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Productivity in the Emerging Asian Economies

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Abstract *Total factor productivity (TFP) has played a vital role in fostering the growth of the agriculture and manufacturing sectors of emerging Asian economies. However, few attempts have been made to unveil this link. The core objective of our paper is to evaluate TFP growth via two different approaches (1) growth accounting framework and (2) Data Envelopment Analysis (DEA) for emerging Asian economies, namely, China, Pakistan, India, Indonesia, South Korea, and Japan. Results obtained from both approaches revealed that on average productivity performance increased for the sample countries over the study period. Furthermore, DEA results indicated that increase in agriculture and manufacturing sector's productivity is largely attributable to the technological advancement in these countries while the role of technical efficiency change is not encouraging. Policymakers need to frame appropriate policies achieving higher TFP growth both through technological innovation and efficiency improvements in order to attain sustainable economic growth.*

Introduction

Asia is the fastest developing region in the world. Its economic progress has been quite impressive over the past few decades. On average the combined GDP growth of Asian economies is about 5.3 percent from 2013 to 2016. Asian economies have also witnessed key structural changes. The agricultural sector contribution to total GDP reduced from 14 percent in 1980 to 9 percent in 2016, whereas the

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contribution of manufacturing sector increased. China, India, South Korea, Indonesia, and Japan are the largest Asian economies. Since 1990, these countries have shown a tremendous increase in its growth rate, except 1997 to 1999 due to Asian financial crisis and 2007 to 2009 due to global financial crises. Before, the global financial crises the average growth rate per year in Asia was 7.0 percent which thereafter has gone down on average to 5.3 percent per year. During this period on average China's growth rate has reduced from 11 percent in 2002-2007 to 6.9 percent in 2016. Whereas the growth rate of European Union economies has shrunk by 0.6 percent from 2011 to 2012 and recovered to 1.8 percent from 2013 to 2016. Similarly, the US growth rate during the same period was 2.3 percent (Kanoktanaporn., 2018). The implication is that Asian economies are growing faster than US and other western economies and as a result Asian economy is considered the new emerging market and becoming the center of attention for investors.

However, Krugman (1994) raised the question of sustainability that whether Asian countries will sustain this growth in the future. Krugman argued that this growth became possible just due to factor accumulation and not due to enhancement in productivity of the factor's inputs. As factor inputs can be increased up to a certain limit, therefore the rapid and sharp growth of Asian countries would not be survived for a longer period due to the law of diminishing returns. Krugman (1994) concluded that productivity is a vital element for sustained economic growth. Therefore, his study led economists and policymakers of Asian countries to put more emphasis on productivity as a fundamental part of their economic policies since 1990s.

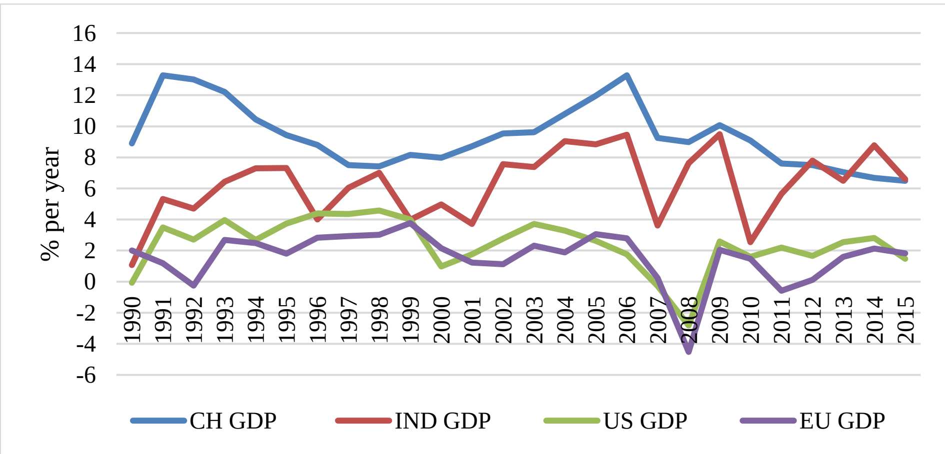

Figure 1. GDP Growth of China, India, US and the EU

Source: APO

This is the focus of this study. We used descriptive analysis to discuss the productivity performance of agriculture and manufacturing sectors of emerging Asian economies. TFP growth is employed as a proxy of productivity performance and is estimated using different approaches for emerging Asian economies, namely, China, Pakistan, India, Indonesia, South Korea, and Japan.

The current paper is organized into 5 sections: Literature on productivity measures and its multidimensionality is explored in section 2. Measures of productivity for the sample countries are discussed in section 3. While results and conclusions are discussed in sections 4 and 5 respectively.

Total Factor Productivity Measures

There are two widely used measures of productivity: Single Factor Productivity (SFP) and Total Factor Productivity (TFP) based on output and factor inputs data. SFP is measured as a ratio of output to a single input such as labor or capital. It is further classified into labor productivity and capital productivity. While TFP is measured by subtracting the growth rate of all inputs weighted by their respective rewards from the growth rate of output.

