ISSN 2664-3995 (Print) & ISSN 2664-6757 (Online)
South Asian Research Journal of Business and Management
Abbreviated Key Title: South Asian Res J Bus Manag

| Volume-3 | Issue-4 | July-Aug -2021 | DOI: 10.36346/sarjbm.2021.v03i04.001

Review Article

Malmquist Indexes of Productivity Change in the East Asian Countries

Dr. Fatma Abdelkaoui[1*], Dr. Mariem Bouzidi[1]
[1]Assistant Professor at Mediterranean School of Business, South Mediterranean University, CEDIMES, Tunis, Tunisia

***Corresponding Author**
Dr. Fatma Abdelkaoui

Article History
Received: 13.06.2021
Accepted: 19.07.2021
Published: 25.07.2021

Abstract: The basic goal of this piece of research is to investigate the extent and nature of productivity growth in East Asian countries using the nonparametric frontier techniques. One major step has consisted in decomposing the total factor productivity into technical efficiency change and technological change. In so doing, we have used the output-oriented Malmquist productivity index method for 8 Asian economies over the period spanning 1990–2019. The results obtained indicate that total factor productivity has witnessed an average growth of 0.6% percent over the said period. The research done has revealed that the productivity growth which has been identified is attributed to the improvements carried in the technology (or frontier-shift) rather than any improvements or changes brought about in the efficiency and its components.

Keywords: data envelopment analysis method; productivity index of Malmquist; East Asian, technical change, efficiency change, Total factors productivity.
***JEL Classification** : C14; C61; D24; O14; O47*.

1.1 INTRODUCTION AND LITERATURE REVIEW

Given the principal role of the productivity growth in the economic literatures and due to the limitation of authoritative data on quantities and prices (Mohamed and Afza, 2008), the economic scholars usually calculate the productivity index to estimate productivity change instead of estimating directly the technology and the shifts in technology (Fare and Grosskopf, 1992).

Focusing on this practice, we, in our analysis, will apply the “Malmquist DEA methods” to a panel data in order to measure the indices of the “total factor productivity change,” the “technological change,” the “technical efficiency change” and finally the “scale efficiency change.” Practically, this idea was discussed for the first time in more detail in the study carried out by Fare et al., (1994). In their study, the latter showed that the index can directly provide an estimate using a non-parametric technique like “Data Envelopment Analysis (DEA).” Also, they developed the decomposition of the “Malmquist Index” to two mutual, exhaustive and exclusive components as “technical change.” Later, many researchers extended this decomposition to provide more detailed analysis of the “Malmquist index” with many new approaches in order to understand and estimate especially the “scale efficiency” and “technical change” (Färe, Grifell-Tatjé, Grosskopf and Lovell, 1997), Balk (2001), Lovell (2003), and Ray (2003-2005).

Similarly, Coelli (1996) investigated the “Malmquist productivity index (MPI)” and reached the conclusion that this index actually measures the productivity change with the time variations and can be decomposed into two changes: in efficiency and technology and that with the so-called previous method the DEA “Data Envelopment Analysis” as a non-parametric approach.

In our paper, we will follow the approach adopted by Coelli (1996) and will use the software developed by the author because it has the advantage of breaking the technical efficiency into two parts automatically: as “pure technical change” and as “scale efficiencies,” in addition to the two other compositions--the technology change and total factor productivity change. There are two basic reasons for choosing to study this particular index: first, there has been little work done at the macroeconomic level on the real contribution of technology to enhancing the productivity by using this index; and second, it is because the Malmquist index offers a better understanding of the real contribution of technology to the productivity growth.

Drawing on Mohamed and Afza (2008) and sharing some of the evidence provided in the study by Castillo, Salem and Guasch (2012), we will in this part expose the contribution of technology to the productivity growth of the chosen countries, i.e., the “seven highly rapid performing economies” as defined by Paige, which are Thailand, Japan, Singapore, South Korea, Malaysia, Indonesia, Hong Kong, to which he added China as an economic miracle from 1990 to 2019.

At this level of our discussion, we will try to test the hypothesis of Estimating the source of the productivity growth to see whether this growth comes via the concept of improvement in the utilization of existing resources (“catching-up”) or through an outward shift in the production frontier as technology using the Malmquist index decomposing.

1.2 The model specifications

As pointed by Mahmood and Talat Afza (2008), the Malmquist index offers a measurement of the productivity changes over the time “t” where t = 0,1..T.

Based on the specifications (cf. APPENDIX A.1), the Malmquist index level illustrates generally how the productivity is growing. If the index value is greater than 1 (MPI>1) this implies increasing and growth in productivity, on the other hand, if the values less that s (MPI<1) this indicates a deterioration of the productivity.

