose a priori restrictions on the effect of TFP on growth such that the effect of TFP on growth to increase (or decrease) monotonically with absorptive capacity. Therefore, this study uses an alternative method that test the level of health impact of TFP on output growth. The main goal of our study is to determine whether there is threshold effect in the TFP-growth link. Specifically, we would like to determine whether the impact of TFP on growth can be characterized as a nonlinear process where the impact of TFP on growth could be positive, negative or neutral depending on some unknown critical level of health.

The first step of our analysis is to estimate a simple linear model. Results are reported in table 2. The results indicate that there is negative impact of health on output growth and this result is consistent with Bhargava, Jamison, Lau and Murray (2001), Caselli, Esquivel, and Lefort (1996); Sachs and Warner (1997). The other two variables physical capital and human capital are positively related to economic growth and statistically significance at the 1% level. This is in line with previous studies by Chow (1993), Becker et al. (1994), Barro (1999), Cohen and Soto (2001), Bassanini and Scarpetta (2001) and Yan and Yudong (2003), among many others. The estimated coefficient on Schooling rate and regulation indicates no direct impact on economic growth.

Table 2: Linear Model

	Coefficient	**s.e**	**t-stat**
Intercept	31.4537**	12.6876	2.4790
HC	9.8068***	2.4575	3.9905
HEA	-24.4961***	7.3380	-3.3382
PC	1.8277***	0.3974	4.5982
SCH	0.2681	0.2292	1.1694
REG	0.4644	0.3898	1.1911
R^2		0.5337	
p-value		2.03E-13	
Number of observation		209	
F-statistics		6.8980	

Note: The dependent variable is output growth per capita, HC= human capital, HEA= Health (life expectancy at birth), PC = physical capital, SCH= schooling rate and REG = Regulation.

Table 3 report the result of estimating a linear interaction specification. In this analysis, an interaction term TFP x HEA is added to the baseline linear model to capture the contingency effect of TFP. The coefficient on TFP x HEA is used to evaluate if there is a contingency growth-effect of TFP. If the estimated coefficient is positive and significant, this would imply that the impact of TFP on growth depends on the health. The result presented in the table show that the coefficient on TFP x HEA is insignificance. This suggests that there is no evidence to support the idea that health is able to moderate the impact of growth-effect of TFP. The results for other control variables indicate significant impacts on economic growth except for regulation.

Table 3: Linear Interaction Model

	Coefficient	**s.e**	**t-stat**
Intercept	-7.8233*	4.3277	-1.8077
HC	4.7677**	2.1833	2.1836
TFP * HEA	-0.3408	0.5722	-0.5957
PC	2.2252***	0.3913	5.6854
SCH	0.5509**	0.2430	2.2667
REG	-0.1230	0.3555	-0.3461
R^2		0.4969	
Number of observations		209	
p-value		3.14E-11	
F-statistics		13.31762	

Note: The dependent variable is output growth per capita, HC= human capital, TFP*HEA= interaction term of productivity and health, PC = physical capital, SCH= schooling rate and REG = Regulation.

Figure 1 shows the plot of the concentrated likelihood ratio function of threshold estimate LR(γ) with 90 per cent confidence intervals. The point estimates are the value of γ at which the likelihood ratio hits the zero axis as is in the figure 1. The results for threshold regression analysis are reported in table 4. As shown in table 4 and figure 1, the threshold estimate is 1.8740 and the test of threshold effect yields a p-value of 0.0189. Thus, we can split the sample into two groups according to the level of health, which are better and weak health condition. Countries that have value of health greater than 1.8740 are classified as healthy labour while the ones with the value below than 1.8740 are characterized as unhealthier labour. The coefficient on TFP for high regime is 2.0344 while the one for low regime is 0.9053. However, only the coefficient for high regime is found to be significant at the usual level. This suggests that TFP will have a positive and significant impact on economic growth only when labour have a good health. Before that, the impact is non-existence. Therefore, we can conclude that health is important in moderating the impact of TFP on economic growth in Asian countries.