Kendrick (1961) measures SFP as the ratio of output to a specific factor input (i.e. labor or capital) and TFP as the ratio of total output to total national income at factor costs in real terms. Kendrick (1961) used the following index to measure TFP.

$$A = \frac{Q}{wl + ik} \tag{1}$$

where A represents total factor productivity, Q denotes the total level of output, l represents units of labor input, k represents the capital input, w and l denotes respectively the rewards of labor and capital. Similarly, Nadiri (1970) defines TFP as the ratio of output obtained by both labor and capital. Nadiri (1970) defines SFP as the average level of output (y) obtained either by per unit of labor or capital. Nadiri (1970) named the average level of output (y) obtained by per unit of labor (L) as labor productivity (LP) and the average level of output (y) obtained by per unit of capital (K) as capital productivity (KP). Labor and capital productivity are specified by the following indices:

$$LP = \frac{y}{l} \tag{2}$$

$$KP = \frac{y}{k} \tag{3}$$

where LP represents average labor productivity and KP is the average capital productivity. Various empirical studies have used measures of SPF to quantify the impact of productivity. However, the accuracy and reliability of single-factor productivity measures have been long debated in the literature. Because output is the result of the combined efforts of all factor inputs that are simultaneously employed for producing output.

It is therefore pointed out by Kendrick (1961) that SFP does not portrait a complete picture of the overall product performance and sheds light only on the performance of single factor input. Brunker and Gallagher (1991) criticized SFP on two counts. First, it often yields misleading results. Second, it also fails to take into account variation in units of labor that is occurred by the differences in working hours. According to Manonmani (2014) these SFP measures misinterpret the results by overstating that output per unit of labor is increasing which implies that labor productivity is increasing. However, this is not always the case happening because labor input is not always efficiently working. Similarly it often understates productivity performance of capital which does not necessarily mean that capital is not getting its weight. Dhehibi (2016) argued that though SFP is frequently employed measure of productivity due to its nature of simplicity, however, it often misinterprets and delude a firm's productivity performance.

The reliability of SFP measures has been criticized in the literature as discussed in the preceding paragraphs. Therefore, it is necessary to consider the overall or TFP rather than relying just on SFP. TFP is considered as a suitable and composite measure of productivity because it considers a number of factor inputs simultaneously used in the production of output. TFP encompasses not only the upshots of technological changes but also the efficiency changes with which factors of production are utilized to produce output (Goldar, 1986). Thus, TFP is a multidimensional concept that reflects the productivity performance of all factors of production.

To deal with multidimensionality, various researchers have used various techniques to portrait the true picture of productivity. Subramanian (1992) estimated total factor productivity by using Kendrick's approach. Subramanian (1992) argued that single productivity also termed as the partial factor productivity captures only a single dimension of productivity with respect to a particular factor input. Hence, it is necessary to use a composite measure of productivity which could capture the productivity performance of all factor inputs. And TFP is such a composite measure. Kendrick's TFP index is given as follows.

$$KTFPI = \frac{Y_t}{w_o L_t + i_o K_t} \tag{4}$$

where $KTFPI$ represents the Kendrick's TFP index, Y is the gross value added, L represents the units of labor, K represents units of capital, w and i represents respectively the rewards of labor and capital, and the subscripts t and o respectively represents time and base period. This index has the advantage to compute productivity performance by combining all factor inputs under the same index.

Mishra, Parhi, and Diebolt (2008) defines TFP as the growth rate of factor inputs subtracted from the growth rate of output and construct measure of TFP through the traditional growth accounting framework. Using labor and capital as inputs, Mishra et al. (2008) derives the following measure of productivity.

$$TFP_t = Y_t - \frac{1}{3}K_t - \frac{2}{3}H_t \qquad (5)$$

where TFP represents total factor productivity performance in time t, Y is the aggregate output, K represents physical capital, H represents human capital, $\frac{1}{3}$ and $\frac{2}{3}$ are respectively the shares of labor and capital in the aggregate output. Mishra, Parhi, and Diebolt (2008) included human capital for the computation of TFP in $eq(5)$ which not only results in the improvement of the efficiency of labor input but also results in generating the stock of physical capital.

Wei and Hao (2011) employed a Stochastic frontier approach to measure changes in TFP. The stochastic frontier approach uses Malmquist TFP index that is symbolically expressed as;

$$MTFPI = \frac{TECH_t}{TECH_s}\sqrt{\left(1+\frac{\partial}{\partial t}lnY_t\right).\left(1+\frac{\partial}{\partial t}lnY_s\right)} \qquad (6)$$

where $MTFPI$ represents Malmquist TFP index, $\frac{TECH_t}{TECH_s}$ denotes the index of efficiency change and $\left(1+\frac{\partial}{\partial t}lnY_t\right).\left(1+\frac{\partial}{\partial t}lnY_s\right)$ represents the index of technological change. This approach has the advantage of decomposing productivity change into its two components technical efficiency change and technological change. Therefore, this measure is efficient in measuring productivity change than the traditional growth accounting framework.

