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The Productivity of Turkey's Agricultural Production on Provincial Basis[1]

Elif Gül KÖSE[2]

Fatih Cemil ÖZBUĞDAY[3]

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Abstract

Given the geographical location, seasonal features, and historical-cultural features, agriculture has always been important in Turkey. In this study, using the data from 81 provinces in Turkey between 2007 and 2015, we analyze whether agricultural production is efficient or not. In our analysis, we use the Data Envelopment Analysis based Malmquist Productivity Index. The input set is determined as the number of tractors used in plant production, the number of laborers in agricultural sector, the cultivated area used in agriculture and the amount of fertilizer used in agriculture, while the output is determined as the amount of inflation-adjusted income generated by the agricultural plant production activities of 81 provinces between 2007 and 2015. In the given period, the province with the greatest increase in agricultural productivity was Hakkari, while the province with the greatest decrease in agricultural productivity was İstanbul. In total, although a slight increase is observed, there is a stable path in agricultural productivity of Turkey.

Keywords: Agricultural Economics, Productivity, Data Envelopment Analysis, Malmquist Efficiency Index
JEL Codes: *Q10, Q14, Q18*

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[2] *Corresponding Author, Ankara Yıldırım Beyazıt University, Economics Department, koseelifgul@gmail.com*
[3] *Ankara Yıldırım Beyazıt University, Economics Department, fcozbugday@ybu.edu.tr*

Özet

Türkiye'nin Tarımsal Üretim Verimliliğinin İller Bazında İncelenmesi

Tarım, coğrafi konumu, mevsimsel özellikleri ve tarihi-kültürel özellikleri göz önüne alındığında, Türkiye için her zaman son derece önemli olmuştur. Bu çalışmada 2007-2015 yılları arasında 81 ilin verilerinden yararlanılarak tarımsal üretimin verimli olup olmadığı incelenmiştir. Metodoloji olarak Veri Zarflama Analizi tabanlı Malmquist Verimlilik İndeksi kullanılmıştır. Girdi seti, bitkisel üretimde kullanılan traktör sayısı, tarım sektöründeki işçi sayısı, tarımda kullanılan ekili alan ve tarımda kullanılan gübre miktarı olarak belirlenirken, çıktı, 81 ilin 2007 ile 2015 yılları arasındaki bitkisel üretim faaliyetleri sonucu elde edilen enflasyondan arındırılmış gelirleridir. Belirtilen dönemde tarımsal üretimindeki verimliliği en fazla artan il Hakkari iken, tarımsal üretimdeki verimliliğin en fazla azaldığı il ise İstanbul olmuştur. Toplamda, Türkiye'de tarımsal verimlilik küçük bir artış eğiliminde olsa da genel olarak durağan bir yol izlediği gözlemlenmiştir.

Anahtar Kelimeler: Tarım Ekonomisi, Verimlilik, Veri Zarflama Analizi, Malmquist Verimlilik Endeksi
JEL Kodları: Q10, Q14, Q18

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1. Introduction

Agriculture is the economic activity that people use and process nature's resources to meet their basic needs (TÇVY, 1997, p. 15). Agriculture in Turkey has always been a critical sector in terms of the share in the gross domestic product (GDP) and providing resources to the industrial sector. Considering that climate diversity, soil diversity, and abundance of water resources, it has always been a matter of debate whether agricultural production is efficient in Turkey. In a country where there is so much diversity of land and climate, and where irrigation resources are abundant, the agricultural sector is expected to be highly developed and efficient. Therefore, it is essential to identify the current situation of agricultural efficiency in Turkey and to make suggestions accordingly for further increase in efficiency. The lack of consistent growth in the agricultural sector and its diminishing share in the GDP, despite the increasing total GDP, make the analysis of Turkey's agricultural performance necessary.

The share of agriculture in total GDP has been declining steadily, especially after 2010. It decreased by 7.52%, 9.03% and 6.83% in 2007, 2010, and 2015, respectively. Therefore, it is crucial to investigate whether the production is efficient in Turkish agricultural sector, while its share in GDP is declining. The agricultural sector is one of the main sectors of the Turkish economy. In 2000, 35% of the population lived in the countryside, while in 2009; this rate went down to 24% after the improvements in urbanization. The main reason for this decline is the migration from rural areas to the urban areas due to the steadily decreasing share of agriculture in the national income, imbalances in income distribution and differences in socio-economic development between rural and urban areas (Gülçubuk, 2005, p. 68). The increase in agricultural input prices, the fragmentation of land by inheritance, the difficulty of agricultural activities for new core families due to labor shortages, and the desire to work in non-agricultural sectors have increased immigration to cities (Gülçubuk, 2005, p. 73). As a result, employment in the agricultural sector, which is the primary source of economic activity in rural areas, has decreased from 36% to 25% since 2000 (DPT, 2011).

This study aims to investigate the question of whether the current plant production is efficient or not. As the population increase in the world and Turkey, the demand for food increases accordingly. The predictions indicate that by 2050 the agricultural production needs to be increased by 70% only for feeding the world's population. For developing countries, this ratio in agricultural production must be around 100% (FAO, 2009). For this reason, analyzing the productivity of agricultural production, determining the problems and recommending solutions according to the analysis results, have vital importance. However, the number of studies examining the productivity of agriculture in Turkey is inadequate. In addition, most of them are broad regional. This study will contribute to the literature on agricultural economics that it uses the most recent data and is carried out on the 81 provinces of Turkey. Moreover, this study is significant since it reveals the problems of Turkey's agricultural sector and makes suggestions to overcome these problems.

