İzmir İktisat Dergisi
İzmir Journal of Economics

ISSN:1308-8173 **E-ISSN:** 1308-8505 **YIL:** 2021 **Cilt:** 36 **Sayı:** 3 **Sayfa:** 589-600
Geliş Tarihi: 26.07.2020 **Kabul Tarihi:** 18.08.2021 **Online Yayın:** 02.09.2021 **Doi:** 10.24988/ije.202136306
ÖZGÜN ARAŞTIRMA

İran Ekonomisindeki Sektörlerin Toplam Faktör Verimliliğinin Ölçülmesi: Malmquist Endeks Analizi

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Özet

Verimliliğin, ülkelerin büyümesinde ve rekabet gücünün artmasında önemli ve etkili bir rolü vardır. Bu çalışmada, Malmquist verimlilik endeksi kullanılarak, 2012-2017 yılları arasında İran ekonomisinin üç önemli sektöründe (tarım, sanayi ve hizmetler) üretim faktörlerinin toplam faktör verimlilik büyüme trendi incelenmiştir. Sonuçlar, çalışma döneminde, sanayi sektörü dışındaki tüm ekonomik sektörlerde toplam faktör verimlilik değişimlerinin teknolojik değişikliklere bağlı olduğunu ve sanayi sektöründe, hem teknik etkinlik hem de teknolojik değişikliklerin bu sektörün verimliliğini etkilediğini göstermiştir. Buna göre, tarım sektöründeki toplam faktör verimliliğinin büyümesi %1,5 azalmayla negatif bir seyir izlerken, sanayi ve hizmetler sektörlerinde sırasıyla %7 ve %11,3 artışla pozitif bir eğilim izlemiştir.

Anahtar kelimeler: *İktisadi sektörler, Etkinlik, Verimlilik, Malmquist Endeksi, Teknolojik Değişme, İran.*
Jel Kodu: *D21, D24, F43, L23.*

Measurement of Total Factor Productivity in Iranian Economic Sectors: Malmquist Index Analysis

Abstract

Productivity has an important and effective role in the growth of production and increasing the competitiveness of countries. In this study, using the Malmquist productivity index, the total productivity growth trend of production factors in three important sectors of the Iranian economy (agriculture, industry and services) during the years 2012-2017 have been discussed. The results showed that during the study period total factors productivity changes in all economic sectors except the industrial sector are due to technological changes, and in the industrial sector, both technical efficiency and technological changes have affected the productivity of this sector. Therefore, the growth of total factor productivity in the agricultural sector has had a negative trend with a decrease of 1.5% and in industry and services has had a positive trend with 7% and 11.3%, respectively.

Keywords: *Economic Sectors, Efficiency, Prdocuctivity, Malmquist Index, Technological Change, Iran.*
Jel Codes: *D21, D24, F43, L23*

1. INTRODUCTION

Today, the existence of commercial competition and the rapid development of technology to keep the market on the one hand and the scarcity of resources on the other, have clearly directed everyone's attention to productivity. In the developing world, increasing productivity is one of the national priorities of any country because the continuation of the economic life of countries, economic growth and improvement of the living standards of all individuals in the society depend on improving productivity. When the countries that have reached important economic growth rates in recent years are analyzed, it is seen that the economic growth of these countries has emerged through more productivity, and the effect of new investments in the economic growth of these countries are smaller than the increase in productivity (Emamimeibodi, 2000, as cited in Atrkar Roshan et al, 2015: 98). In other words, increasing productivity is seen today as the best

ATIF ÖNERİSİ (APA): Hajıhassaniasl, S., (2021). İran Ekonomisindeki Sektörlerin Toplam Faktör Verimliliğinin Ölçülmesi: Malmquist Endeks Analizi. İzmir İktisat Dergisi, 36(3), 589-600. Doi: 10.24988/ije.202136306

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and most effective way to achieve economic growth due to scarcity of production resources. Productivity has an important and effective role in production growth and increasing competitiveness. About half a century after the Second World War, Germany and Japan are the most developed countries that have resulted from increased productivity (Dashti Moghaddam, 1997: 15).