Noah and Ichoku (2015) used data envelopment analysis (DEA) to gauge changes in productivity performance. Noah and Ichoku (2015) argued that this is a non-parametric frontier technique that does not need any specification of a functional form unlike the stochastic frontier technique and it, therefore, circumvents the misspecification problem of model. The DEA compute the Malmquist TFP index that is represented as:

$$MTFPI_o(y_t, x_t, y_{t+1}, x_{t+1}) = \sqrt{\frac{d_t(y_{t+1}, x_{t+1})}{d_t(y_t, x_t)}.\frac{d_{t+1}(y_{t+1}, x_{t+1})}{d_{t+1}(y_t, x_t)}} \qquad (7)$$

where $MTFPI$ is the Malmquist TFP index, *y* represents output, *x* represents inputs and $d^t(y^{t+1}, x^{t+1})$ represents the distance from period t observations to period $t+1$. Being free from the specification of functional form and hence model's misspecification problem, this approach is more suitable to measure productivity performance than the previous stochastic frontier approach and the growth accounting framework.

Data and Methodology

Data

Researchers and policymakers have employed different techniques to measure TFP performance. Based on the existing literature and availability of data the present study is applying (1) growth accounting framework and (2) Data Envelopment Analysis (DEA) to compute measures of productivity performance for emerging Asian economies; China, Pakistan, India, Indonesia, South Korea, and Japan.

Growth Accounting Framework (GAF)

The traditional growth accounting technique used for the estimation of TFP is instigated in the seminal paper of Solow (1956). This method is based on aggregate production function and the assumptions of constant returns to scale and the perfect competition in factor markets. The aggregate production function links the production of goods and services to units of labor (L) and capital (K). Symbolically this link is specified as:

$$Y_{a(m)it} = A_{a(m)it} F\left(K_{a(m)it}, L_{a(m)it}\right) \quad (8)$$

where $Y_{a(m)it}$ is output, $A_{a(m)it}$ is TFP, $K_{a(m)it}\, and\ L_{a(m)it}$ are units of capital and labor inputs respectively. Taking the logarithms on both sides the following equation is obtained as:

$$lnY_{a(m)it} = lnA_{a(m)it} + lnF\left(K_{a(m)it}, L_{a(m)it}\right) \quad (9)$$

Next by differentiating equation (9) with respect to time and then simplifying, equation (10) is obtained.
Now Solow residual can be obtained by rearranging equation (11) as follows:

$$\frac{\dot{A}_{a(m)\iota t}}{A_{a(m)it}} = \frac{\dot{Y}_{a(m)\iota t}}{Y_{a(m)it}} - i\,\frac{K_{a(m)it}}{Y_{a(m)it}} \cdot \frac{\dot{K}_{a(m)it}}{K_{a(m)it}} - w\,\frac{L_{a(m)it}}{Y_{a(m)it}} \cdot \frac{\dot{L}_{a(m)it}}{L_{a(m)it}} \quad (10)$$

where $\frac{\dot{A}_{a(m)\iota t}}{A_{a(m)it}}$ shows the TFP growth rate, $\frac{\dot{Y}_{a(m)\iota t}}{Y_{a(m)it}}$ represents output growth rate, $\frac{K_{a(m)it}}{Y_{a(m)it}}$ is the ratio of the stock of capital to output, $\frac{\dot{K}_{a(m)it}}{K_{a(m)it}}$ shows stock of capital's growth rate, $\frac{L_{a(m)it}}{Y_{a(m)it}}$ is the ratio of labor to output, $\frac{\dot{L}_{a(m)it}}{L_{a(m)it}}$ shows the labor's growth rate while i and w demonstrate respectively the prices of capital and labor.

Equation (10) is used for estimating the TFP. As the data on the series of capital's stock is not published, the following perpetual inventory method is used to calculate it.

$$K_{a(m)it} = (1 - \sigma)K_{a(m)it-1} + I_{a(m)it} \quad (13)$$

The initial stock of capital can be calculated by the following formula:

$$K_{a(m)it-1} = \frac{I_{a(m)it-1}}{\sigma + g_{a(m)}} \quad (5.14)$$

where $K_{a(m)t}$ shows the stock of capital of the present period, $I_{a(m)t}$ represents investment in the present period, σ represents depreciation rate of the capital stock and $g_{a(m)}$ shows the output growth. The current study used a depreciation rate of 4 percent for the capital's stock as also used by Vikram and Ashok (1993) and Khan (2006).

Malmquist TFP Index (MTFPI)

The Malmquist TFP index (MTFPI) was firstly presented by Douglas, Laurits, and Erwin (1982) and then further developed by Rolf (1988) and Rolf, Shawna, Mary, and Zhongyang (1994). The Malmquist TFP indices have several desirable advantages. They can breakdown productivity growth into TFP change, technical change, and efficiency change. The decomposition of productivity change provides insight into the sources of productivity performance. The Data Envelopment Analysis (DEA) presented by Coelli (1996) is employed in the present study to compute output-based MTFPI. Rolf et al. (1994) pointed out that the MTFPI is based on distance functions that reflect patterns of production technology and requires only input and output data. Rolf et al. (1994) also argued that distance functions can be utilized to identify the sources of productivity growth that whether change in productivity growth is due to the efficiency change or whether it is attributed to the technological change. Shephard (1970) and Rolf (1988) defined distance function on production technology S_t such that input x_t can produce output y_t. The distance function can be expressed as;

$$d_o^t\,(y_t, x_t) = \min\{(\theta: y_t, x_t/\theta)\epsilon S_t\} \quad (15)$$

This function measures the maximum proportional change in output that can be attained from a certain combination of inputs. When distance function $d_o^t\,(y_t, x_t)$ is equal to 1, it shows that (y_t, x_t) is on the boundary of the production frontier. This implies that output is technically efficient. However, if the distance function $d_o^t\,(y_t, x_t)$ is less than 1 this implies that there is technical inefficiency. To show trends in productivity growth the MPI uses distance function with respect to time that is defined in the following way;

$$d_o^t\,(y_{t+1}, x_{t+1}) = \min\{(\theta: y_{t+1}, x_{t+1}/\theta)\epsilon S_t\} \quad (16)$$