However, it is essential to study at the same time the efficiency and technical change components, because according to the reference studies, it is somehow impossible for us to deduce a comprehensive conclusion about any changes in the productivity growth without taking them into consideration (Ammara and Talat, 2008). Therefore, we have adopted the method prescribed by Fare et al., (1989, 1992) of rewriting the productivity index, which has allowed us to distinguish between changes, both technical and efficiency; thus, the Malmquist index will be defined as follows:

$$\mathbf{M_0}\,(\mathbf{X^{t+1}}, \mathbf{Y^{t+1}}, \mathbf{X^t}, \mathbf{Y^t}) = \frac{D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^t, Y^t)} * \left[\left\{\frac{D_0^t(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^{t+1}, Y^{t+1})}\right\}\left\{\frac{D_0^t(X^t, Y^t)}{D_0^{t+1}(X^t, Y^t)}\right\}\right]^{\frac{1}{2}}$$

= Efficiency change * Technical change

Where:

Efficiency change = $\frac{D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^t, Y^t)}$

This index measures the general change in the efficiency, also it is an instrument to measure the distance between the “maximum” possible production level and the detected production between two separate periods of time “t” and “t+1”.

Technical change = $\left[\left\{\frac{D_0^t(X^{t+1}, Y^{t+1})}{D_0^{t+1}(X^{t+1}, Y^{t+1})}\right\}\left\{\frac{D_0^t(X^t, Y^t)}{D_0^{t+1}(X^t, Y^t)}\right\}\right]^{\frac{1}{2}}$

The value for technical change is determined as a geometric means of two ratios that measure the shift in the technology production. This ratio indicates the “relative change” in the technologies input between two time period “t” and “t+1”, for instance “change in x_t and x t+1”.

According to the previous studies, to make the study more appealing, especially when our sample countries (East Asian) all share the characteristic of having shown exceptional growth over the past few decades (Day et al (2005); Ammara and Talat (2012)), It is therefore very interesting to make comparisons on the basis of efficiency changes and technical changes in the “Malmquist index”.

Although, the Malmquist index can be used for any type of returns to scale, however, for the purpose of analysis we going to use the index under a condition of a constant return scale technology production and follow the suggestion of Fare et al., (1994).

1.3 Data Description

The dataset we will be using for conducting our research covers the economies of China, South Korea, Thailand, Malaysia Japan, Hong Kong, Singapore and Indonesia over the 1990-2019 period. For evident reasons, these nations have achieved what is commonly described as “the East Asian Miracles” that have marked the history of the region from the 1960’s onwards. This fact was corroborated by the World bank reports in 1993, not only because these nations owe this achievement by crediting it to individuals, adopting separate trajectories put together, in the growth process, but also due to a striking feature of East Asian growth in the recent years, which consists of the increasing role of China's and Hong Kong's economies in the regional economic activity and the significant shift in the pattern of East Asia's trade (Day et al., 2005). China's economic rise has increasingly affected the East Asian growth dynamics; this explains why we have, therefore, included China as part of our sample. Taiwan has been left out for lack of data availability.

In order to calculate the Malmquist index, we have used data that are composed of four variables as they have been proposed by Castillo, Salem and Guasch (2012). The inputs of the Malmquist productivity index are Stock of capital as "K", Labor as "L" and Energy as "E", and the Gross value added as "Y" which is considered as the output.

The data related to these variables are generally available in the World Bank's World Development Indicators, the International Labor Organization, OECD data, and BP plc. However, we have used proxies for the most of these four indicators to calculate the Malmquist productivity index.

First, for the Gross value added we used the GDP with constant prices as proxy, due particularly to the absence of reliable figures for this variable. Second, for the Stock of capital, we have used as proxy the Gross fixed capital formation (formerly gross domestic fixed investment). Third, for Labor, we have also used a proxy, the total labor force to be estimated.

Furthermore, as mentioned above we are going to use three inputs instead of two to calculate "the Malmquist productivity index" following the suggestion of Castillo, Salem and Guasch (2012), the added variable is the Energy, and we used the Primary energy: Consumption per capita to referee to it.

In the below Table-1, we present the means and standard deviations for the dataset used to measure the Malmquist index for each country in the sample between the period of 1990 and 2012.