Production factors are always needed for production. Increasing production can be achieved in two ways; The first is to increase production factors and the second is to adopt appropriate management on resources and to use them better by using newer methods in their combination (EmamiMeibodi et al., 2015: 60). In classical growth theories, the physical accumulation of production factors has been emphasized. According to Solow (1957), sustainable growth cannot be achieved through physical accumulation due to the decreasing scale in production factors. To achieve long-run growth, the productivity of production factors needs to be increased. According to Solow, firms can increase their efficiency, lower their costs and thus increase their competitiveness (IsaZadeh & Soofi Majidpour, 2017: 30).

One of the ways of optimization of production factors is to ensure efficiency and productivity. Efficiency and productivity are the criteria for continuous improvement of the existing conditions. Efficiency represents the relationship between outputs and inputs in the production process, which can be described at a glance, the ratio of the quantitative index of a particular output to the quantitative index of a particular input, or a combination of several inputs. Considering that all production factors are economically scarce, total factor productivity is not only an indicator that calculates the relative efficiency of an input set in the production of one or a series of products for different technological situations, but also, in real terms, it is a criterion for defining the correct and optimal use of production factors as well as the level of achieving predetermined targets (AmirTeymouri & Khalilian, 2010: 143).

Basically, the concept of total factor productivity has gained importance when organizations realize that long-term output growth cannot be achieved through continuous input growth due to resource scarcity (Jahangard et al, 2012: 52).

In Iran, due to the growing population and needs, and the unreliable oil revenues and limited resources available to meet these growing needs, the only remaining path is optimal allocation of production resources in different sectors of the country. In other words, by increasing the productivity level, the efficiency of the sectors can be increased, thus the amount of production activities and the production growth can be improved (AmirTeymouri & Khalilian, 2010: 144).

Considering the effective role of total factor productivity in economic growth and at the same time to ensure sustainable economic growth, this study examined the growth trend of total factor productivity in the most important sectors of the Iranian economy in the 2012-2017 period using the Malmquist productivity index.

2. THEORETICAL FRAMEWORK

Today, considering the scarcity of production factors (labor, capital and intermediate inputs), increasing efficiency and productivity is considered the best and most effective way to achieve economic growth. Total factor productivity, known as an important and key factor, affects economic growth due to the optimal combination of production resources, human knowledge and skills (human capital), information and communication technology, raw materials, energy and other unknown factors. This has led most countries around the world to pay much attention to increasing efficiency and productivity in their long-term development plans to achieve their growth targets. However, it is important to note that although the concepts of efficiency and productivity are closely related, they are different. Therefore, after defining the efficiency, productivity and issues related to it will be discussed.

2.1 Efficiency

Efficiency refers to the comparison between the actual quantity (value) of a product and its potential quantity that can be obtained by using a certain set of production inputs in a production process. In fact, efficiency indicates the amount of using potential production facilities. Using the Figure 1, the concepts of different types of efficiency, including technical efficiency, allocative efficiency and economic efficiency, can be easily defined and understood from Farrell's (1957) viewpoint. Farrell's model is a model that produces a single output using two inputs under the assumption of constant returns to the scale (CRS). The production curve for an economic unit whose distance function is on the boundary of the production facilities curve is represented by AA'.

In Figure 1, if the point P represents one of the firms, the technical efficiency of this firm, which indicates the extent of a firm's ability to maximize production according to specific factors of production, is defined as below:

$$TE = OR / OP \quad (1)$$

The technical efficiency of the company at point P is less than 1. It is clear that if the firm was on the SS curve, the ratio was 1 and therefore the firm would be fully efficient.