In this study, the method in the analysis is determined as Data Envelopment Analysis (DEA) based Malmquist Total Factor Productivity (TFP) indices. These indices were introduced by Caves et al. (1982). The innovation of Färe et al. (1994) was showing that this index could be estimated by using a nonparametric approach (Shahabinejad & Akbari, 2010). The DEA and Malmquist TFP indices were computed using the DEAP 2.1 computer program written by Coelli (1996).

The data set consists of four inputs, which are land, labor, tractor and fertilizer, and one output, which is the amount of inflation-adjusted income generated by the agricultural plant production activities of 81 provinces between 2007 and 2015. With these inputs, it was examined whether agricultural production is efficient or not in Turkey. In the study, the producers, who are Decision Making Units (DMU), were identified as the 81 provinces of Turkey and the period has been determined between 2007 and 2015.

The study consists of five sections. In the following section, a literature review is provided.

In the third section, detailed information about methodology, computer program, and data used in this study is given. In the fourth section, the analysis results have been examined in two different ways. Firstly, a mean analysis results for each province between 2007 and 2015 are presented. Secondly, a mean analysis results of all provinces in total for each period are provided.

Finally, the fifth chapter concludes and summarizes the key empirical and theoretical findings. An overview of the analysis results, problems of Turkish agriculture and the proposed solution for these problems are presented. In addition, the problems encountered in this study and suggestions for future studies are included.

2. Literature Survey

In the literature of agricultural economics, there are numerous studies on agricultural productivity. These studies mainly cover comparisons between countries or comparisons between the provinces or counties within a particular country.

Bhattacharjee (1955) conducted one of the earliest studies known in agricultural productivity. In this study, the aim is to examine the efficiency of resources used in worldwide agricultural production. In the paper of Hayami and Ruttan (1970) differences among the agricultural productivity of countries were studied. Mao and Koo (1996) focused on the TFP, efficiency, and technology of Chinese agricultural production covering the years from 1984 to 1993. Their sample set consists of 29 provinces in China. Fulginiti and Perrin (1997) examine the changes in agricultural productivity in 18 developing countries covering the period of 1961-1985. Aldaz and Millan (2003) analyze the agricultural productivity of 17 Spanish regions. Their former study conducted in 1998 uses nonparametric Malmquist efficiency index while the latter study employs the method of DEA applied to panel data. Nin et al. (2002) carried out a study on the agricultural productivity growth of 20 developing countries by using the method of nonparametric Malmquist efficiency index. Nghiem and Coelli (2002) studied the productivity growth of Vietnamese rice production by using the data covering the period from 1976 to 1997. Thirtle et al. (2003) estimated the multilateral, multifactor productivity indices for agriculture in 18 regions and the business sector in Botswana from 1981 to 1996.

Coelli and Rao (2003) examined the levels and trends in agricultural output and productivity in 93 developed and developing countries, covering the period of 1980-2000. Ball et al. (2005) demonstrated how productivity growth could be amended to account for non-traditional outputs, such as positive or negative externalities or other social outputs by using the Malmquist cost productivity index method. This study was conducted in 46 states of the US. Tonini and Jongeneel (2006) investigated the TFP growth in agriculture. Their sample set consists of the ten Central and East European countries, which are Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. The common point of these ten countries is that they all began formal negotiations for EU accession in September 1998. Zhengfei and Lansink (2006) explained the differences between family farms and company firms by expanding the capital structure study to the situation in agriculture. In the article by Chen and Ding (2007), they studied whether it is possible to create a framework for assessing the trend of China's agricultural infrastructure and measuring its effect on TFP.

Lissitsa et al. (2007) measured TFP growth in the agriculture of transition countries after the breakdown of socialism and compared their TFP growth with that of other European countries. They use a panel data set on the agricultural sectors of forty-four countries between 1992 and 2002. Latruffe et al. (2008) study the usefulness of applying bootstrap procedures to TFP by using Malmquist indices, derived with DEA. They analyze 250 Polish farms during 1996-2000. Luh et al. (2008) analyze the agricultural growth of eight East Asian economies to describe their sources. Wu et al. (2008) approach the geographical and physical condition of Chinese agricultural productivity growth between 1980 and 1995, which is the post-reform period. Chen et al. (2008) investigated the agricultural productivity growth of China's 29 provinces for the period between 1990 and 2003.

Nin-Pratt et al. (2010) make a comparison between China and India concerning productivity, technical changes, and agricultural TFP growth. They also test whether there is a structural break in the development of TFP on policy milestones. Yao and Li (2010) study on the agricultural productivity change, which is induced by the Sloping Land Conversion Program (SLCP), with the data collected from Wuqi County. Swinnen and Vranken (2010) investigate the changes in the agricultural performances of the Central and Eastern European and the Former Soviet republics between 1989 and 2005. Shahabinejad and Akbari (2010) examine the agricultural productivity of eight developing countries, which are Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan and Turkey covering the years from 1993 to 2007. Fuglie and Schimmelpfennig (2010) focus on the agricultural productivity change in the global economy, with particular attention to large agricultural producers outside the Organization for Economic Co-operation and Development (OECD) countries, namely, China, India, Indonesia, and collectively the transition economies of the former Soviet Union and Eastern Europe. Li and Zhang (2013) conduct a study analyzing the productivity growth in China's agriculture covering 25 years from 1985 to 2010.

In addition to all these articles, the studies carried out in Turkey are as follows. As can be seen below, the number of studies conducted on a provincial basis is very limited, and these studies do not contain current data. Apart from these, other studies have been carried out at the regional level or the firm level. According to the studies mentioned below, it is found that agricultural production in Turkey is generally inefficient, at both regional and firm level. However, in the work done on a provincial basis, it is mentioned that productivity has an overall increase in a similar way to the result of this study. Detailed information about those studies can be found below.