$d_o^t\,(y_{t+1}, x_{t+1})$ measure the proportionate change in output in order to confirm that (y_{t+1}, x_{t+1}) is attainable. (y_{t+1}, x_{t+1}) is not attainable in time period t. The maximum proportional change in output entailed the attainability of (y_t, x_t) in time period $t+1$ that is represented by $d_o^{t+1}(y_t, x_t)$. According to Rolf et al. (1994) the $MTFPI$ in time period t is defined as:

$$MTFPI^t = \frac{d_o^t\left(y_{t+1,}x_{t+1}\right)}{d_o^t\,(y_t, x_t)} \qquad (17)$$

Likewise, the Malmquist TFP index of time period $t+1$ is defined as follows;

$$MTFPI^{t+1} = \frac{d_o^t\left(y_{t+1,}x_{t+1}\right)}{d_o^t\,(y_t, x_t)} \qquad (18)$$

So, according to Douglas et al. (1982), the MTFPI index can be defined in terms of the geometric mean of two Malmquist indexes as defined above.

$$MTFPI_o(y_s, x_s, y_t, x_t) = \sqrt{\frac{d_o^t\left(y_{t+1,}x_{t+1}\right)}{d_o^{t+!}(y_{t+1}, x_{t+1})} \cdot \frac{d_o^t\left(y_{t,}x_t\right)}{d_o^{t+1}(y_t, x_t)}} \qquad (19)$$

This index is based on the ratios of output distance functions to show changes in productivity growth over time. A value of $MTFPI_o > 1$ will show positive growth in the overall TFP performance from period t to period $t+1$. And a value of $MTFPI_o < 1$ will show that the overall productivity performance is declining over the period. By rewriting equation (4), $MTFPI$ can be decomposed into its two main sources; technical efficiency that represent a shift towards the production frontier and technological change that represent a shift of the production frontier (Fare, Grosskopf, Lindgren, & Roos, 1992);

$$MTFPI_o(\,y_{t+1}, x_{t+1},\, y_t, x_t) = \frac{d_o^{t+1}\left(y_{t+1,}x_{t+1}\right)}{d_o^t\,(y_t, x_t)} \cdot \sqrt{\frac{d_o^t\left(y_{t+1,}x_{t+1}\right)}{d_o^{t+!}(y_{t+1}, x_{t+1})} \cdot \frac{d_o^t\left(y_{t,}x_t\right)}{d_o^{t+1}(y_t, x_t)}} \qquad (20)$$

$$= Efficiency\ Change\ .Technological\ Change$$

where $\frac{d_o^{t+1}(y_{t+1,}x_{t+1})}{d_o^t\,(y_t,x_t)}$ is the change in technical efficiency between the current period t and next

period $t+1$ and the remaining part of this equation, $\sqrt{\frac{d_o^t(y_{t+1,}x_{t+1})}{d_o^{t+!}(y_{t+1},x_{t+1})} \cdot \frac{d_o^t(y_{t,}x_t)}{d_o^{t+1}(y_t,x_t)}}$ is the technical change between the current period t and next period $t+1$.

Results and Discussion

Figure 1 and 2 shows trends in growth rate of agricultural and manufacturing sector's productivity performance of China, Pakistan, India, Indonesia, South Korea and Japan respectively.

