Human Capital and Productivity Growth in ASEAN Countries for 2000-2010: A Malmquist Index Analysis

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Abstract
This study emphasizes a role of human capital in the measurement of productivity growth and highlights the importance of sample selections in analyzing productivity change of ASEAN countries, especially from 2000 to 2010. The productivity growth in ASEAN countries appears to deteriorate, mainly due to efficiency losses in the first half of the decade and the lack of technological improvement in the second half of the decade.
Keywords: Productivity, Human Capital, Malmquist Index, ASEAN

Introduction

The Association of Southeast Asian Nations (ASEAN)has been one of the fastest growing economies since the new millennium. Its combined GDP has increased from 0.58 trillion US dollars in 2000 to 2.4 trillion in 2014,which makes it the seventh largest economy in the world. However, whether the growth could be sustained remains debatable. This paper examines the issue by investigating the productivity growth change in ASEAN countries for a period of 2000-2010.

The total factor productivity (TFP) is defined as the ratio of output to factor inputs (Tinbergen, 1942). The neoclassical growth model integrated an economic theory into the calculation of productivity elegantly using calculus (Solow, 1957). But the interest in growth theory was only resurged until the early 1990s when the neo-classical endogenous growth model was developed (Lucas, 1988; Romer, 1990) and an international comparison dataset became available (Summers and Heston, 1988; Barro and Lee, 1993). Numerous empirical studies have discussed whether growth in a cross section of countries or an individual country or region was driven by accumulation of factor inputs or by productivity gains (Barro, 1991). The East Asia Miracle, in particular, has stimulated one of the most debates. The TFP growth in the East Asian Newly Industrialized Economies (NIE) – Hong Kong, Singapore, South Korea, and Taiwan, the Association of Southeast Asian Nations (ASEAN)-4 (Indonesia, Malaysia, the Philippines, and Thailand), China and Japan over the period of the 1950s-1990s has also been widely studied in the literature (see a review by Felipe, 1999).

However, in the new millennium, how ASEAN, now a 10-member international organization, has performed in terms of productivity growth is not well studied[1].

This paper intends to fill the gap by employing the Malmquistproductivity index to identify the sources of TFP growth in ASEAN countries and examine differences and similarities of TFP growth patterns in each member states for the recent decade.

The Malmquistindex was first introduced in 1953 to analyze consumption changes (Malmquist, 1953). Later Fare *et al.* (1994) applied it to the productivity analysis and created the Malmquist productivity index to decompose the TFP change to technical change and technical efficiency change using non-parametric programming. Since then, the Malmquist index has gained substantial popularity. Compared to the two commonly used approaches to measuring TFP, namely, econometric estimation of an aggregate production function and the growth accounting approach, the Malmquist index has several advantages. It is a non-parametric method requiring no function form, allowing accommodation of multiple outputs, and enabling the identification of sources of TFP growth. Compared to the Tornqvist index which needs information on prices, cost or revenue shares to aggregate inputs or outputs to calculate the TFP growth, it is less data demanding. Since the Malmquist productivity index constructs a best-practice frontier from the data of a sample, the selection of samples affects the choice of best practice, which in turn affects the decomposition results. That being said, estimates of TFP change and its decomposition of one country may vary when it is included in different samples of countries. The usual practice is to construct a world frontier by incorporating the US in a dataset, given its superiority in economy and technology. Recently, a growing literature on knowledge diffusion, however, shows that knowledge decays rapidly with

geographic distance and technology is to a large extent local, rather than global (Keller, 2002; Keller *et al.*, 2013). Based on this theory, ASEAN is likely to benefit less from spillovers of advance technology compared to Canada and Mexico, assuming that the US is the knowledge exporting country. Taking this into consideration and ASEAN's close cooperation with China, Japan and South Korea, this study investigates the TFP change of ASEAN within two samples, one is the ASEAN plus three (China, Japan, and South Korea), and the other is to further include Hong Kong, Taiwan, the U.S. and 28 countries of European Union (EU).