The first study was carried out by Tipi and Rehber (2006). It evaluates the agricultural technical efficiency and the TFP for South Marmara Region of Turkey between 1993 and 2002. They use DEA and the DEA based Malmquist TFP index as the method. Their inputs are utilized area, fertilizer, tractors, and labor while their outputs are crops and livestock production. This study concludes that the South Marmara Region of Turkey produces only about 88.3% of the potential production with given inputs.

Başarır et al. (2006) analyze the Turkish agricultural production by using the method of Cobb-Douglas production function on the data of the period between 1961-2001. They use the number of tractors, animals, land, labor, fertilizers, and irrigation as inputs and agricultural production as output. They analyze the technical change by separating the 40 years into four 10-years. According to the analyses, there is a negative technical production in the first 10-years period. However, the technical change rate reaches its highest level, in the second period, compared to the other periods. In the third period, the rates become negative. Lastly, in the fourth period, the rate of technical change becomes positive again, but not as high as in the second period.

Deliktaş and Candemir (2007) examine the productivity performance of Turkish State Agricultural Enterprises using DEA approach. This study mainly focuses on the 1999-2003 period. The inputs are labor, amortization (as a capital input), amount of fertilizer (in thousands of metric tons), cultivatable land (hectares), seed (in thousands of metric tons), annual mean rainfall (in mm by district from the meteorology department), and animal feed (in real value) and livestock in the beginning of each year for 37 state agricultural enterprises. Additionally, the output is the total combined annual plant and animal production values in real terms. The results of regression estimation indicate that irrigation rate, tractor (an indicator of existing technology), and the geographic regions of enterprises are essential determinants of production efficiency.

Avcı and Kaya (2008) examine the performance of agricultural sectors of 25 transition economies including Turkey in the period of 1992-2004. The performance of the agricultural sector of each country is measured through the DEA and Malmquist Index. Labor, tractor, land, and fertilizer are used as inputs, and added value in terms of US Dollar at 2000 constant prices is determined as output. Regarding the findings, for the 1992-2004 period, the average technical efficiency value of the transition economies was 0.665, and average technical value of Turkey was 0.826.

In the article by Armağan et al. (2010), NUTS regions in Turkey are accepted as a DMU. The efficiency values of these regions, changes in the TFP and technology are calculated for the ten years covering 1994–2003. Methods of DEA and Malmquist Productivity Index are used in order to measure the crop production of NUTS-1 regions in Turkey. The number of tractors, the amount of land cultivated, the economically active population in the agricultural sector, and the amount of fertilizers with nitrogen, potash and phosphorous in 81 provinces were determined as inputs. Also, the agricultural structure, production, price and the value of the crop production in 81 provinces are determined as outputs. As a result of this study, there has been a decrease in the technical efficiency and TFP in the regions, excluding the Western Marmara, the Aegean, the Mediterranean, and The Eastern Black Sea Region, within the ten years analyzed.

In Kaya and E. Aktan (2011), the agricultural performances of 81 cities in Turkey are analyzed by using nonparametric Malmquist efficiency index and the data of the 2000-2009 period. Their inputs are the number of tractors per cultivated area, planting ratio of agricultural lands, the share of agriculture in public investments, and agricultural electricity use per cultivated area. Their output is total revenue acquired from plant production per cultivated area. They discover that technological progress in the given period caused an increase in the TFP of Turkey's agricultural sector.

In the study of Yavuz and İşçi (2013) the relative efficiency of 25 firms, which ranked among the top 500 largest companies operating in the food sector in Turkey in the last three years, are measured for 2009, 2010 and 2011 by using the DEA. The inputs are resources, total assets, and labor and the outputs are crops and livestock production. According to the study, the percentage of average activity is 77%. For the data of 2011, ten companies are found to be effective according to the model of the CCR (Charnes, Cooper & Rhodes) while 12 companies are found to be effective according to the model of BCC (Banker, Charnes & Cooper).

Lastly, in the study of Eruygur, et al. (2016) they estimate the determinants of agricultural TFP change by using 26 NUTS-2 level regions' data between 2005 and 2014. They also calculated the capital stock of Turkish agricultural sector on NUTS-2 level basis. Their model is a stochastic frontier analysis based Cobb-Douglas log-linear agricultural production equation. The model includes 15 variables, which are agricultural gross domestic added value, agricultural employment, agricultural capital stock, total agricultural land, the share of irrigable land in total agricultural land, use of fertilizer per hectare, Thornthwaite thermal efficiency index, a dummy variable for the drought in Turkey in between 2007 and 2008, human capital per labor force, export of high technological products, volatility of exchange rate of dollar, rural development support, time trend, exchange rate of dollar and inflation rate. As a result of this study, it is conducted that human capital, technological developments, and rural development support have a significant positive impact on TFP in agriculture. In addition, changes in foreign exchange rates, an increase in economic uncertainty (inflation and volatility of exchange rates) have a significant negative impact on TFP in agriculture. On the other hand, agricultural support policies except rural development support have no statistical impact on TFP in agriculture.

To sum up, the literature on agricultural productivity regarding various countries and Turkey was reviewed, and the critical findings from the literature were presented above in chronological order. There are two production functions determined for the established models. The first one is the parametric production function, namely, the stochastic frontier analysis which was applied in a few studies. The second and the prevalent one in non-parametric production functions, one of which is DEA.

3. Methodology and Data

There are two broad paradigms to measure economic efficiency. One of them is based on an essentially nonparametric programming approach to the analysis of observed outcomes, and the other one is based on an econometric approach to estimation of theory-based models of production, cost, or profit (Greene, 2008, p. 92). In econometric approaches, the most common method which is used to measure the efficiency is stochastic frontier analysis (SFA). This method was developed by Dennis Aigner, Knox Lovell, Peter Schmidt, Wim Meeusen and Julien Van Den Broeck, in 1977. According to this method, there are production borders of all the operations. This method assumes that these operations cannot make efficient production by using their resources.