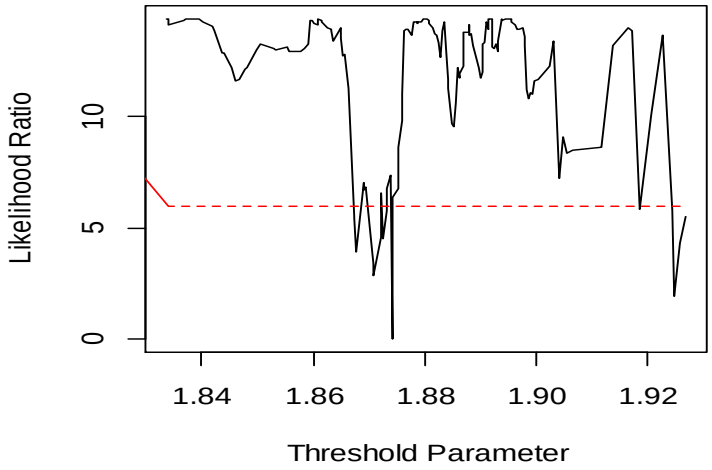

Figure 1: Plots of the Concentrated Likelihood Ratio
(Note: 90 per cent confidence intervals)

Table 4: Threshold Regression

Regressor	Coefficient estimate	s.e	t-stat
HC	1.3608**	0.5336	2.5502
PC	0.7751*	0.4479	1.7305
SCH	0.9621**	0.4174	2.3049
REG	1.9430*	0.5176	3.7538
TFP			
Low HEALTH - (HEALTH $\leq$ 1.8740)	0.9053**	0.2975	3.0430
High HEALTH - (HEALTH $>$ 1.8740)	2.0344***	0.4882	4.1671
Threshold estimate	1.8740		
LR Threshold estimate	2.6178		
Bootstrap p-value	0.0189		

Note: The dependent variable is output growth per capita, HC= human capital, PC = physical capital, SCH= schooling rate, REG = Regulation, TFP = Total Factor Productivity, HEALTH=

Health (life expectancy at birth), p-value was bootstrapped with 1000 replications and 10% trimming value.

Sensitivity test are carried out to evaluate whether the previous finding is robust. The test of the sensitivity of the p-value is carried out for testing the null of no threshold effect to different numbers of bootstrap replications and trimming percentages. The results are reported in table 5. Based on the results presented in the table, we can conclude that at all of bootstrap replications that we examined (1000, 5000 and 10,000) and with 10%, 15%, 20%, 25% and 30% of trimming percentage, we can easily reject the null hypothesis of no threshold. This indicates that the existence of threshold effect in the TFP-growth relationship is not driven by trimming percentages and number of bootstrap replications.

Table 5: Bootstrap p-value

Threshold Estimate: 1.8740	Trimming Percentage				
LR test of threshold: 2.6178					
Bootstrap Replications	10	15	20	25	30
1000	0.0065	0.0209	0.0375	0.0447	0.0605
5000	0.0023	0.0165	0.0329	0.0492	0.0589
10000	0.0001	0.0155	0.0287	0.0398	0.0502

Note: Bootstrap replication and trimming percentage obtain by using R statistical software.

This study performs second sensitivity tests to ensure that the estimation results are robust by assessing the potential impact of outliers on the results. Based on the graph plotted, two countries detected as an outlier, that are China and Singapore. The results which exclude outliers are reported in table 6. Interestingly, the exclusion of outliers has slightly increased the threshold value with the value 2.0802 and the test of threshold effect yields a p-value of 0.0073.

The estimation results show the value of threshold parameters is statistically highly significant at which indicates the existence of threshold effect in the TFP-growth relationship. This result shows that the identified effect of health on TFP-growth link remain intact. More importantly, the estimated coefficient on health index in high regime shows the coefficient value of β_2=1.9548; s.e = 0.6765 and highly significant at the 1% level. However, the coefficient for the low regime indicate negative coefficient value and insignificant (β_1= -0.0786; s.e = 0.0480). Thus, the results support earlier finding on the important role played by health in moderating the impact of TFP on economic growth in Asian countries.