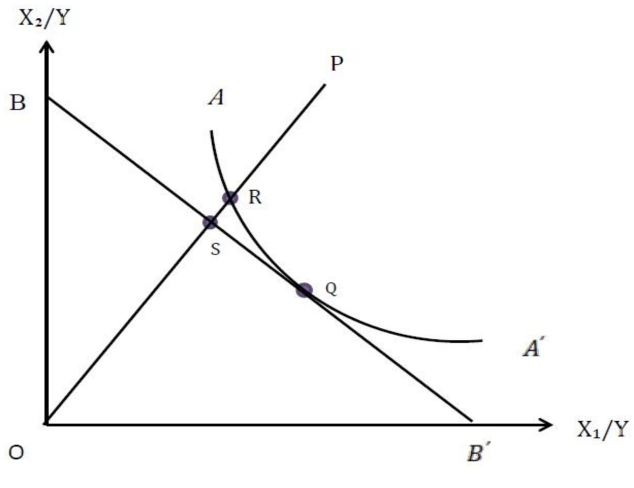

Figure 1: Description of the Farrell's Efficiencies Type

If price information is available and we consider a behavioral assumption such as cost minimization or profit maximization, then in such cases it can be measured allocative efficiency in addition to technical efficiency. Allocative efficiency in the selection of production factors requires the selection of a set of production factors that produce a certain level of product at the lowest cost (at given prices). In Figure 1, the prices of production factors are shown by the isocost BB'. The allocative efficiency (price efficiency) of the firm that produces in P can be defined as follows:

$$AE = OS / OR \quad (2)$$

If a firm is both technically efficient and allocative efficiency is provided, then the economic efficiency of that firm is provided. The economic efficiency is obtained from the multiplying of technical efficiency and allocative efficiency as follows (Emami Meibodi, 2000:105):

$$EE = TE \times AE = (OR / OP) \times (OS / OR) = OS / OP \quad (3)$$

Both parametric and non-parametric methods are used to measure efficiency. In parametric methods, the frontier function is considered as a special functional form such as Cobb-Douglas, Translog, and etc that is estimated by econometric methods. Since the frontier function is never available in practice, according to Farrell (1957) it is estimated by sample information. Parametric method based on mathematical methods and based on the distance of firm production from the efficiency frontier of production was able to introduce Farrell efficiency frontier as a non-parametric efficiency frontier. The origin of the nonparametric method (DEA) goes back to Farrell's (1957) study. He calculated the efficiency of the American agricultural sector in practice; However, due to problems in measuring the efficiency and limitations of his method, this method did not find much practical application. After Farrell, other researchers used the linear programming model to measure efficiency, but little attention was paid to these papers until in the 1970s on two continents of the world (the United States and Europe) simultaneous practical efficiency measurement in terms of Farrell's definition was made possible by Stochastic Frontier Analysis (SFA) and linear programming. The linear programming method, first introduced by Charnes, Cooper, and Rhodes (1978), was developed by integrating the Farrell method to include the characteristics of the production process with multiple inputs and multiple outputs (EmamiMeibodi et al. 2015: 67)

2.2 Productivity

Productivity indicates the performance of a production factor or the total production factors used in the production process of an output. In development economics texts, productivity is defined as the amount of output from a given amount of one or more inputs. This criterion reflects the use of resources and production factors at a point in time and includes the three effects of technology change, scale change and change in the performance of inputs use, ie moving towards the frontier production function from within. Hence, the change in productivity from one period to the next or the productivity gap between production units in a period of time indicates a change and difference in technical capacity and performance of the unit or economic sector in converting inputs into goods and services and in other words a change in the effectiveness of a set of inputs in the production of outputs. (Salami, 1997: 17). Productivity can be considered as relative efficiency, every point on the production (cost) frontier indicates the maximum efficiency, but this does not mean maximum productivity and only at a certain point of the production frontier, productivity is at its maximum. In other words, efficiency is part of productivity. In general, it can be said that although increasing efficiency leads to productivity growth, but technological improvement and economies of scale are other factors that play an important role in increasing productivity and changes in the productivity of all production factors are obtained from changes in technical efficiency and changes in production technology (Kafaie & Bagherzadeh, 2016: 219). An increase in productivity, in fact, means more efficient use of existing technology. Changes in technical efficiency are followed by increases in productivity by measuring the movement of an economy toward the production frontier, and technological progress is followed by productivity growth by measuring the rate of transfer of the production frontier over time (AliRezaei & Afsharian, 2007: 139).

The study and measurement of productivity can be considered both in Partial Productivity (PP), that is, the productivity of a particular production factor, and in Total Factor Productivity (TFP), that is the productivity of all production factors.