Statistical errors are taken into account. This method, also, identifies the minimum level of costs at a certain output level, input prices and production technology (Özbuğday & Nillesen, 2013)

In nonparametric approaches, the level of efficiency is reached by expressing the inputs and outputs with different characteristics in a single index. In order for inputs and outputs to be collected in a single index, it is crucial to establish the required weights and exhibits the share of receivables from the inputs. The Malmquist Productivity Index shows the output distance of the inputs under the condition of fixed technology at different times. That is, when the input vector is data, the output vector becomes maximum. In this method, which measures productivity by linear programming method for input and output without any restriction on production technology, the production curve is created for each input and output, and production technology is determined. The specified technology level gives the efficiency rate (Vergil & Abasız, 2008).

In this study, DEA based Malmquist TFP indices were adopted as the method. Caves et al. (1982) introduced these indices. The new approach of Färe et al. (1994) show that this index can be estimated by using a nonparametric approach (Shahabinejad & Akbari, 2010). The DEA and Malmquist TFP indices were computed using the DEAP 2.1 computer program written by Coelli (1996). One of the most advantageous sides of this method is that in DEA, fewer assumptions are made. So, applying this method is relatively easy, compared to applying parametric methods. On the other hand, regulating the data according to expected results is relatively probable in parametric methods (Çakmak, Akder, Levent, & Karaosmanoğlu, 2008, p. 35).

In our article, the data set consists of 4 inputs, which are land, labor, tractor and fertilizer, and one output which is the revenue of 81 provinces from their agricultural plant production activity. With these inputs, it is going to be examined whether the agricultural production is efficient or not in Turkey. The producers, which can also be named as DMUs, have been identified as the 81 provinces of Turkey and the period has been determined between 2007 and 2015.

While collecting the data, some problems were encountered with respect to the number of laborers in the agricultural sector. It forced the study to calculate the approximate values for this input data. In this study, the data regarding the 81 provinces of Turkey has been collected. Nonetheless, the Turkish Statistical Institute (TURKSTAT) does not include the number of laborers in the agricultural sector between the years 2007 and 2015 for each province, separately. They have the survey results of the General Agricultural Census (2001). According to this census, the total number of settlements, total number of households, total number of households engaged in agricultural activity, and total number of households not engaged in agricultural activity can be found for 81 provinces of Turkey (TURKSTAT, 2004).

On the other hand, the number of laborers in agricultural sector between the years of 2007 and 2015 can also be found in The Nomenclature of Territorial Units for Statistics II (NUTS II) level, which TURKSTAT grouped, the 81 provinces of Turkey in 26 regions according to their population, geographical position, regional development plans, basic statistical indicators and socio-economic development rankings of provinces. Thus, in order to reach the specific data including the number of agricultural laborers between the years of 2007 and 2015 for 81 provinces, the General Agricultural Census results were rearranged according to the NUTS II regions. Then, the proportion of agricultural laborers in all provinces and the number of agricultural laborers in NUTS II regions in the year of 2001 have been converted to the data mentioned above as the number of laborers in the agricultural sector in NUTS II level between the years of 2007 and 2015. In this way, the most approximate data for this input is expected to be reached.

The input set has been determined as the number of tractors used in plant production, number of laborers in agricultural sector, the cultivated area used in agriculture and the amount of fertilizer used in agriculture, while the output has been determined as the inflation-adjusted revenue of 81 provinces from agricultural plant production activity between the years of 2007 and 2015. At the end of this study, it can be easily seen whether the plant production of each province is efficient or not.

4. Analysis Results

According to the data, composed of 4 inputs and one output, the analysis of agricultural efficiency is conducted for 81 provinces of Turkey between 2007 and 2015. In the study, the DEAP 2.1 program is employed. The analysis has been carried out constant returns to scale assumption by using the output-oriented model. It is possible to observe whether the TFP change (TFPCH) results from the catch-up effect or the frontier-shift effect by the technical efficiency change (EFFCH) and technical change (TECHCH) values found on the table. If these values are above 1, it will show the increase in TFP; if they are below 1, it will show a decrease in TFP.

In summary, if TFPCH is less than 1, then one of the EFFCH or TECHCH values is necessarily less than 1. Likewise, if the TFPCH value is greater than 1, then one of the EFFCH or TECHCH values is necessarily greater than 1. If TFPCH value equals to 1, then neither EFFCH nor TECHCH is observed between those years. Besides, the SE and pure efficiency (PE) can be calculated by this software.

The analysis results are presented under two different headings. Accordingly, the results are examined as the Total Factor Productivity Over Provinces and the Total Factor Productivity Over Years (See Table 1 and Table 2).

4.1. Examination of Total Factor Productivity Over Provinces

While the first five provinces with the highest TFPCH value are Hakkari, Giresun, Bartın, Kırıkkale, and Samsun, the first five provinces with the lowest TFPCH values are İstanbul, Artvin, Bingöl, Yalova, and Diyarbakır between 2007 and 2015, respectively (See Table 1).