Table 1: Descriptive statistics of variables by country: The means and standard deviations (1990--2019)

Country	**Y**	**K**	**L**	**E**
Japan (JPN)	5.35E+12	1.45E+12	6.67E+07	3.87E+03
	(3.44E+11)	(1.19E+11)	(9.79E+05)	(1.90E+02)
Hong Kong SAR, China (HKG)	1.67E+11	4.13E+10	3.38E+06	1.90E+03
	(4.31E+10)	(8.32E+09)	(2.92E+05)	(2.18E+02)
Malaysia (MYS)	1.75E+11	4.43E+10	9.86E+06	2.14E+03
	(5.92E+10)	(1.22E+10)	(1.85E+06)	(4.68E+02)
Korea, Rep. (KOR)	7.53E+11	2.57E+11	2.30E+07	3.88E+03
	(2.50E+11)	(5.89E+10)	(2.01E+06)	(8.98E+02)
Singapore (SGPO	1.48E+11	4.05E+10	2.14E+06	5.15E+03
	(5.78E+10)	(1.42E+10)	(4.35E+05)	(7.78E+02)
Indonesia (IDN)	5.27E+11	1.58E+11	9.87E+07	7.24E+02
	(1.51E+11)	(5.18E+10)	(1.44E+07)	(9.69E+01)
Thailand (THA)	2.47E+11	7.43E+10	3.55E+07	1.28E+03
	(6.54E+10)	(1.82E+10)	(3.29E+06)	(3.33E+02)
China (CHN)	3.06E+12	1.09E+12	7.30E+08	1.20E+03
	(1.94E+12)	(9.85E+11)	(4.73E+07)	(4.68E+02)
Note: Numbers in parentheses indicate standard deviations. Y: Gross value added, K: Capital, L: Labor, E: Land				
Source: Author's contributions via Multi data sources				

1.4 Empirical Test and Results

1.4.1 The Malmquist indexes

Table 2 shows an annual total factor productivity growth of 0.6%; with technical change (or frontier-shift) contributing 1 % per year and decline in efficiency change of 0.4%. We can say that during our study period, the increase of productivity is a result majorly of technological progress.

Table 2: Annual Means Total Factor Productivity Change TFP, Technical Change, Efficiency, Pure and scale Technical Change (1990-2019)

Year*	TFPCH	TECHCH	EFFCH	Pech	Sech
2	0.926	0.865	1.017	0.964	1.110
3	1.041	1.043	0.998	0.998	0.999
4	1.001	1.317	0.761	0.958	0.794
5	0.905	0.983	0.921	1.005	0.917
6	0.916	0.666	1.375	1.073	1.281
7	1.014	1.027	0.987	0.976	1.011
8	1.019	1.048	0.972	0.995	0.977
9	1.131	0.995	1.137	1.036	1.097
10	1.012	1.042	0.971	1.000	0.971
11	1.158	1.176	0.984	1.000	0.984
12	1.030	1.082	0.952	0.956	0.995
13	1.013	1.041	0.972	0.973	0.999
14	1.007	0.979	1.028	1.000	1.028
15	1.027	1.166	0.881	0.998	0.883
16	1.030	1.035	0.995	1.000	0.995
17	0.921	0.957	0.962	1.000	0.962
18	1.026	1.023	1.003	1.013	0.990
19	0.974	0.984	0.990	1.001	0.989
20	1.018	0.887	1.147	1.021	1.124
21	1.017	1.113	0.898	0.970	0.926
22	1.031	1.043	0.988	1.000	0.988
23	0.990	0.994	0.996	1.003	0.993
24	0.974	0.952	1.023	0.960	1.065
25	1.009	1.003	1.007	1.000	1.007
26	1.016	1.017	0.999	1.000	0.999
27	0.997	1.015	0.982	1.000	0.982
28	1.019	0.995	1.024	0.983	1.042
29	0.976	0.973	1.003	1.018	0.985
Mean	**1.006**	**1.010**	**0.996**	**0.996**	**1.000**
Note * that 1990 refers to the change between 1990 and 1991, etc..					
Source: Author's calculation via DEAP					

Table 3 below presents a brief description of the average performance of each country over the period 1990-2019 in each index deduced, using the Malmquist index decomposition.

Table-3: Individual performances over time

Country	TFPCH	TECHCH	EFFCH	Pech	Sech
Japan (JPN)	1.016	1.016	1.000	1.000	1.000
Hong Kong (HKG)	1.004	1.009	0.995	1.000	0.995
Malaysia (MYS)	1.005	1.011	0.995	1.000	0.995
Korea Rep. (KOR)	0.986	1.017	0.969	0.970	0.999
Singapore (SGP)	1.013	1.008	1.004	1.000	1.004
Indonesia (IDN)	1.006	1.012	0.995	1.000	0.995
Thailand (THA)	1.025	1.013	1.012	1.000	1.012
China (CHN)	0.990	0.990	1.000	1.000	1.000
Mean	**1.006**	**1.010**	**0.996**	**0.996**	**1.000**
Note: number are Average Annual Changes					
Source: Author's calculation via DEAP					

As mentioned previously, if the value of the Malmquist index or any of its components is higher than unity, this denotes an increase in performance, whereas values less than unity denote deterioration in the relevant performance. Thus, the last line of table 3 above shows that for the whole sample on average and the productivity improved perceptible over the twenty-nine years analyzed; the growth in Total Factor Productivity (TFPCH) or as given by the Malmquist productivity index was 0.6[1] percent for our entire sample.