2.2.1 Partial Productivity

Partial productivity is defined as the output of a given input unit at any given time, and the production function or value-added method is usually used to calculate it. Partial productivity is in fact the average production of each inputs. The disadvantage of using this method is that the effects of other factors used in the production process are ignored and in other words, it takes into account changes caused by other inputs in production into a specific input. (Nghiem & Coelli ,2010: 75). In addition, when a change in production technology occurs, the efficiency of all production factors generally changes. Under such conditions, partial productivity can not provide a proper estimate of technological progress in the manufacturing sector (Salami, 1997: 14).

2.2.2 Total Factor Productivity

Total productivity, given the fact that all factors of production are economically scarce, is an indicator that calculates the relative productivity of a set of inputs in the production of one or a set of products for different technology situations and shows the relative improvement of sector performance or the production unit over time. Therefore, it is preferable to calculate the TFP index to show the productivity performance in a production unit or economic sector. The change in total productivity can be broken down into effects such as changes in the scale of production, technical efficiency and technological improvement, and can be a good guide for policymakers in economic sectors in recognizing the weaknesses of production (Chambers, 1998).

2.3 Productivity Measurement and Malmquist Productivity Index

Two major parametric (econometric) and non-parametric methods have been proposed by economists to measure productivity. In econometric method, productivity is calculated by estimating a production function or a cost function. In the second method, the productivity criterion is determined using mathematical programming or calculating the index number (Salami, 1997: 11).

The nonparametric method of calculating productivity using mathematical programming, which is based on the distance function and is calculated using the data envelopment analysis method, is the Malmquist index. In this study, to calculate the productivity growth of all production factors, the Malmquist index has been used.

The advantages of using Malmquist index are as follows:

a. This index is made only based on the quantities of data and the problems related to the preparation of price information statistics do not create any limitations in its calculation.

b. This index has less restrictive hypotheses than advanced econometric indices.

c. Due to the lack of need for econometric estimates and the lack of need to adapt it to a specific functional form, it is free from the technical and statistical limitations that usually occur in econometric methods (Kruger et al, 1998: 3).

Malmquist Productivity Index, which uses distance functions to calculate, makes it easy to explain the production process of multiple outputs using multiple inputs without taking into account explicit prices and behavioral assumptions. Productivity change by Malmquist index between two times s and t according to the common technology in time t is defined as follows (Nghiem and Coelli, 2002: 10):

$$M_{\circ}^{t}\ (y_t, y_s, x_t, x_s) = \frac{d_{\circ}^{t}\ (x_t,y_t)}{d_{\circ}^{t}\ (x_s,y_s)} \qquad (4)$$

Similarly, the Malmquist index using time s technology is:

$$M_{\circ}^{s}\ (y_t, y_s, x_t, x_s) = \frac{d_{\circ}^{s}\ (x_t,y_t)}{d_{\circ}^{s}\ (x_s,y_s)} \qquad (5)$$

In order to avoid the optional choice of time period, Fare et al. (1994) defined Malmquist Productivity Index (MPI) as the geometric mean of the equations 4 and 5 as follows:

$$M_{\circ}\ (y_t, y_s, x_t, x_s) = \left[\frac{d_{\circ}^{s}\ (x_t,y_t)}{d_{\circ}^{s}\ (x_s,y_s)} \times \frac{d_{\circ}^{t}\ (x_t,y_t)}{d_{\circ}^{t}\ (x_s,y_s)}\right]^{1/2} \qquad (6)$$

In Equation 6, $d_{\circ}^{s}\ (x_t, y_t)$ represents the distance of time t observations from time s observations using time s technology. A similar definition can be given for $d_{\circ}^{t}\ (x_s, y_s)$.