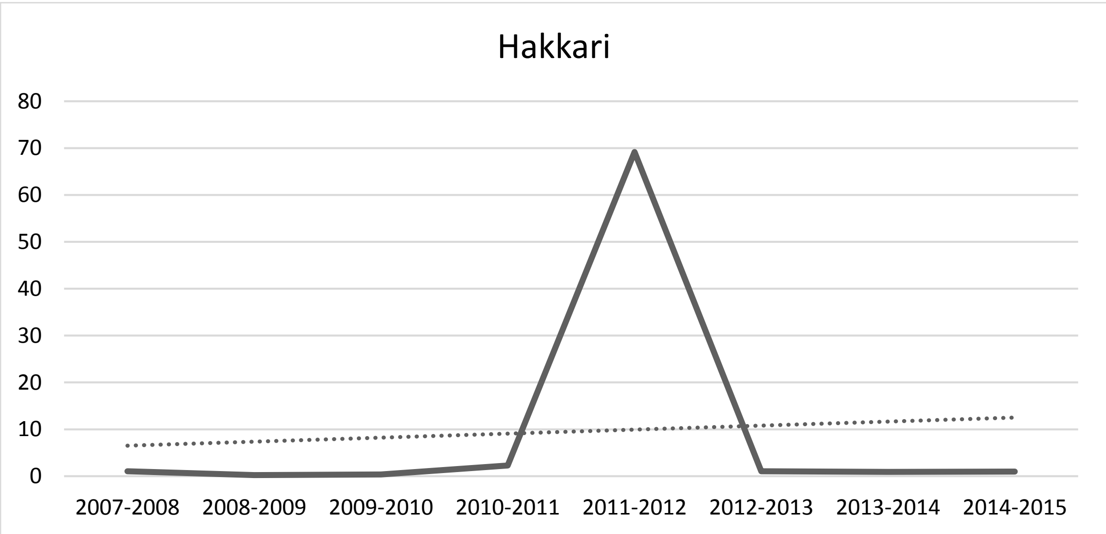
Table 1 Malmquist Index Summary of Provincial Means

Name of the Province	Plate Code	Avg effch	Avg techch	Avg pech	Avg sech	Avg tfpch
Hakkari	30	1	1.384	1	1	1.384
Giresun	28	1.121	1.025	1.1	1.018	1.149
Bartin	74	1.129	0.968	1.106	1.021	1.093
Kirikkale	71	1.085	0.998	1.076	1.008	1.082
Samsun	55	1.054	1.023	1.04	1.014	1.078
Kars	36	1.068	1	1.044	1.023	1.068
Siirt	56	1.057	1.007	1.069	0.989	1.065
Konya	42	1.06	1.002	1.068	0.992	1.063
Nigde	51	1.052	1.006	1.051	1	1.058
Sinop	57	1.078	0.982	1.048	1.028	1.058
Amasya	5	1.059	0.997	1.061	0.998	1.057
Burdur	15	1.048	1.006	1.051	0.997	1.055
Düzce	81	1.059	0.993	1.061	0.999	1.052
Çorum	19	1.053	0.999	1.05	1.003	1.051
Çanakkale	17	1.049	1	1.049	1	1.049
Mardin	47	1.03	1.017	1.024	1.007	1.048
Trabzon	61	1.005	1.038	1	1.005	1.043
Rize	53	1	1.041	1	1	1.041
Eskisehir	26	1.058	0.983	1.055	1.003	1.04
Ordu	52	1.026	1.013	1	1.026	1.039
Karabük	78	1.094	0.949	1.057	1.035	1.038
Tokat	60	1.038	0.999	1.016	1.021	1.037
Kahramanmaras	46	1.042	0.995	1.042	1	1.036
Gaziantep	27	1.031	1.003	1.03	1.002	1.035
Malatya	44	1.033	1.002	1.036	0.997	1.035
Adiyaman	2	1.039	0.995	1.04	1	1.034
Kilis	79	1.025	1.009	1	1.025	1.034
Osmaniye	80	1.037	0.998	1.039	0.998	1.034
Gümüshane	29	1.086	0.948	1.079	1.007	1.03
Bitlis	13	0.999	1.028	1.012	0.987	1.027
Mus	49	1.049	0.98	1.051	0.998	1.027
Aksaray	68	1.04	0.986	1.04	1	1.026
Sivas	58	1.057	0.97	1.049	1.008	1.025
Balikesir	10	1.023	1	1.019	1.004	1.023
Nevsehir	50	1.031	0.99	1.031	1	1.02
Kastamonu	37	1.033	0.987	1.005	1.028	1.019
Usak	64	1.019	0.999	1.02	1	1.018
Çankiri	18	1.031	0.983	1.041	0.991	1.014

Name of the Province	Plate Code	Avg effch	Avg techch	Avg pech	Avg sech	Avg tfpch
Antalya	7	1	1.008	1	1	1.008
Zonguldak	67	1.05	0.96	1.005	1.045	1.008
Batman	72	1.007	1	1.008	0.998	1.007
Mugla	48	1.032	0.975	1.012	1.02	1.006
Agri	4	1.025	0.977	1.012	1.013	1.002
Tunceli	62	1.02	0.982	1	1.02	1.001
Tekirdag	59	0.996	1.004	0.997	1	1
Elazig	23	0.999	1	1.003	0.996	0.999
Sirnak	73	0.996	1.002	0.982	1.014	0.998
Bursa	16	0.997	0.999	0.997	1	0.995
Edirne	22	0.99	1.005	0.989	1.001	0.995
Kirklareli	39	0.989	1.003	0.989	1	0.992
Erzincan	24	1	0.987	0.999	1	0.987
Aydin	9	0.986	1	0.985	1.001	0.986
Hatay	31	0.981	1.002	0.981	1	0.984
Kütahya	43	1.005	0.979	0.98	1.025	0.984
Afyonkarahisar	3	0.99	0.994	0.985	1.005	0.983
Bayburt	69	1.02	0.963	1.046	0.975	0.983
Igdir	76	1.006	0.976	0.993	1.013	0.982
Kirsehir	40	0.979	1.003	0.975	1.004	0.981
Van	65	1.033	0.949	1.025	1.008	0.98
Bilecik	11	0.997	0.982	1.028	0.969	0.979
Erzurum	25	1.01	0.969	0.984	1.027	0.979
Karaman	70	1	0.977	1	1	0.977
Adana	1	0.979	0.997	0.979	1	0.976
Yozgat	66	0.999	0.977	0.996	1.003	0.976
Isparta	32	0.982	0.99	0.963	1.02	0.972
Izmir	35	0.974	0.997	0.974	1	0.972
Kayseri	38	1	0.972	1.002	0.998	0.972
Ankara	6	0.973	0.996	0.983	0.99	0.969
Kocaeli	41	0.995	0.974	0.992	1.003	0.969
Bolu	14	0.988	0.98	0.986	1.001	0.968
Denizli	20	0.965	1.003	0.965	1	0.968
Mersin	33	0.977	0.988	0.98	0.997	0.965
Sakarya	54	0.96	1	0.961	0.999	0.96
Sanliurfa	63	0.956	1.005	0.989	0.967	0.96
Manisa	45	0.952	1.003	0.961	0.99	0.955
Ardahan	75	1.009	0.947	0.958	1.053	0.955
Diyarbakir	21	0.937	1.007	0.954	0.983	0.944
Yalova	77	0.997	0.944	1	0.997	0.941
Bingöl	12	1.026	0.909	0.911	1.125	0.932
Artvin	8	0.977	0.928	1	0.977	0.906
Istanbul	34	0.893	0.991	0.903	0.989	0.885