Also, the results of table 3 show that the major contribution to productivity growth in the East Asian countries comes from technological progress which is known also the technical change (TECHCH) which improved by 1 percent. However, the Efficiency Change Indices (EFFCH) are relatively low to the technical change, suggesting that this component does not contribute much to productivity growth, also, it is two component one of theme is completely neutral the Scale of efficiency change and other one see's some sort of deterioration in it is value by 0.4%. Hence, these results are in line with the several referenced studies by Mahmood and Afza (2008) and Castillo, Salem and Guasch (2012), Fare et al., (1994) for their sample of seventeen OECD countries for the time period 1979- 1988.

Finally, Figure 1 shows the indices of Total Factor Productivity (TFPCH), technological progress or known as the technical change (TECHCH) and the Efficiency Change (EFFCH) by country.

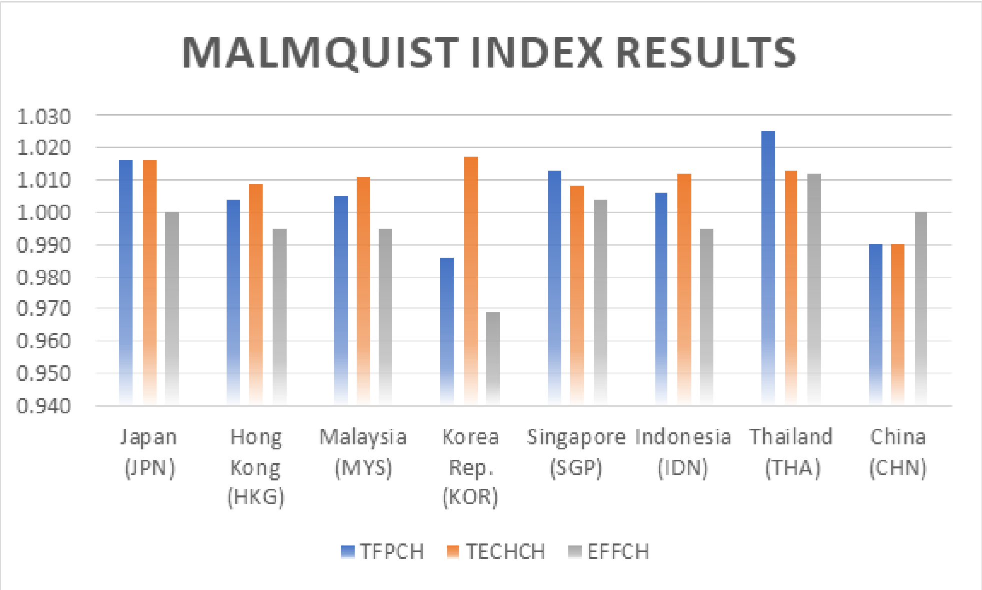

Figure 1: Malmquist index Results
Source : Author's contribution via Excel

1.4.1.1 The Total Factor Productivity (TFP):

Moving on to the country-by-country results, based on results in table 3 above, we note that Thailand has the highest Total Factor Productivity change among the eight economies studied, at 2.5% per annum on average, most of which can be attributed to improvements in technological progress, followed by Japan which has seen an increase in its Total Factor Productivity change by 1.6% per annum on average. And in the third rank we find the Singapore which also has an important increase rate in her Total Factor Productivity with 1.3% per annum on average.

However, the three other sampled economies—Indonesia, Malaysia and Hong Kong-- actually display positive values for an increase in the Total Factor Productivity but are relative albeit lower, as compared to Thailand and Japan, 0.6%, 0.5%, and 0.4% respectively. On the other hand, South Korea exhibits a decrease in Total Factor Productivity of 1.4 %, which is even lower than China where Total Factor Productivity fell by 1%.

For the purpose of meaningful and in-depth analysis, we have mapped the trends of Total factor productivity change over twenty-nine years for all countries in our simple. By examining figure 2 below relating to the distribution of the productivity factors in East Asia area, the map illustrates the level of this variable by country in the East Asian area over the observed period and it shows that the highest level was in Thailand (red color) and the country with the major decrease is South Korea (white color).

[1]Subtracting 1 from the number reported in the table gives average increase or decrease per year for the relevant time period and relevant performance measure.