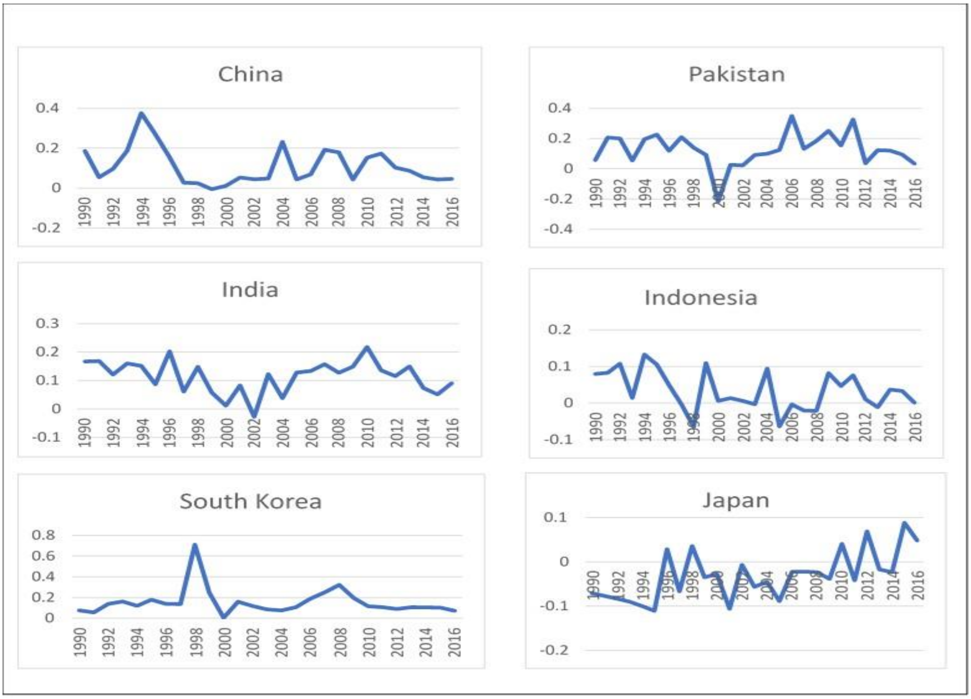

Figure 1: Agriculture Sector Total Factor Productivity

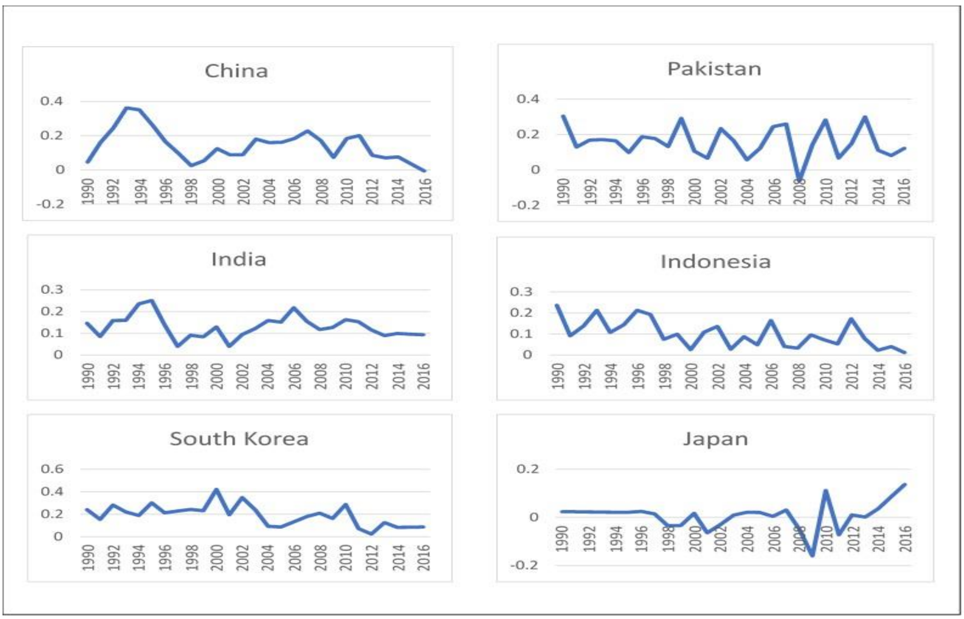

Figure 2: Manufacturing Sector Total Factor Productivity

The growth rate of Pakistan's agricultural TFP is 0.058% in 1990 and -0.216% in 2000, thereafter showing an increasing trend and reaches at 0.349% in 2006. After this period there is a decreasing trend in the growth rate of TFP and reaches to 0.034% in 2016. While the growth rate of Pakistan's manufacturing TFP is 0.142% in 1990, then showing an increasing trend and reaches at 0.30 % in 2013. And after 2013 it starts decreasing and reaches 0.122%. Hence, Pakistan's growth rate of both agricultural and manufacturing sectors TFP shows a declining trend over the period of the study. In China agricultural sectors' TFP growth rate is 0.186% in 1990 and reaches 0.192% in 2007. The agricultural TFP in China declines from 0.192% in 2007 to 0.046% in 2016. Like the agriculture sector, Chinese manufacturing sector's TFP growth declines from 0.046% in 1990 to -0.006% by 2016. For India the agriculture growth rate of TFP is estimated at 0.167% in 1990, which declined to 0.090% in 2016. Similarly, the growth rate of manufacturing sector's TFP for India in 1990 is 0.147% which reduced to 0.093% in 2016. For Indonesia the estimated growth rate of agriculture sector TFP declined from 0.097% in 1990 to 0.002% by 2016. While its manufacturing sector TFP estimated at the rate of 0.237% and then reduced to 0.012% in 2016. Among the emerging Asian economies South Korea has recorded the most noteworthy performance of TFP growth both in agriculture and manufacturing sector over the study time frame. Its TFP growth rates were 0.076% for agriculture sector and 0.241% for manufacturing sector in 1990. However, like other Asian economies South Koreas' growth rate of both agriculture and manufacturing sectors has also shown a declining trend over the study's period and reaches 0.072% and 0.088% respectively for agricultural and manufacturing sectors in 2016. Japan has recorded the lowest agriculture and manufacturing sectors' TFP growth of -0.071% and 0.023% respectively in 1990 that have improved by 0.049% for agriculture sector and 0.137% for manufacturing sector by 2016. Despite its remarkable increase in economic growth, productivity performance is continuously deteriorating over the study period.