If the value of x is greater than 1, the TFP increases between t and s, and decreases if it is less than 1. If the Malmquist index is based on the minimization of production factors, in contrast to the previous case, less than 1 index indicates an improvement in firm performance, and vice versa. One of the problems with Equation 6 is that it shows the change in TFP, which according to Fan (1991) is a set of changes in technology, production scale, and technical efficiency, as a number. He also showed that to solve this problem the following equation is equal to Equation 6:

$$M_{\circ}\ (y_t, y_s, x_t, x_s) = \frac{d_{\circ}^{t}\ (y_t,x_t)}{d_{\circ}^{s}\ (y_s,x_s)} \left[\frac{d_{\circ}^{s}\ (y_t,x_t)}{d_{\circ}^{t}\ (y_t,x_t)} . \frac{d_{\circ}^{s}\ (y_s,x_s)}{d_{\circ}^{t}\ (y_s,x_s)}\right]^{1/2} \qquad (7)$$

In Equation 7, the expression outside the bracket represents the change in technical efficiency in the time interval s to t and is equal to the ratio of technical efficiency at time t to technical efficiency at time s. The phrase inside the bracket also indicates technological changes between the two times. In fact, Equation 7 divides the change in TFP into two parts. In this study, the same method is used to calculate the changes in TFP during the study period.

The methods of calculating the Malmquist productivity index are divided into two groups; in first group, to calculate the index, price information and quantitative data are needed, and in the second group, only quantitative data are needed. In this research, the second method is used.

Each distance function contains a linear programming problem. If the constant returns to the scale is assumed, the output-oriented linear programming problem for calculating these distance functions will be defined as follows:

$$\left[d_{\circ}^{t}\ (y_{it}, x_{it})\right]^{-1} = max\theta \qquad (8)$$

s.t.

$-\theta y_{it} + \sum_{i=1}^{N} Y_t\, \lambda \geq 0$

$x_{it} - \sum_{i=1}^{N} X_t\, \lambda \geq 0$

$\lambda \geq 0$

$$[d_{\circ}^{s}\ (y_{is}, x_{is})]^{-1} = max\theta$$

s.t.

$-\theta y_{is} + \sum_{i=1}^{N} Y_s\, \lambda \geq 0$

$x_{is} - \sum_{i=1}^{N} X_s\, \lambda \geq 0$

$\lambda \geq 0$

$$\left[d_{\circ}^{t}\ (y_{is}, x_{is})\right]^{-1} = max\theta$$

s.t.

$-\theta y_{is} + \sum_{i=1}^{N} Y_t\, \lambda \geq 0$

$x_{is} - \sum_{i=1}^{N} X_t\, \lambda \geq 0$

$\lambda \geq 0$

$$[d_{\circ}^{s}\ (y_{it}, x_{it})]^{-1} = max_{\theta,\lambda}\theta$$

s.t.

$-\theta y_{it} + \sum_{i=1}^{N} Y_s\, \lambda \geq 0$

$x_{it} - \sum_{i=1}^{N} X_s\, \lambda \geq 0$

$\lambda \geq 0$

Where y_i is the vector M×1 of the outputs of the i unit, x_i is the vector K×1 of the inputs of the i unit, Y is the matrix M×N of the product values in the N sector, X is the matrix K×N of the input values, λ is the vector N×1 weights and θ is a number whose inverse value indicates the degree of technical efficiency.

2.4 Literature Review

The importance of productivity has also been recognized by researchers and several studies have been conducted in this field, some of which are mentioned below:

Tutkavul (2018) analyzed the efficiency and total factor productivity changes of the manufacturing companies traded in the BIST-SINAI index in the 2012-2016 period using the malmquist index. The results showed that the technical efficiency and technological changes of the firms examined in the period under consideration remained constant on average and therefore the total factor productivity of these firms did not change. Ding et al. (2016) examined the total productivity of agents and components in Chinese industries. The results show that the average growth of TFP in Chinese industries in the period 1998-2007 was equal to 9.6%, the most important factor of which is the reallocation of resources. Araujo et al. (2014) in their study examined the determinants of TFP in Latin America. The results of their study show that inflation and government expenditures have a negative effect on the productivity of all factors of production in this region. Vu (2012) used the Malmquist Productivity Index to calculate total factor productivity in Vietnam's agricultural sector during the period 1985-2000 and showed that TFP growth was upward during 1985-1989 and decreasing TFP growth during 1990-1995. TFP has been growing again in 1995-2000. Haggar (2011) used a stochastic production frontier model to analyze the sources of TFP growth by analyzing total factor productivity for the Canadian manufacturing industry. The results showed that during the study period, technological progress is the factor of productivity growth while efficiency changes are the factor of reducing the average economic growth. Amirteymouri and Khalilian (2010) examined the Total factor productivity by using malmquist index in three important sectors of Iran (industry and Mining, Agriculture and Transportation) in the period 1989-2004. The results of the study showed that the total factor productivity changes were positive in sectors other than the transportation sector in the period under consideration. In addition, while the positive change in technological development was effective in the productivity increase in the agricultural sector, positive changes in both technical efficiency and technological development were effective in the productivity increasing in the industry and mining sector. Lorcu (2010) using the Malmquist index, conducted productivity analysis of Turkish automotive industry and its subsidiaries in the 2003-2007 period. According to the results of the study, in contrast to the positife change in technical efficiency in all years, the total factor productivity decreased in other years except 2004. However, as a result, an average of 1.7% productivity increase occurred in this sector. Kula et al. (2009) investigated the efficiency and total factor productivity of companies in the Turkish cement industry, which were traded on the IMKB between 2001-2007. Data Envelopment Analysis was used as a method in the study and a total of 16 firms were included in the analysis. According to the results of the study, three firms were efficient throughout the period under consideration and the Turkish cement industry showed 1.5% productivity increase in this period.

3. RESEARCH FINDINGS

The main purpose of this study is to examine the efficiency and total factor productivity in Iran's three important economic sectors (Agrilculture, Industry and Services) between 2012 - 2017. Although some studies have been done on the subject, this study is the only study that deals with the current situation of the sectors in Iran with the most up-to-date data. In the study, Malmquist productivity index was used to examine the total factor productivity of the sectors. Accordingly, GDP values of each sector according to 2011 prices were handled as output variables. The number of annual employees and capital stock data in each sector are used as input variables. The data required for this study were collected from the database of the Statistics Center of Iran and Central Bank of the Islamic Republic of Iran. In order to estimate the productivity growth of all production factors using Malmquist index, DEAP 2.1 software designed by Coelli (1996) was used.

Average technical efficiencies of the sectors in the period under consideration are given in Table 1. According to the results in Table 1, all sectors, except for the industry sector, reached full efficiency under the assumption of both constant return to scale and variable return to scale. In these sectors, since the CRS technical efficiency and VRS technical efficiency are equal to 1, the scale efficiency is equal to 1. This means that there are no scale problems in these sectors (agriculture and service sectors) and in other words, it is an indicator that they are operating at an optimum scale.

Table 1: Average Technical Efficiencies of Iran's Economic Sectors between 2012-2017

Sector	**CRSTE**	**VRSTE**	**SE**	**Scale Type**
Agriculture	1.000	1.000	1.000	-
Industry	0.980	0.993	0.988	irs
Services	1.000	1.000	1.000	-
Mean	**0.993**	**0.998**	**0.996**	**-**

Source: Research Findings

As the CRS and VRS technical efficiencies are below 1 in the industrial sector, 1.2% scale inefficiency occurred in this sector. Since there is an increasing return to scale in this sector, firms operating in the sector can increase the production scale in order to achieve the optimal scale. In general, it is understood from the Table 1 that the economic sectors operating in Iran operate on average close to full efficiency.

Malmquist index productivity results of economic sectors in Iran between 2012-2017 are shown in Table 2. When the results in Table 2 are taken into consideration, the average technical efficiency in the agricultural sector remained constant, while in the industrial sector increased and in the service sector decreased.

Table 2: Malmquist Productivity Results in Economic Sectors of Iran in 2012-2017

Sector	**EFFCH**	**TECHCH**	**TFPCH**
Agriculture	1.000	0.985	0.985
Industry	1.003	1.067	1.070
Services	0.999	1.114	1.113
Mean	**1.001**	**1.054**	**1.054**

Source: Research Findings

The fact that technical efficiency does not change in the agricultural sector shows that productivity changes are dependent only on technological changes. However, since the increase in technical efficiency in the industrial sector and the decrease in technical efficiency in the services sector are very low, technical efficiency changes in these sectors will not be very effective on the productivity of sectors. It is also seen from the results that the average technical efficiency of all sectors increased by 0.1% during the period.