Hakkari has been the province with the highest productivity in the years indicated earlier. According to the analysis results, the most important reason for the decrease or increase in productivity in Hakkari is the change in the frontier-shift effect. In the formation of this effect, there may be technological improvements in the province, subsidies made by the state, and so on. In other words, the situations that shift the production possibility frontier (PPF) are called the frontier-shift effect. Considering Hakkari's agricultural sector, 70 percent of the population earns their income from agriculture (T.C. Hakkari Valiliği, 2014, p. 17). An average of 20-25 percent of the province's economy also comes from agricultural activities. However, due to the rugged terrain, farming in the field is possible in certain areas. The major crops produced in the province are feed crops, wheat, walnuts, apples, tomatoes, and grapes (T.C. Hakkari Valiliği, 2014, p. 18).

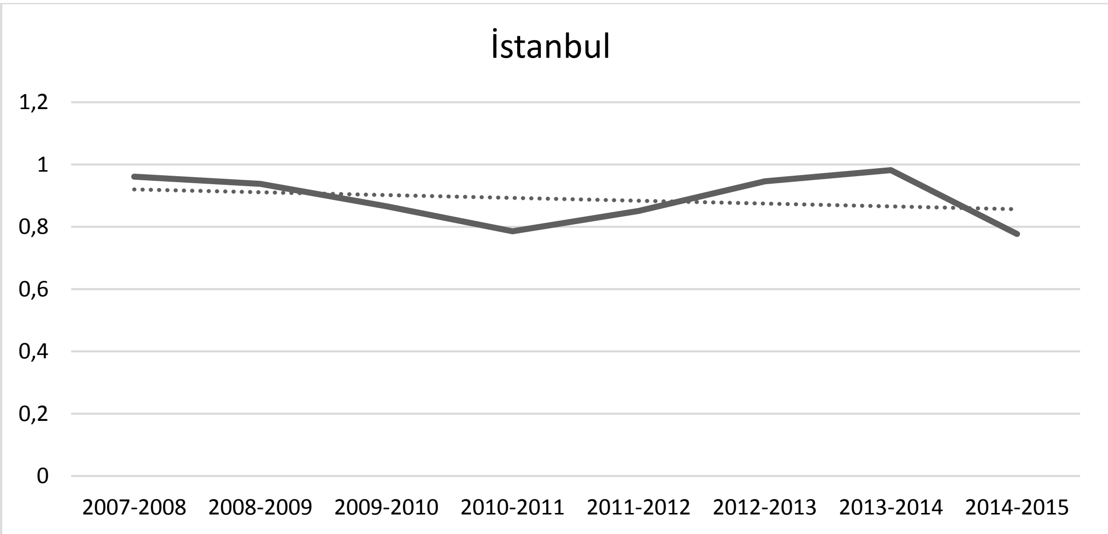
Figure 1 Total Factor Productivity Change of Hakkari



A significant increase was observed in the monetary value of agricultural production, due to the increased incentives and supports, along with the peace process affecting the province. Between 2006 and 2013, the grants, which were provided by the Ministry of Food, Agriculture, and Livestock to Hakkari Province as part of the Rural Development Investment Support Program was 12,824,284.41 TL, while the grant support in 2014 was 22,808,759.84 TL (T.C. Hakkari Valiliği, 2014, p. 5). Within this framework, agriculture is of utmost importance for Hakkari economy. As such projects and supports increase, the productivity of Hakkari in agricultural sector undoubtedly increases.

On the other hand, the lowest level of agricultural productivity was realized in İstanbul between 2007 and 2015. The average TFPCH is at the lowest level in this province. Figure 2 also shows this overall decrease. The main reason for the low level of productivity is the catch-up effect. Here, the catch-up effect shows whether an optimal output can be achieved through existing inputs or not. At this point, we should look at the main reasons for this situation. İstanbul has never been an agricultural center of Turkey. The major crops plant in this province are wheat, sunflower, green beans, apple, and hazelnut. This province's agricultural consumption has always been much higher than its production. The most important reasons of this are the urbanization of agricultural lands with the increasing population, and people living in rural areas tend to move to the city center and want to work in a different sector (T.C. İstanbul Valiliği, 2015).

Figure 2 Total Factor Productivity Change of İstanbul



According to the statistics, industrial space and the subsidies given in the industrial sector are higher than the cultivatable area and the subsidies given in agricultural sector.

This shows us, in this province, industrial improvement is more critical than agricultural activities. That is why the agricultural sector has always been in the background.