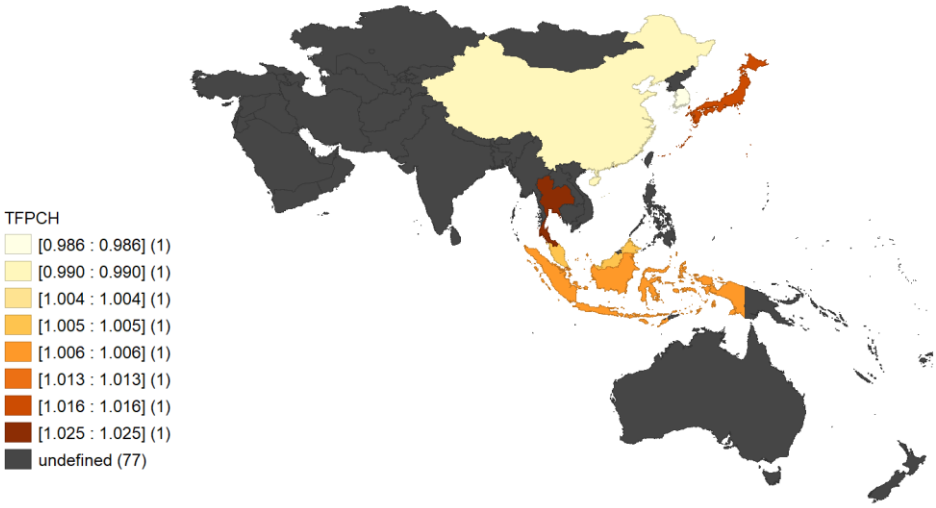

Figure 2: Total Factor Productivity level in the East Asian zone
Source : Author's contribution via Geo.Da output

1.4.1.2 The Efficiency Change (EFF)

According to table 3 above, the result can be grouped in three sets of countries: one for the countries that have witnessed an increase in efficiency change and a second group for the countries that have not seen such an increase; they have instead seen a deterioration and the third group is for those that neither increase or decrease.

For the first group, the Thai economy has had the highest value for Efficiency change equal to 1.2% per annum on average; also, this group includes Singapore which has registered an increase in its efficiency change but not as much as by the other above-mentioned country, by 0.4%.

On the other hand, in light of the result in table 3 above, Hong Kong, Malaysia, Indonesia and south Korea have had the lowest level of Efficiency change which represents the Third group of countries. Hong Kong, Malaysia and Indonesia exhibits a decrease in Efficiency change of 0.5%, which is even better South Korea where Total Factor Productivity fell by 3.1% over the same period of time, this can be seen as a sign of no catching up.

According to Figure 3, a map that represents the level of the efficiency change in the east Asian zone over the twenty-nine years, throughout the sampled period we can see that Japan and China kept an efficiency index of 1 and did not register any improvements in efficiency (orange color).

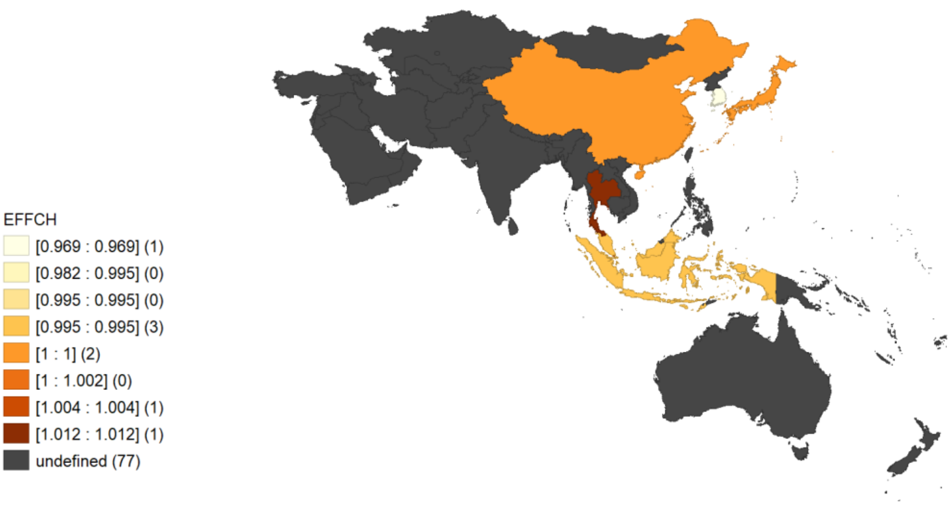

Figure 3: Efficiency change level in the East Asian zone
Source: Author's contribution via Geo.Da output

1.4.1.3 The Technical Change (Tech)

Based on the results in Table-3 above, we can note that for this indicator South Korea, Japan, Thailand, Indonesia and Malaysia have registered the highest Technical change among the other eight countries of the sample with an increase of between 1.7 and 1.1% per annum on average. For their part, Hong Kong and Singapore have seen an increase but is respectively lower than the above-mentioned economies by 0.9% and 0.8%.

Besides, yet one country in this analyzed sample has witnessed a decrease in Technical change --China—where the indicator fell by 1% during this period. All in all, China has been incapable to catch up with the best practice nations.