When the results of the technological changes of the sectors are analyzed, an improvement has occurred in all sectors except in agriculture sector. While the most technological development occurred in the services sector by 11.4%, there was a 6.7% development in the industrial sector. Technological change in the agricultural sector decreased by 1.5%. Technological development in all sectors increased on average by 5.4% during the period.

When the total factor productivity values of the sectors are taken into consideration, productivity increase has occurred in the all sectors except the agriculture sector. Again, depending on the rates in its technological development, the highest productivity increase has been observed in the services sector by 11.3%, while the industry sector has seen an increase of 7% and the agriculture sector has a decrease of 1.5%. Note that, since the technical efficiency change in the sectors is constant or very few, the determining variable in the productivity change is the technological change. For example, while technical efficiency in the agricultural sector did not change during the period under consideration, the 1.5% decrease in technological development was reflected in productivity in the same way and decreased the average productivity in this sector as well. The rates in the technological development of other sectors and the rates of productivity change were very close to each other. This shows that the technological development of firms operating in the economic sectors of Iran plays an important role in each sector's productivity change.

To examine the technological changes effectiveness on the productivity of the sectors, the technical efficiency changes, technological development and total factor productivity changes of each sector in the period discussed are shown in separate charts.

When the results in the agricultural sector (Chart 1) are analyzed, it is seen that the changes in technical efficiency are in a constant way. However, as there has been an increase and decrease in technological change, productivity changes in this sector have progressed with the same trend due to technological change.

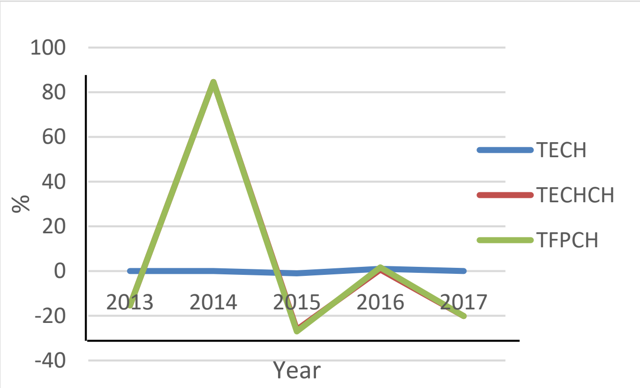

Chart 1: Trend of Total Factor Productivity Growth and its Components in the Iran's Agricultural Sector

Considering the results of productivity changes in the industrial sector (Chart 2), slight changes have occurred in technical efficiency. In addition, there have been serious increases and decreases in technological development and this has significantly affected the productivity change in this sector in the period under consideration.

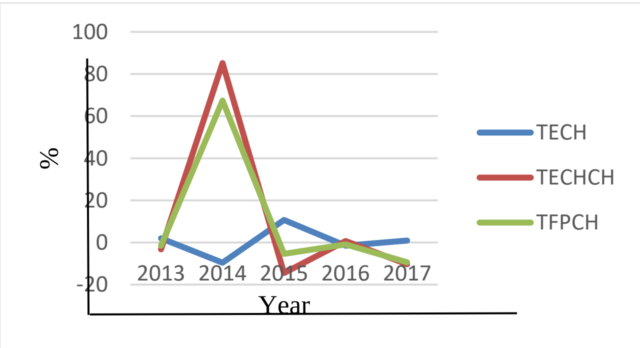

Chart 2: Trend of Total Factor Productivity Growth and its Components in the Iran's Industry Sector

Considering the results of Iran's efficiency changes in the services sector, technical efficiency in this sector, like the agriculture sector, has progressed with a nearly stable trend. However, increases and decreases in technological development have also significantly affected the productivity changes of this sector.

As a result, it is seen again that technological developments progress in parallel with total factor productivity changes in all sectors. This progress continues with a very close trend in agriculture and services sectors. However, although there are very few disconnections between these two variables in some years due to the changes in technical efficiency in the industrial sector, it can be said that the progress of productivity in this sector is parallel with the progress of technological development. The meaning of this parallel progress is that the productivity change in the sector depends on the development of technological changes rather than technical efficiency changes.