4.2. Examination of Total Factor Productivity Over Years

When the TFP changes experienced in 2008 are examined in comparison with the previous year, the first five provinces, which achieved the highest increase in agricultural productivity, were Giresun, Uşak, Kırıkkale, Muş, and Aksaray. An increase in the catch-up effect caused the increase in the productivity of these provinces. On the other hand, the first five provinces, which realized the most significant decline in productivity, were Şırnak, Batman, Diyarbakır, Kilis, and Gaziantep, respectively. The cause of the decline in the productivity of these provinces was observed as a decrease in the catch-up effect.

Considering the change in agricultural productivity in 2009 compared to the previous year, the top five provinces with the highest TFP value were Şırnak, Siirt, Kilis, Batman, and Diyarbakir. The increase in the catch-up effect caused the increase in productivity of these provinces. The first five provinces where TFP value most decreased were Hakkari, Bayburt, Ordu, Giresun, and Bolu. While the frontier-shift effect determined the decrease in the productivity of Hakkari, the cause of the decrease in other provinces was the catch-up effect.

When the agricultural productivity of 2010 is compared with the year 2009, the following results were reached. Firstly, the first five provinces with the highest TFP values were Bayburt, Trabzon, Samsun, Zonguldak, and Çorum, respectively. While the cause of the increase in productivity in Bayburt, and Trabzon was the catch-up effect, the frontier-shift effect was effective in Samsun, Zonguldak, and Çorum. Secondly, the first five provinces with the lowest TFP value are Ardahan, Hakkari, Şırnak, Karaman, and Ankara, respectively. The reason for this decrease in the productivity of Hakkari and Ankara is the frontier-shift effect, while in Karaman, Şırnak, and Ardahan, the reason for this decrease is the catch-up effect.

When the agricultural productivity change of 2011 is examined in comparison with the previous year, it is observed that Hakkari, Malatya, Yalova, Isparta, and Mardin were the top five provinces with the highest TFP value. It is also seen that while the catch-up effect was influential in Malatya, Isparta, and Mardin's productivity increase, the frontier-shift effect was effective in Hakkari, and Yalova. On the other side, the first five provinces with the smallest TFP value in this period were Kilis, Artvin, Kayseri, Yozgat, and Ordu, respectively. Here, the cause of the productivity decrease in those provinces was the catch-up effect.

The changes in agricultural productivity in 2012 compared to 2011 indicate that the top five TFP values were in Hakkari, Siirt, Artvin, Karaman, and Düzce. The five provinces with the lowest TFP were Nevşehir, Antalya, Bolu, Ankara, and Muğla. While in Hakkari, the frontier-shift effect was influential in productivity improvement, in Siirt, Artvin, Karaman, and Düzce, the catch-up effect was influential. On the other hand, all the negative changes observed in agricultural productivity during this year were the result of the catch-up effect.

When we look at the agricultural productivity change between 2013 and 2012, the five provinces with the highest TFP value were Kilis, Çankırı, Sivas, Kahramanmaraş, and Bitlis, respectively, while the first five provinces with the lowest TFP value were Zonguldak, İzmir, Düzce, Sakarya, and Malatya, respectively. When all the positive effects on TFP change caused by the catch-up effect, all the negative effects on TFP change caused by the frontier-shift effect.

In 2014, according to the previous year, the five provinces with the highest increase in agricultural productivity were Bolu, Zonguldak, Sakarya, Düzce, and Bursa respectively. The five provinces with the lowest agricultural productivity were Malatya, Giresun, Bingöl, Şırnak, and Tunceli. While the catch-up effect is the cause of the increase in agricultural productivity, except Bingöl, the frontier-shift effect is the cause of the decrease in productivity. We can say that the reason for productivity decrease in

Bingöl is the catch-up effect with a slight difference. Namely, both technological and technical inefficiencies affect this situation.

Unlike the previous period, between 2014 and 2015 Giresun and Malatya have the biggest TFP. They are followed by Ordu, Kars, and Gaziantep. The most important reason for this productivity increase is the increase in technical factors, that is the catch-up effect. On the other hand, in this period, Bolu, İstanbul, Ağrı, Denizli, and Isparta became the least productive provinces in agriculture. Again, the catch-up effect is the most important reason for this decrease in agricultural productivity.

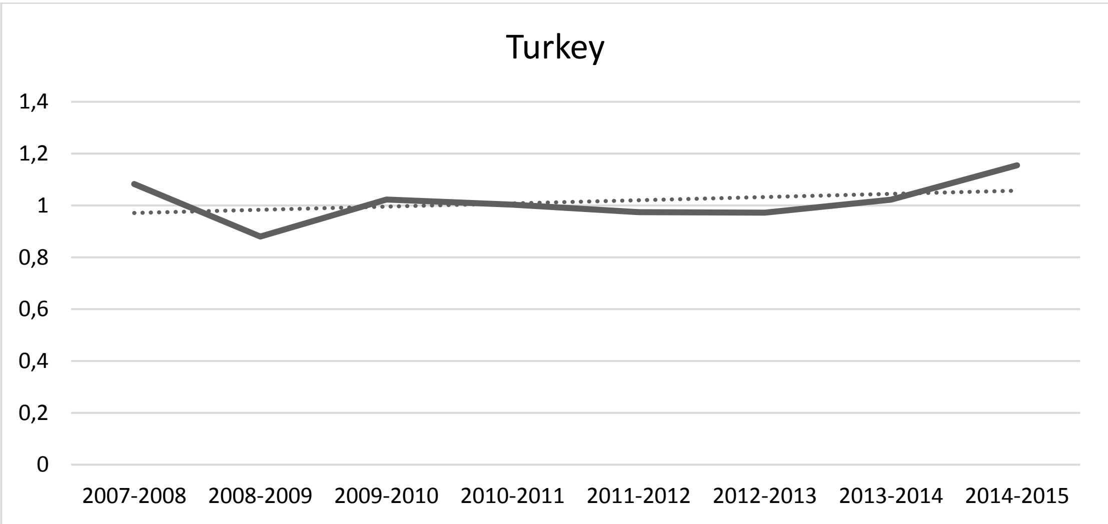
Lastly, in general, Turkey has stable agricultural productivity in the given period. Table 2 shows the mean TFPCH values of all the provinces for each period, and Figure 3 shows the TFP change of Turkey between 2007 and 2015. The level of agricultural productivity in Turkey can be followed annually in this table. For example, between 2008 and 2009, there were only 19 provinces of which agricultural sector is productive. In other words, 62 provinces have realized agricultural unproductivity.