Table 6: Threshold Regression exclusion of outliers.

Regressor	Coefficient estimate	s.e	t-stat
HC	1.8133***	0.3960	4.5790
PC	0.5862**	0.3784	1.5491
SCH	0.3908*	0.2413	1.6195
REG	0.8851**	0.7050	1.2554
TFP			
Low HEALTH - (HEALTH $\leq$ 2.0802)	-0.0786**	0.0480	1.6375

High HEALTH - (HEALTH > 2.0802)	1.9548***	0.6765	2.8895
Threshold estimate	2.0802		
LR Threshold estimate	2.3698		
Bootstrap p-value	0.0073		

Note: The dependent variable is output growth per capita, HC= human capital, PC = physical capital, SCH= schooling rate, REG = Regulation, TFP = Total Factor Productivity, HEALTH= Health (life expectancy at birth), p-value was bootstrapped with 1000 replications and 10% trimming value.

Conclusion

Economic growth and productivity improvement are among the most important issue in the field of economics. This issue has been examined extensively using many different methodologies. Over the years, economists have been looking into factors that influence growth and inquire on policies which are required for the nations to maintain and promote sustained output growth. The literature on this issue is filled with many controversies in both theoretical and empirical due to several studies revealed that there are more than sixty different variables which are able to improve our understanding of variations in long-term growth performance across countries (Durlauf et al., 2005; Sala-i-Martin, 1997). Among these factors, health appeared to be important for output growth and productivity improvement.

The theory suggests that the effect of health and schooling on output depends only on the average level of health and schooling in the economy. However, the empirical literatures suggested that their impacts are ambiguous. Recent literatures argued that the benefit of TFP could be contingent on other intervening factors, which are usually referred to as "absorptive capacity". Departing from this argument, this study has conducted empirical analyses regarding the issues in developing countries. Specifically, issues addressed in this study are examining the role of health in moderating the impact of TFP on economic growth.

This study takes a step further by examining the role of health in moderating the growth-effect of TFP. Threshold estimation was employed to data collected from 10 Asian countries for the 2000 -2018 period. The main finding indicates that the TFP-growth link is influenced the level of health in the host countries. Specifically, it shows that the impact of TFP on output growth is positive and significant only after host countries has achieved a certain level of health which worker able to increase their productivity when they are in good health condition. This finding is consistent with the growing view that host countries must have absorptive capacity in order to successfully benefit from positive externalities linked to worker productivity.

References

Acemoglu, D., & Johnson, S. (2007). Disease and development: the effect of life expectancy on economic growth. Journal of political Economy, 115(6), 925-985.

Barro, R. J. (1996). Determinants of economic growth: a cross-country empirical study (No. w5698). National Bureau of Economic Research.

Barro, R.J. & Sala-i-Martin, X. (1995). Economic Growth. MIT Press, Cambridge MA.

Bassanini, A., Scarpetta, S., & Hemmings, P. (2001). Economic growth: the role of policies and institutions. Panel data evidence from OECD countries.

Batuo, M. E., & Fabro, G. (2009). Economic Development, Institutional Quality and Regional integration: Evidence from Africa Countries. Munich Personal RePEc Archive Paper No, 19069

Becker, G. S., Murphy, K. M., & Tamura, R. (1994). Human capital, fertility, and economic growth. In Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education. The University of Chicago Press, 3rd Edition, 323-350.

Bhargava, A., Jamison, D. T., Lau, L. J., & Murray, C. J. (2001). Modeling the effects of health on economic growth. Journal of health economics, 20(3), 423-440.

Bloom, D. E., & Canning, D. (2000). The health and wealth of nations. Science, 287(5456), 1207-1209.