Figure 3 shows that on average India and South Korea have the highest growth of Malmquist based agriculture productivity approximately 3.9 % and 0.7% respectively. This increase in agriculture sector productivity is mostly attributable to the technological progress in these countries. While Pakistan, China, Indonesia, and Japan display a decline in productivity performance of 14%, 7.9%, 9%, and 6% respectively. The decline in productivity performance stems from the deterioration of technical efficiency change. Moving on to the manufacturing sector, Figure 4, it is noted that South Korea and India are again the best performers. On average per annum productivity growth rate in South Korea and India is 26.2% and 7.1 % respectively. Indonesia also displays a positive TFP growth of 2.8% per annum. Similarly, Pakistan shows a positive growth rate, albeit slighter, increase in the manufacturing sector's TFP of 0.8%. While in China and Japan growth rate of TFP is negative during the sample time frame. On average, TFP growth of China and Japan dropped by 15.2% and 2.5% respectively. So, it is concluded that South Korea and India have succeeded in shifting out the frontier due to technological improvements, followed by Indonesia.

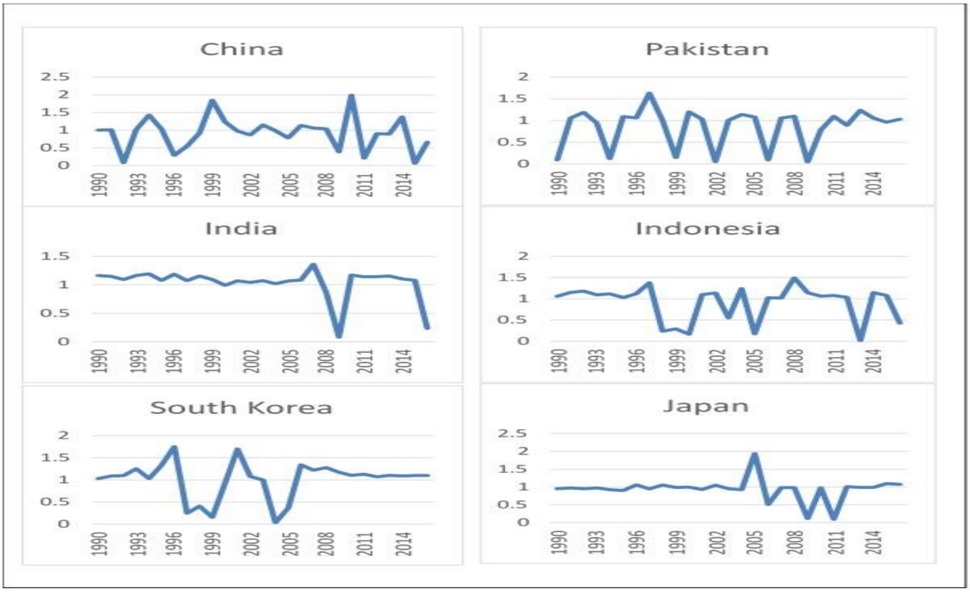

Figure 3: Agriculture Sector MPI
Source: Authors 'own calculation

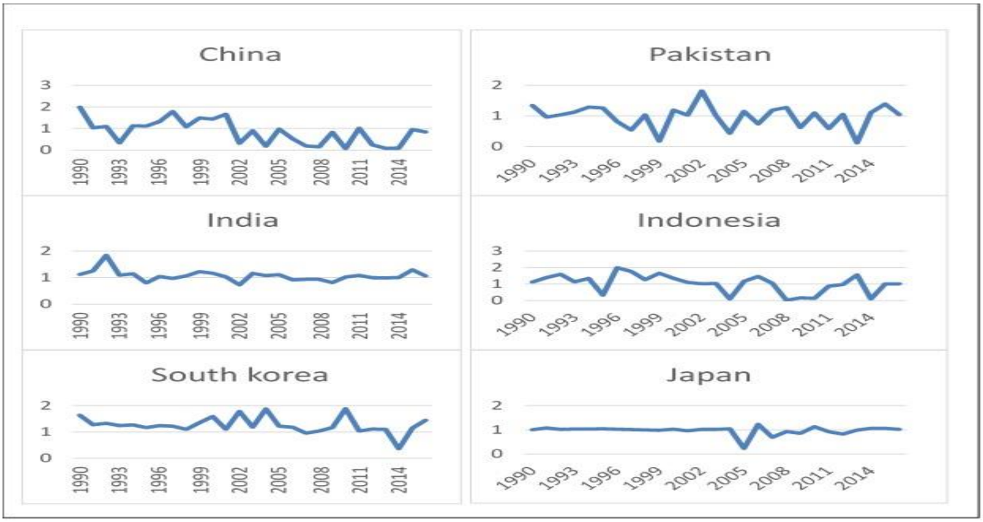

Figure 4: Manufacturing Sector MPI
Source: Authors 'own calculation

Figure 5 and 6 illustrates agriculture and manufacturing sectors efficiency change component of TFP index for the sample economies over time. The efficiency performance for all the sample countries did not report any enhancement and exhibited a similar declining pattern throughout the study period. This provides evidence that the sample countries are not able to attain the best practice frontier.