Additionally, the Map below (figure 4) illustrates the level of technical change growth over the observed period ,and the highest level is allocated in South Korea (red color) and it is important to note that technical change in almost all countries follows similar patterns as Total Factor Productivity growth as a whole except South Korea. This strengthens our earlier claim that Total Factor Productivity growth has been caused primarily by technical change, which is technology progress rather than improvements in efficiency.

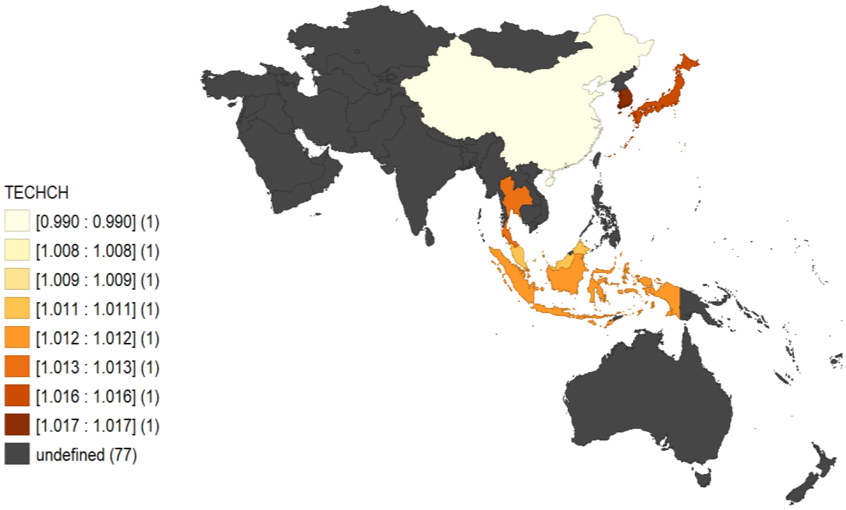

Figure 4: Technical change level in the East Asian zone
Source: Author's contribution via Geo.Da output

1.5 CONCLUSION

In light of the high rapid growth of the East Asian economies, combined with the observed evidence of cross-country convergence in per capita incomes and output, there has been growing focus on the role of productivity growth in influencing overall growth patterns of the developed economies. Given the lack of research on the dynamics of productivity growth in East Asia, we have used in this paper the Malmquist productivity index to calculate the Total Factor Productivity growth in eight East Asian countries, namely Japan, China, Indonesia, Malaysia, South Korea, Hong Kong, Singapore and Thailand over the period spanning 1990-2019.

Under the assumption of constant returns to scale production technology, the Malmquist productivity index was used to construct the best practice frontier and to separate the technical and efficiency components of Total Factor Productivity growth.

For most of the sample on average, productivity increased noticeably over the twenty-nine years except for China and South Korea. This growth was largely due to technological progress rather than to the improvements in efficiency. Therefore, to answer our hypothesis in, we have been able to deduce that improvement in the efficient utilization of resources was slower compared to the technological evolution, as indicated by the larger value of the technical change component of the Malmquist index except for China and specially the case of South Korea the negative impact of the Efficiency was bigger than the technological improvement which led to deterioration in the productivity.

After probing and analyzing the Total Factor Productivity growth and its possible determinants for the case of East Asia, a crucial question arose: Shall we assess the government policy in any country's case, or suggest a more suitable policy for the State to still implement?

We have adopted the answer proposed by Felipe (1997), as he considers that the results of the growth accounting practices or even the estimation of productivity values and its composition do not give us the permission to make a judgment on the Countries policy or/and any sort of government intervention. The author considers that performing a Total Factor Productivity growth estimation specially with the intention of decomposing overall economic growth is not a main tool to explain the major causes of growth.

Therefore, all that we can recommend in light of the results we have reached throughout our research is a need to emphasize that in the catch-up phase of development for low and medium-developed countries governments should have a GDP growth-oriented focus rather than worrying about their level of Total Factor Productivity growth.

APPENDIX A.1

As shown by Mahmood and Talat Afza (2008), the production technology is referred to as $\boldsymbol{S^t}$and it is defined such that inputs referred to as $\boldsymbol{X^t} \in \boldsymbol{R^N_+}$ into output referred to as $\boldsymbol{Y^t} \in \boldsymbol{R^M_+}$.

Thus, the production function can be writhed as:

$$\boldsymbol{S^t} = \{(X^t, Y^t); X^t \; produces \; Y^t\}$$

While, the Malmquist productivity index is generally defined as an "input-based" index which leads to determines the effect changes in inputs have on the productivity, however this index can be also used as an "output-oriented" index (Mahmood and Talat (2008). These two approaches have been proposed by two different groups of other, the first approach has been setting up by Fare and Grasskopf (1992), while the second approach has been proposed by Fare et al., (1994).

As for our study and since we are following the methodology of Mahmood and Afza (2008), we are also going to use the second approach proposed by Fare et al., (1989, 1992, 1994), the "output-oriented productivity index". The author explained this decision by two reasons.