In the country productivity studies using frontier techniques, real gross domestic product (GDP) is used as the output measure, whereas labor and physical capita are the two factor inputs (Fare *et al.*, 1994). This studyfurther includes human capital as an additional factor input. As long emphasized by the endogenous growth models, human capital is one of the key determinants of long-term economic growth. More human capital facilitates the absorption and exploitation of existing advanced technologies from leading countries, benefits pure innovation, increases productive capacity and stimulates growth (Mankiw *et al.*, 1992; Barro, 2001; Vandenbussche, *et al.,* 2006). Maudos *et al.* (1999) incorporate human capital in the calculation of the Malmquist productivity index in the OECD countries and indeed find a significant effect on the accurate measurement of TFP. The importance of human capital in a context of ASEAN countries is examined in this paper.

The remainder of the paper is organized as follows: Section 2 describes the method of Malmquist productivity index; section 3 introduces the data used, discusses results of productivity change, sources of TFP change and importance of sample selection and inclusion of human capital; section 4 concludes.

Methodology

Following Fare *et al.* (1994), the Malmquist productivity index with technology in periodτas the reference technology is defined as

$$M^\tau = \frac{D^\tau(x^{t+1}, y^{t+1})}{D^\tau(x^t, y^t)},$$

where x^t and y^t are a vector of inputs and outputs

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[1] ASEAN was formed in 1967 by foreign ministers of five countries – Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Brunei joined the organization in 1984, a week after gaining independence. Vietnam became the seventh member in 1995, Laos and Myanmar joined two years later in 1997, and Cambodia became the tenth member in 1999.

at period t, and D^τ (x^t, y^t) is the distance function measuring the maximum proportional change in output required to make (x^t, y^t) feasible in relation to the technology at period τ^2. The essence of this method is to construct a best practice frontier using inputs and outputs data from a sample of countries and compute the distance of individual countries from the frontier. A Malmquist productivity index greater than unity indicates improvement in productivity and a Malmquist productivity index less than unity indicates deterioration in productivity.

In order to avoid arbitrary choice of benchmarking technology, especially when analyzing the productivity change of a longer period of time, the Malmquist productivity change index is specified as the geometric mean of two Malmquist productivity index, which is further decomposed as the product of efficiency change and technical change:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = (M^t M^{t+1})^{1/2}$$
$$= \underbrace{\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}}_{\text{Efficiency Change}} \underbrace{\left[\left(\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})}\right)\left(\frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right)\right]^{1/2}}_{\text{Technical Change}}$$

The efficiency change index greater than one is considered to show evidence of catching up to the technical frontier, and the technical change greater than one is interpreted as innovation, or shift of technical frontier. This method allows one to identify sources of productivity growth and countries put forward the technical frontier (innovator).

Data and Result Analysis

This study applies the Malmquist index to the analysis of productivity growth for two samples of countries over the period of 2000-2010: ASEAN plus three as one sample, and on top of that adding Hong Kong, Taiwan, the US and EU as another sample. The data is from the Penn World Table (PW) Version 8.0, a database widely used for international comparison. It includes information on relative levels of income, output, inputs, productivity and human capital index covering 167 countries between 1950 and 2011 (see Feenstra *et al.*, 2013 for more detail). For some less developed countries, however, the data is not complete. For example, TFP is missing in Cambodia, Laos and Vietnam; and Myanmar is not covered by the database.Therefore, this study excludesMyanmar from the analysis. Aggregate output is measured by real GDP (expressed in 2005 US dollar); human capital stock is calculated as a product of number of workers and human capital index, which is based on years of schooling in Barro and Lee (2010) and assumed returns to schooling; physical capital stock (in 2005 US dollar) and total employment are the other two conventional aggregate input proxies.