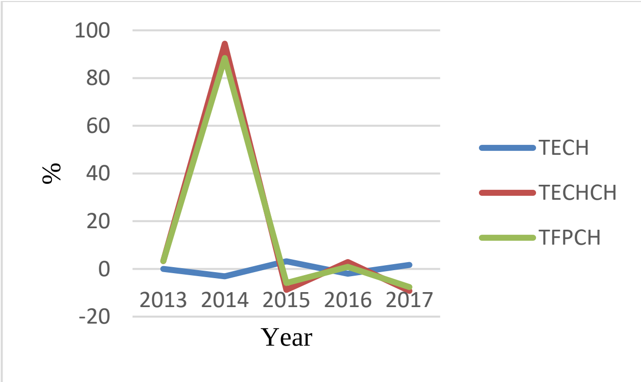

Chart 3: Trend of Total Factor Productivity Growth and its Components in the Iran's Services Sector

The changes in the annual productivity and efficiency of the sectors in Iran are given in Table 3.

Table 3: Annual Malmquist Index Changes of Economic Sectors in Iran between 2012-2017

Year	**EFFCH**	**TECHCH**	**TFPCH**
2012	-	-	-
2013	1.007	0.945	0.952
2014	0.957	1.880	1.799
2015	1.042	0.832	0.866
2016	0.992	1.014	1.006
2017	1.009	0.867	0.874
Mean	**1.001**	**1.054**	**1.054**

Source: Research Findings

Considering the results in Table 3, the average technical efficiency of the sectors increased in all other years except 2014 and 2016. While the highest increase occurred in 2015 with 4.2%, the lowest increase was experienced in 2013 with 0.7%. The highest technical efficiency decrease in the analyzed period was 2014 with 4.3%.

According to the results of the annual technological developments of the sectors, a decrease in technological change has occurred in all other years except 2014 and 2016. The most decrease in the technological development is seen in 2015 with 16.8%. The best year in technological development was 2014, with an increase of 88%.

Looking at the results of the annual total factor productivity changes of the sectors, similar to the technological change, the average productivity has decreased in all other years except 2014 and 2016. The highest productivity decrease occurred in 2015 with 13.4%. Similarly, the highest productivity increase was 2014 with 79.9%.

Similar to the results in Table 2, it is understood how effective the technological development is on productivity changes. For example, although there was a 4.2% increase in technical efficiency in 2015, productivity decreased by 13.7% in the same year as the change in technological development decreased by 16.8%. The same statements can be made for 2013 and 2017 years.

4. CONCLUSION

In this study, the productivity growth of total factors productivity in three important sectors of the Iranian economy (agriculture, industry and services) during the period 2012-2017 was studied using the Malmquist productivity index. The results showed that the negative change of total factor productivity in the agricultural sector during the study period was due to technological changes and the growth of total factor productivity in industry and services was also due to technological changes In the analyzed period, the service sector had the highest productivity increase with an average of 11.3%. On the other hand, productivity of the agricultural sector decreased by 1.5% in the period under consideration. Considering the annual productivity changes, the highest productivity increase occurred in 2014 with an average of 79.9%, while the highest productivity decrease occurred in 2015 with an average of 13.4%. Technological change has been the most important factor that determines productivity, both on a sector basis and when looking at annual productivity changes. This result is the same as the previous results. For this reason, it is understood that the firms operating in the sectors should pay more attention to the technological development and the factors that accelerate this technological development. However, this does not mean that the technical efficiencies of the firms are ignored and only technological change is taken into account. Factors that increase the technical efficiency of firms should also be taken into consideration. However, more importance should be given to variables that support technological development. Accordingly, the following suggestions can be made:

a. Allocation of government development credits and investment in economic sectors based on the criteria of productivity and efficiency.

b. Investing in research, development and promotion of new technologies in order to increase technical efficiency in all economic sectors;

c. Increasing the support of the government in determining the optimal scales by firms in the sectors (especially the industry sector).

d. Increasing the education level of the manufacturers and research, development, innovation, etc. of the related institutions towards the development of new technologies.

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