Table 2 The Mean TFPCH Values of All the Provinces for Each Period

	year	**effch**	**techch**	**pech**	**sech**	**tfpch**	**Min tfpch**	**Max tfpch**	**Number of provinces tfpch ≤ 1**	**Number of provinces tfpch > 1**
2	2007-2008	1.113	0.973	1.151	0.967	1.083	0.451	1.955	28	53
3	2008-2009	0.973	0.905	0.934	1.042	0.88	0.232	2.952	62	19
4	2009-2010	0.905	1.131	0.889	1.018	1.023	0.339	2.197	32	49
5	2010-2011	1.034	0.97	1.072	0.965	1.003	0.509	2.29	39	42
6	2011-2012	0.93	1.048	0.939	0.99	0.974	0.625	69.165	60	21
7	2012-2013	1.05	0.925	0.996	1.055	0.972	0.673	1.789	49	32
8	2013-2014	1.082	0.945	1.087	0.995	1.022	0.453	2.196	36	45
9	2014-2015	1.07	1.079	1.053	1.016	1.155	0.757	4.312	25	56
	mean	1.017	0.994	1.012	1.005	1.011	-	-	-	-

When we look at the mean values, although a higher catch-up effect is observed, the overall agricultural productivity is relatively stable around one due to the lower frontier-shift effect. That is, they balance each other. In summary, it is possible to propound that some structural changes are required to obtain a high yield in Turkish agriculture. The factors; such as technological developments and government incentives are affecting productivity to a large extent.

Figure 3 Total Factor Productivity Change of Turkey



5. Conclusion

Even if the prominence of agriculture in the Turkish economy diminishes relatively, it still holds great importance in terms of the domestic food requirement, input to the industrial sector, export and employment opportunities (Yavuz F., 2005). While the share of agricultural sector in GDP was 42.8% 1920s, it decreased to 36.0% in 1970s, 25% in 1980, 16% in 1990, 13.5% in 2000, and 12.6% in 2003. The gradual decrease in the share of the agricultural sector in the GDP is a result of more emphasis on the industrial and service sectors. Hence, Turkey's agricultural sector remained in the background.

Nevertheless, demand for food is expected to increase as the population increases, and thus, investments, incentives, and projects on the agricultural activity must be continuously developed in synchronism with other sectors. The decrease in the share of agricultural sector in GDP should not prevent policy-makers from supporting the agricultural sector. Agricultural sector should benefit from technological developments so that agriculture-related population does not have to tend towards other sectors.

In this study, the agricultural productivity of 81 provinces of Turkey was measured for the 2007-2015 period. The agricultural productivity performances of these provinces, namely, catch-up effect (technical efficiency/efficiency change/EFFCH), frontier-shift effect (technological change/TECHCH) and total factor productivity change (TFPCH) values were calculated by using DEA based Malmquist productivity index and DEAP 2.1 computer program. The data used in this study consists of four inputs, including land, labor, tractor and fertilizer and one output, which is the amount of inflation-adjusted income generated by the agricultural plant production activities of 81 provinces between 2007 and 2015.

The analysis results were evaluated in two different ways. Firstly, when the average of nine years is taken, Hakkari and İstanbul were identified as the most efficient and the least efficient provinces, respectively for the productivity of agricultural production in Turkey. According to this, in the general average, there are 36 provinces in which agricultural sectors are unproductive, whereas there are 45 provinces in which agricultural sectors are productive. Various assumptions were made in the analysis results chapter about the reasons for this situation.

Secondly, whether the agricultural production of each province is efficient or not was examined. This analysis was carried out for each year in the 2007-2015 period. As a result of this analysis, provinces, which have the most efficient and inefficient agricultural production annually, were tried to be revealed. According to this, Giresun, which increases the productivity of agricultural production most in 2007-2008, while

Şırnak is the province with the least increase in productivity. Between 2008 and 2009, Şırnak is the most productive province, contrary to the previous year, and Hakkari is the most unproductive province. The province with the most productivity increase in 2009-2010 is Bayburt, and the province with the most decrease in productivity is Ardahan. The province with the highest productivity increase between the years of 2010 and 2011 is Hakkari, and the province with the most productivity decrease is Kilis. Between 2011 and 2012, the highest productivity is in Hakkari and the lowest in Bingöl. Between 2012 and 2013, the highest agricultural productivity was in Kilis and the lowest agricultural productivity was in Zonguldak. Between 2013 and 2014, agricultural the highest productivity is in Bolu while it is the lowest in Malatya. Lastly, between 2014 and 2015, the productivity of agricultural production is the highest in Giresun while it was the lowest in Bolu. The reasons for these situations have been examined in detail in the chapter of analysis results.

In terms of suggestions for future studies, it is useful to refer to the data collection issue. In Turkey, the agricultural sector has many shortcomings in terms of registration and statistics. Thus, the significance of the data obtained will always be an ambiguous issue. The importance given to the elimination of these deficiencies will give more meaningful results. In this regard, with the cooperation of the universities, trade associations and the Ministry of Food, Agriculture, and Livestock, the agricultural sector is expected to develop, which is vital for Turkey.

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