Table 1 presents the average annual growth rates of real GDP, human capital stock, physical capital stock and total employment of each country in the sample over 2000-2010. The average annual growth rate of real GDP in ASEAN only second to that of China for the period. For annual growth rate of human capital stock and total employment, ASEAN ranks the first; and it ranks the third in the growth of physical capital, after China and South Korea. Looking at the individual member states of ASEAN, Cambodia's GDP growth rate is the highest of 8.9%, Singapore contributes most to the human capital stock and total employment growth, and Vietnam and Laos see the fastest growth of physical capital. The productivity growth and its sources are investigated next by the method of Malmquist index.

2 Mathematically, the distance function is specified as D^τ $(x^t, y^t) = \inf\{\theta : (x^t, y^t) \in S^\tau\}$, where S^τ is the technology set.

Table 1 Average Annual Growth Rates: 2000-2010 (%)

Country	Real GDP	Human Capital Stock	Physical Capital Stock	Total Employment
Brunei	1.752	2.253	3.507	1.892
Cambodia	8.906	3.611	9.706	2.689
Indonesia	4.658	2.712	8.401	1.761
Laos	5.191	2.256	11.408	1.328
Malaysia	3.964	3.105	4.604	2.353
Philippines	2.384	3.029	4.604	2.353
Singapore	5.718	4.840	10.181	4.085

Thailand	4.301	3.536	2.408	2.187
Vietnam	7.467	3.854	15.713	2.549
ASEAN*	4.564	3.163	6.320	2.148
China	8.754	1.849	12.890	0.858
Japan	0.412	0.029	2.720	-0.422
South Korea	3.665	1.910	8.713	1.297
Hong Kong	1.673	1.336	4.495	0.552
Taiwan	1.993	1.893	4.868	1.015
US	1.533	0.441	3.229	0.179
EU	1.778	1.174	5.553	0.546

Note: * Myanmar is not included.

Table 2 shows productivity change during the period of 2000-2010 using different samples and factor inputs. It is clear to see that in the sample of ASEAN plus three, the factor of human capital has little effect on the average performance of each country. Thailand is the only country that has productivity improvement. ASEAN as a whole outperforms China and South Korea, while among ASEAN countries, Cambodia, Malaysia and Brunei are the next three countries whose productivity change is close to one. After including Hong Kong, Taiwan, the US and 28 countries in EU, Singapore also appears to experience productivity improvement, but only when human capital is not considered a factor input. Another country that has a positive productivity growth is the US. Cambodia, Malaysia and Brunei still stay high in the ranking of productivity growth among ASEAN. The rate of productivity growth of ASEAN as a whole is lower than Hong Kong, Taiwan, Japan, and the US, but slightly higher than that of the EU.

Table 2 TFP Change: 2000-2010

Country	Sample 1		Sample 2	
	With Human Capital	**Without Human Capital**	**With Human Capital**	**Without Human Capital**
Brunei	0.990	0.991	0.993	0.995
Indonesia	0.970	0.970	0.966	0.966
Cambodia	0.998	0.998	0.994	0.994
Laos	0.954	0.954	0.946	0.946
Malaysia	0.994	0.994	0.993	0.993
Philippines	0.982	0.982	0.981	0.981
Singapore	0.967	0.968	0.997	1.009
Thailand	1.018	1.018	1.018	1.019
Vietnam	0.941	0.941	0.930	0.930
ASEAN*	0.979	0.979	0.979	0.981
China	0.970	0.970	0.964	0.964
Japan	0.979	0.979	0.996	0.996
South Korea	0.956	0.956	0.992	0.992
Hong Kong			0.994	0.997
Taiwan			0.991	0.997
US			1.001	1.001
EU			0.978	0.979