Firstly, this index captures the relative changes over the time, secondly, this index uses the ratio of distance from the productive frontier during successive periods of time. Consequently, Shephard (1970), and later Fare (1988) defined the distance function as:

$$\boldsymbol{D^t_0}(\boldsymbol{X^t}, \boldsymbol{Y^t}) = inf\{\theta: (X^t, Y^t/\theta) \in S^t\}$$

This above function is called by the above authors as "the reciprocal of the maximum" relative expansion of an output from certain combinations of inputs

When:

- $D^t_0\,(X^t, Y^t) = 1$, this suggest that (X^t, Y^t) located on the boundary of the production frontier, therefore, the output is considered as "technically efficient"
- However, when $D^t_0\,(X^t, Y^t) \leq 1$, in this case the output is considered as technically inefficient

Deaton (1979) has found a similar result using the input distance function, and this later was defined as follow, however, under one condition of constant returns to sale:

$$\boldsymbol{D^t_i}\,(\boldsymbol{X^t}, \boldsymbol{Y^t}) = sup\{\lambda: (X^t/\lambda, Y^t) \in S^t\}$$

According to a reference study, if we are in the case of under constant return to scale production technology, the "Maximum" achievable output, it can be only attained when the productivity average "(Y/X)" is "maximized". This latter is defined as "the benchmark country with the highest level of production" (Ammara and Talat (2008)). However, if the rest of the countries are in the situation, of decreasing this indicate "catching up" to the frontier of maximum productivity, which defined as technical efficiency. This "maximal level" is determined using especial "programming techniques" that are clarified later on.

As we mentioned above, to explain the trends growth among the periods of time, the Malmquist index of productivity growth gives a distance function in the same line with time variation. This function is defined as:

$$\boldsymbol{D^t_0}(\boldsymbol{X^{t+1}}, \boldsymbol{Y^{t+1}}) = inf\{\theta: (X^{t+1}, Y^{t+1}/\theta) \in S^{\text{t}}\}$$

Where:

$D^t_0\,(X^{t+1}, Y^{t+1})$is the measurement of the "maximal" relative change in Outputs to guarantee that (X^{t+1}, Y^{t+1}) is attainable, However, at the "t" time period (X^{t+1}, Y^{t+1}) is unfeasible (Fare et al. (1994)).

Thus, this "Maximal" relative change in output is mandatory to ensure the attainability of (X^t, Y^t) at T+1 is created by $D^{t+1}_i\,(X^t, Y^t)$.

So, based on the above results and according to Fare et al. (1994) the productivity index function is defined in period "t" as:

$$\boldsymbol{M^t} = \frac{D_0^t\,(X^{t+1},Y^{t+1})}{D_0^t\,(X^t,Y^t)}$$

Correspondingly, the "Malmquist index" is defined for period "T+1" as follows:

$$\boldsymbol{M^{t+1}} = \frac{D_0^{t+1}\,(X^{t+1},Y^{t+1})}{D_0^{t+1}\,(X^t,Y^t)}$$

Keep in line with common practice and to evade setting arbitrary standard, we follow the definition of the "Malmquist productivity index" proposed by Caves et al., (1982), as a geometric mean of two Malmquist indices:

$$\mathbf{M_0}\,(\mathbf{X^{t+1}},\mathbf{Y^{t+1}},\mathbf{X^t},\mathbf{Y^t}) = \left[\left\{\frac{D_0^t(X^{t+1},Y^{t+1})}{D_0^t(X^t,Y^t)}\right\}\left\{\frac{D_0^{t+1}\,(X^{t+1},Y^{t+1})}{D_0^{t+1}\,(X^t,Y^t)}\right\}\right]^{\frac{1}{2}}$$

This technique according to Fare et al., (1994), this form is typical to "Fisher Ideal Indices", since this technique is using ratios of a two distance functions "year on year" to evaluate the productivity growth. Due to this technique we became not only able to evade setting arbitrary standard, but also, we become able to use two a parted time period of the distance functions to notice how the "technological change" contribution in the productivity growth.