Bloom, D. E., Canning, D., & Sevilla, J. (2001). The effect of health on economic growth: theory and evidence (No. w8587). National Bureau of Economic Research.

Bloom, D. E., Canning, D., Kotschy, R., Prettner, K., & Schünemann, J. J. (2019). Health and economic growth: reconciling the micro and macro evidence (No. w26003). National Bureau of Economic Research.

Bloom, D. E., Canning, D., and Moore, M. (2014). Optimal retirement with increasing longevity.

Butkiewicz, J. L., & Yanikkaya, H. (2006). Institutional quality and economic growth: Maintenance of the rule of law or democratic institutions, or both?. Economic Modelling, 23(4), 648-661.

Caselli, F., Esquivel, G., & Lefort, F. (1996). Reopening the convergence debate: a new look at cross-country growth empirics. Journal of economic growth, 1(3), 363-389.

Cervellati, M., & Sunde, U. (2013). Life expectancy, schooling, and lifetime labor supply: theory and evidence revisited. Econometrica, 81(5), 2055-2086.

Chow, G. C. (1993). Capital formation and economic growth in China. The Quarterly Journal of Economics, 809 - 842.

Cohen, D. and M. Soto (2001), "Growth and human capital: good data, good results," Technical Paper No. 179, OECD Development Centre, Paris.

Dimova, R., & Nordman, C. J. (2014). Understanding the links between labour and economic development. The European Journal of Development Research volume 26, pages387–396(2014)

Durlauf, S. N., Johnson, P. A., & Temple, J. R. (2005). Growth econometrics. Handbook of economic growth, 1, 555-677.

Grossman G. M., & Helpman, E. (1991). Innovation and Growth in the Global Economy, MIT Press, Cambridge MA.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of Econometrics 93, 345 – 368.

Hanushek, E. A., & Wößmann, L. (2007). The role of education quality for economic growth. The World Bank. Scandinavian Journal of Economics, 116(3):838–858.

Lucas Jr, R. E. (1993). Making a miracle. Econometrica: Journal of the Econometric Society, 251 - 272.

Nordin, N. N. & Nordin, N. H., (2017). The Role of Economic Freedom in Research and Development-Productivity Growth Nexus: Study Based on Different Income Level on Developing Countries. Journal Economic Cooperation and Development, 38(1), 1-32.

Nordin, N., Nordin, N., Mawar, M. Y., & Zainudin, N. (2019). Growth effect of foreign direct investment: The role of labor market flexibility. Economic Journal of Emerging Markets, 11(1), 19-31.

Prettner, K. (2013). Population aging and endogenous economic growth. Journal of population economics, 26(2), 811-834.

Raleva, S. (2014). Impact of labour on economic growth in Bulgaria (1991-2013). Economic Alternatives, 3, 5-14.

Ramos, R., Surinach, J., & Artís, M. (2012). Regional economic growth and human capital: the role of over-education. Regional Studies, 46(10), 1389-1400.

Ranis, G., Stewart, F., & Ramirez, A. (2000). Economic growth and human development. World development, 28(2), 197-219.

Romer, P., (1990). Human capital and growth: theory and evidence. In Carnegie-Rochester Conference Series on Public Policy, North-Holland, 32, 251 - 286.

Sachs, J. D., & Warner, A. M. (1997). Sources of slow growth in African economies. Journal of African economies, 6(3), 335-376.

Sala-i-Martin, X. X. (1997). I just ran two million regressions. The American Economic Review, 178 – 183

Schultz, T. P. (2002). Wage gains associated with height as a form of health human capital. American Economic Review, 92(2), 349-353.

Strauss, J., & Thomas, D. (1998). Health, nutrition, and economic development. Journal of economic literature, 36(2), 766-817.

Topel, R. (1999). Labor markets and economic growth. Handbook of labor economics, 3, 2943-2984.

Yan, W., & Yudong, Y. (2003). Sources of China's economic growth 1952–1999: incorporating human capital accumulation. China Economic Review, 14(1), 32 - 52.