Tables 3 and 4 present the sources of productivity growth - technical efficiency change and technical change, respectively. A half of the ASEAN countries (Cambodia, Malaysia, the Philippines and Thailand) experience efficiency progress; however, the negative innovation effects in three of them (Cambodia, Malaysia and the Philippines) outperforms the catching-up effect leading to a productivity deterioration, and only in Thailand the efficiency gain dominates the technical regress resulting in productivity growth. In Laos and Vietnam, deterioration of productivity comes from both the efficiency loss and technical regress, whereas Brunei experiences TFP deterioration exclusively from a lack of technical progress. The decomposition results for Indonesia and Singapore vary by samples and input compositions. In the sample of ASEAN plus three, Indonesia and Singapore experience lack of progress in both efficiency and innovation. In the extended sample, however, although there is a catching-up effect in Indonesia, it did not gain a productivity growth due to the technical regress. In Singapore, the innovation effect exists no matter whether human capital is included or not; nonetheless, the catching-up effect appears only when human capital is excluded. When human capital is taken into consideration in the extended sample, efficiency loss dominates the innovation effect, leading to a TFP deterioration. This ascertains that the sample and inclusion of human capital do have an impact on the TFP change decompositions.

Turning to countries other than ASEAN, the results indicate that in the sample of ASEAN plus three, the three countries experience loss of both technical efficiency and technical progress. In the extended sample, all the other countries experience efficiency gain and technical regress; furthermore, the technical regress dominates efficiency gain in all except the US during the period of 2000-2010.

Table 3 Technical Efficiency Change: 2000-2010

Country	Sample 1		Sample 2	
	With Human Capital	**Without Human Capital**	**With Human Capital**	**Without Human Capital**
Brunei	1.000	1.000	1.000	1.000
Indonesia	0.990	0.990	1.001	1.001
Cambodia	1.009	1.009	1.023	1.023
Laos	0.974	0.976	0.978	0.977
Malaysia	1.016	1.016	1.034	1.034
Philippines	1.001	1.001	1.017	1.017
Singapore	0.982	0.982	0.996	1.003
Thailand	1.040	1.040	1.057	1.057
Vietnam	0.966	0.966	0.962	0.962
ASEAN*	0.997	0.998	1.007	1.008
China	0.993	0.993	1.000	1.000
Japan	0.997	0.997	1.007	1.007
South Korea	0.977	0.977	1.012	1.012
Hong Kong			1.005	1.007
Taiwan			1.022	1.025
US			1.013	1.013
EU			1.008	1.009

Table 4 Technical Change: 2000-2010

Country	Sample 1		Sample 2	
	With Human Capital	Without Human Capital	With Human Capital	Without Human Capital
Brunei	0.990	0.991	0.993	0.995
Indonesia	0.980	0.979	0.965	0.965
Cambodia	0.989	0.989	0.972	0.972
Laos	0.980	0.977	0.967	0.968
Malaysia	0.978	0.978	0.960	0.960
Philippines	0.981	0.981	0.964	0.964
Singapore	0.984	0.985	1.001	1.006
Thailand	0.979	0.979	0.963	0.963
Vietnam	0.975	0.975	0.966	0.966
ASEAN*	0.982	0.982	0.972	0.973
China	0.977	0.977	0.964	0.964
Japan	0.981	0.981	0.990	0.990
South Korea	0.979	0.979	0.980	0.980
Hong Kong			0.989	0.990
Taiwan			0.969	0.973
US			0.989	0.989
EU			0.970	0.970

Figure 1 depicts the cumulative evolution of productivity change, catching-up and innovation effects for ASEAN and a few countries for comparison in different samples and factor input compositions. It is clear that samples and inclusion of human capital have a significant effect on the measurement of TFP and the decomposition of sources of productivity growth. The general pattern over time is similar, but the ranking of countries and size of changes vary in different cases. Overall, for the recent decade, the productivity of ASEAN countries has gradually deteriorated; technical efficiency decreased slowly from year 2000 till 2005, and began to increase afterwards; on the contrary, technological improvement halted around 2005, and subsequently slid down significantly. Other countries exhibit a similar trend but with different magnitude.

Conclusions

This study investigates the productivity change of ASEAN countries in the recent decade using the Malmquist productivity change index, and highlights the importance of sample selections and incorporation of human capital in the measurement of productivity growth.