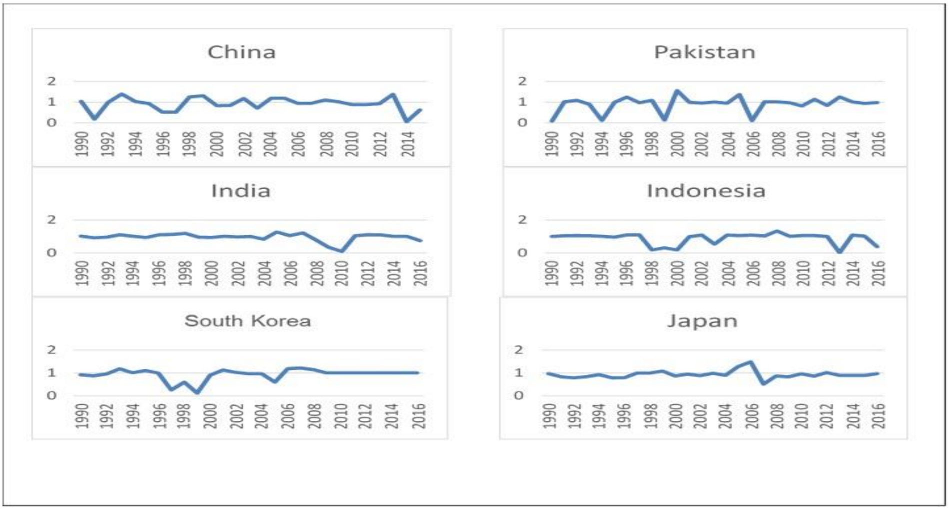

Figure 5: Agriculture Sector Efficiency Change
Source: Authors 'own calculation

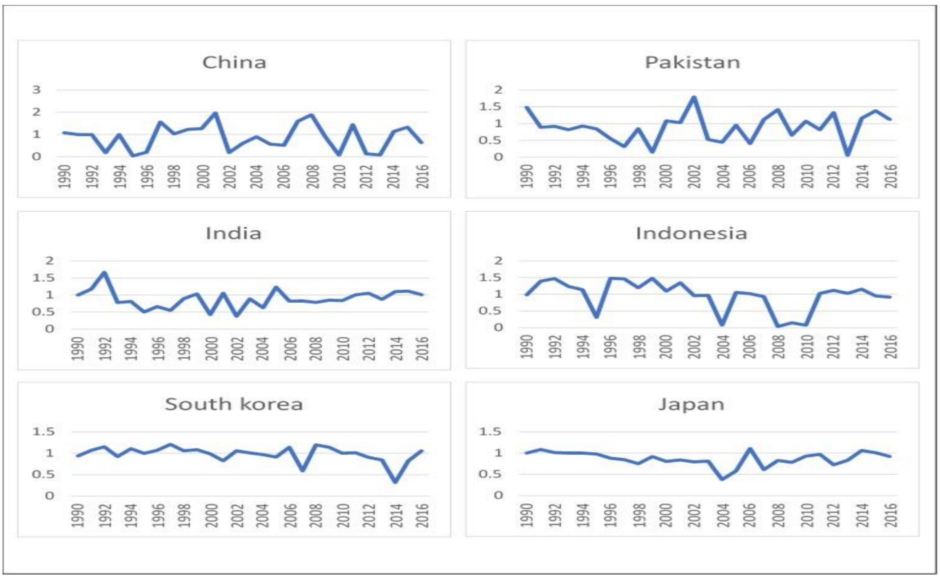

Figure 6: Manufacturing Sector Efficiency Change
Source: Authors 'own calculation

Lastly, Figure 7 and Figure 8 demonstrates technological change for agriculture and manufacture sectors respectively in the sample countries. It is revealed from these figures that all countries exhibit a rising trend in technological change throughout the sample countries that strengthen our previous claim that improvement in productivity stems from improvements in technological change.

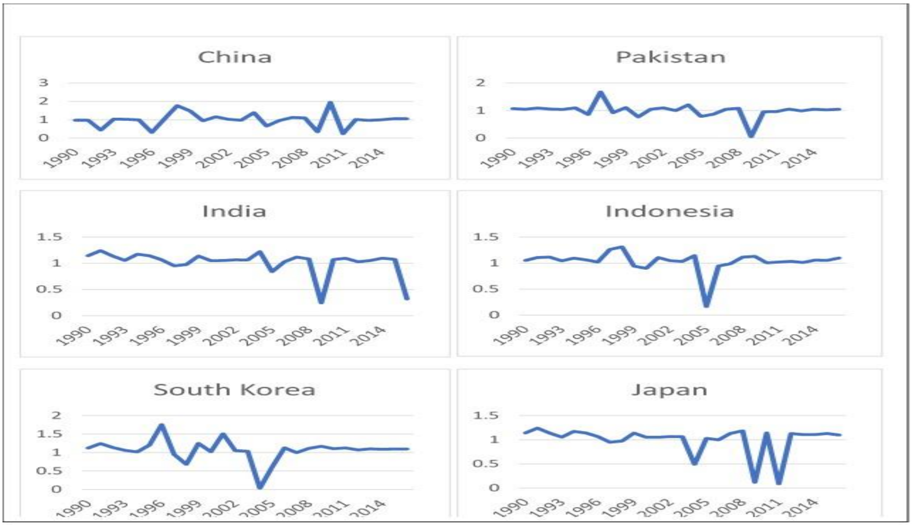

Figure 7: Agriculture Sector Technological Change
Source: Authors 'own calculation