REFERENCES

- Abdelkaoui F., & Bouzidi, M. (2018). Technology Transfer: Role of FDI and Trade Case of Tunisia. International Journal of Innovative Research and Development, 7(11).
- Abdelkaoui, F. (2017). Innovation and Economic Growth Case Study China after the WTO. International Journal of Social Science & Economic Research, 2(7), 3972-980.
- Agola, N. O. (2016). Technology Transfer and Economic Growth in Sub-Sahara African Countries: Lessons from East Asia. Berlin Heidelberg: Springer-Verlag.
- Coelli, T. (2018, January 23). A Data Envelopment Analysis (Computer) Program. Https://economics.uq.edu.au/cepa/software
- Damijan, J. P., Knell, M., Majcen, B., & Rojec, M. (2003). The role of FDI, R&D accumulation and trade in transferring technology to transition countries: evidence from firm panel data for eight transition countries. Economic systems, 27(2), 189-204.
- Draper, N. R. (1998). Applied regression analysis bibliography update 1994-97. Communications in Statistics-Theory and Methods, 27(10), 2581-2623.
- Fadhil, M. A., & Almsafir, M. K. (2015). The role of FDI inflows in economic growth in Malaysia (time series: 1975-2010). Procedia economics and finance, 23, 1558-1566.
- Fatma, A. (2018). Overview of the Japanese Innovation Systems vs. The American Innovation System. Journal of Global Economics, 6(4).
- Henry, M., Kneller, R., & Milner, C. (2009). Trade, technology transfer and national efficiency in developing countries. European Economic Review, 53(2), 237-254.
- Hoekman, B. M., Maskus, K. E., & Saggi, K. (2005). Transfer of technology to developing countries: Unilateral and multilateral policy options. World development, 33(10), 1587-1602.
- Inada, K. I. (1969). Fixed Factor Coefficients and Harrod-Neutral Technical Progress. The Review of Economic Studies, 36(1), 89–97.
- Jafarieh, H. (2001). Technology Transfer to Developing Countries: A Quantitative Approach. Ph.D., University of Salford.
- James, D. D. (1996). Technology and Third-World Development: A Twenty- To Thirty-Year Retrospective. In The Institutional Economics of the International Economy, 143–59.
- Tae-Hyung, K. (1999). International Trade, Technology Transfer, Growth, and Welfare in a Schumpeterian Model of Endogenous Growth. Review of International Economics, 7(1), 37-49.
- Kim, Y. (2009). Choosing between International Technology Licensing Partners: An Empirical Analysis of U.S. Biotechnology Firms. Journal of Engineering and Technology Management, 26(1), 57–72.
- Krüger, J. J. (2003). The global trends of total factor productivity: evidence from the nonparametric Malmquist index approach. Oxford Economic Papers, 55(2), 265-286.
- Lemoine, F., & Ünal-Kesenci, D. (2004). Assembly trade and technology transfer: the case of China. World development, 32(5), 829-850.
- Lopez, R. A. (2008). Foreign technology licensing, productivity, and spillovers. World Development, 36(4), 560-574.
- Mahmood, A., & Afza, T. (2008). Total factor productivity growth in east Asia: A two pronged approach. European Journal of Economics, Finance and Administrative Sciences, 14(14), 93-111.
- Mastromarco, C., & Ghosh, S. (2009). Foreign Capital, Human Capital, and Efficiency: A Stochastic Frontier

Analysis for Developing Countries. World Development, 37(2), 489–502.

- Maudos, J., Pastor, J. M., & Serrano, L. (1999). Total factor productivity measurement and human capital in OECD countries. Economics letters, 63(1), 39-44.
- Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. European Economic Review, 76, 168-187.
- Osabutey, E. L., & Jin, Z. (2016). Factors influencing technology and knowledge transfer: Configurational recipes for Sub-Saharan Africa. Journal of Business Research, 69(11), 5390-5395.
- Page, J. M. (1994). The East Asian miracle: an introduction. World Development, 22(4), 615-625.
- Park, H., Yoon, J., & Kim, K. (2013). Using function-based patent analysis to identify potential application areas of technology for technology transfer. Expert Systems with Applications, 40(13), 5260-5265.
- Popović, M., Savić, G., Kuzmanović, M., & Martić, M. (2020). Using Data Envelopment Analysis and Multi-Criteria Decision-Making Methods to Evaluate Teacher Performance in Higher Education. Symmetry, 12(4), 563.
- Fare, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. American economic review, 84(1), 66-83.
- Saggi, K. (2002). Trade, foreign direct investment, and international technology transfer: A survey. The World Bank Research Observer, 17(2), 191-235.
- Tanaka, H., Iwaisako, T., & Futagami, K. (2007). Dynamic analysis of innovation and international transfer of technology through licensing. Journal of International Economics, 73(1), 189-212.
- Zrelli, H., Alsharif, A. H., & Tlili, I. (2020). Malmquist Indexes of Productivity Change in Tunisian Manufacturing Industries. Sustainability, 12(4), 1367.
- Dataset, The data that support the findings of this study are openly available in the World Bank's World Development Indicators, the International Labor Organization, OECD data, and BP plc at https://data.worldbank.org/, https://www.ilo.org/global/statistics-and-databases/lang--en/index.htm, https://stats.oecd.org/ , https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html

CITATION: Fatma Abdelkaoui & Mariem Bouzidi (2021). Malmquist Indexes of Productivity Change in the East Asian Countries. *South Asian Res J Bus Manag, 3*(4), 63-72.