This study finds that ASEAN's productivity gradually deteriorates over the period of 2000-2010, and the productivity change is mainly due to efficiency loss in the first half and lack of technological improvement in the second half of the last decade. The performance of individual member states varies. Thailand is the only country that experienced a productivity growth for the last decade, though there is a technical regress as all other ASEAN countries except Singapore. Majority of ASEAN states have experienced efficiency improvement (except Laos, Vietnam and Singapore), but due to lack of innovation, their productivity performance deteriorates. The policy implications for the ASEAN countries are to incentivize innovative activities while keeping up with its efficiency momentum.

Figure 1 Cumulated Productivity Change, Technical Efficiency Change and Technical Change (Year 2000 = 1.0)

(A) Productivity Change

(B) Technical Efficiency Change

(C) Technical Change
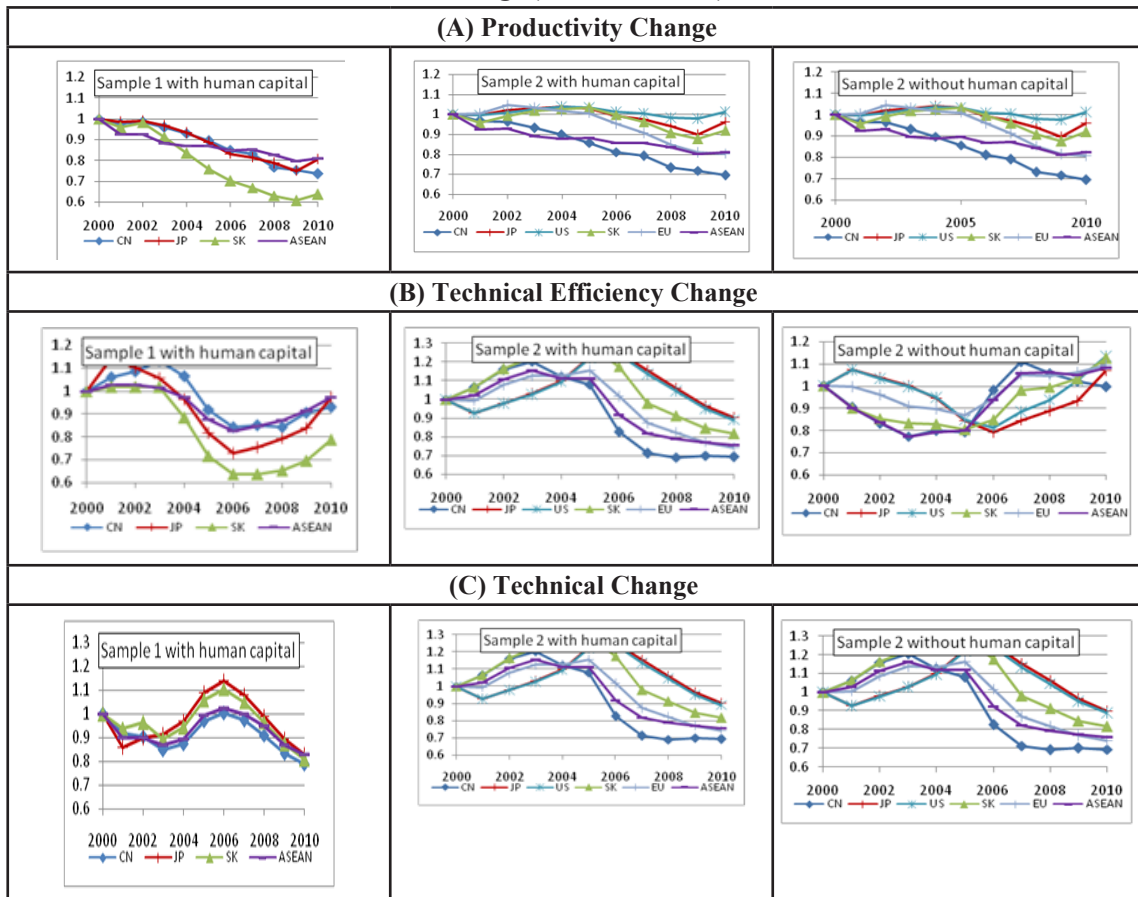
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