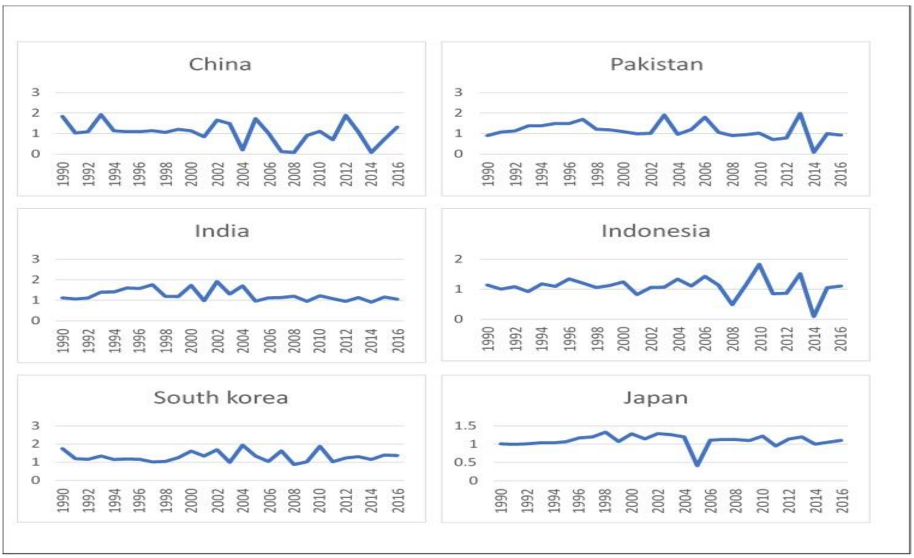

Figure 8: Manufacturing Sector Technological Change
Source: Authors 'own calculation

Conclusions

In this paper, TFP growth is estimated via two different approaches; growth accounting framework and a recently developed technique Data Envelopment Analysis (DEA) for emerging Asian economies; China, Pakistan, India, Indonesia, South Korea, and Japan. Results obtained from both approaches revealed that on average productivity performance has increased for the sample countries over the study period. Data Envelopment Analysis based measure of productivity is more comprehensive than the measure developed by the traditional growth accounting framework as it can provide bits of knowledge into the sources of productivity by separating productivity into its two principal sources; technical efficiency change and technological change. The results obtained by DEA show that increase in agriculture and manufacturing sector's productivity is mostly attributable to the technological advancement in these countries. While the contribution of technical efficiency changes to agriculture and manufacturing sectors productivity is not much impressive.

References

Brunker, D., & Gallagher, C. (1991). *An Analysis of Total Factor Productivity with an Application to Australian National*. Australia: Bureau of Transport and Communications Economics

Coelli, T. J. (1996). Measurement of total factor productivity growth and biases in technological change in Western Australian agriculture. *Journal of applied econometrics, 11*(1), 77-91.

Dhehibi, B. (2016). Approaches to Total Factor Productivity Measurements in the Agriculture Economy: CRP on Dryland Systems (DS).

Douglas, C., Laurits, C., & Erwin, D. W. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica: Journal of the Econometric Society*, 1393-1414.

Fare, R., Grosskopf, S., Lindgren, B., & Roos, P. (1992). Productivity changes in Swedish pharmacies 1980–1989: A non-parametric Malmquist approach. *Journal of productivity analysis, 3*(1-2), 85-101.

Goldar, B. (1986). Import substitution, industrial concentration and productivity growth in Indian manufacturing. *Oxford Bulletin of Economics and Statistics*, *48*(2), 143-164.

Kanoktanaporn., D. S. (2018). *APO Productivity DataBook*. Tokyo: Asian Productivity Organization.

Kendrick, J. W. (1961). Front matter, Productivity Trends in the United States *Productivity trends in the United States* (pp. -52-50): Princeton University Press.

Khan, S. U. (2006). *Macroeconomic determinants of total factor productivity in Pakistan*. Working Paper No. 10. State Bank of Pakistan.

Krugman, P. (1994). The myth of Asia's miracle. *Foreign affairs*, 62-78.

Manonmani, M. (2014). Total factor productivity of Indian corporate manufacturing sector. *The Indian Journal of Industrial Relations*, 513-525.

Mishra, T., Parhi, M., & Diebolt, C. (2008). Human capital accumulation and spatial TFP interdependence. *Historical Social Research/Historische Sozialforschung*, 346-358.

Nadiri, M. I. (1970). Some approaches to the theory and measurement of total factor productivity: a survey. *Journal of economic literature, 8*(4), 1137-1177.

Noah, A., & Ichoku, H. E. (2015). Total factor productivity dynamics in Sub-Saharan Africa: Malmquist index approach. *International Business and Management*, *10*(3), 54-73.

Rolf, F. (1988). *Fundamentals of Production Theory: Lecture Notes in Economics and Mathmetical System,* . Heidelberg: Springer.

Rolf, F., Shawna, G., Mary, N., & Zhongyang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *The American Economic Review*, 66-83.

Shephard, R. W. (1970). Theory of Cost and Production Functions Princeton University Press. *Princeton, New Jersey*.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics, 70*(1), 65-94.

Subramanian, M. (1992). Productivity growth in cotton textile industry in Tamil Nadu. *Indian Journal of Industrial Relations*, 383-395.

Vikram, N., & Ashok, D. (1993). A new database on physical capital stock: sources, methodology and results. *Revista de análisis económico, 8*(1), 37-59.

Wei, Z., & Hao, R. (2011). The role of human capital in China's total factor productivity growth: A cross-Province analysis. *The Developing Economies, 49*(1), 1-35.