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Analysis of total factor productivity growth of sugar beet in Iran using Malmquist approach

P. Khaligh Khiavi [(1)*], R. Moghaddasi [(2)] and B. Eskandarpour [(3)]

[(1)] *Ph.D Candidate of Department of Agricultural Economics, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[(2)] *Associate Professor of Department of Agricultural Economics, Science and Research Branch, Islamic Azad University, Tehran,Iran.*
[(3)] *Lecturer in Payame Noor University, Iran*

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ABSTRACT

In this study, total factor productivity(TFP) growth of sugar beet in Iran during 1989-1990 through 2007-2008 was analyzed, using Nonparametric Malmquist approach. So, amounts of inputs usage including seeds, fertilizers, insecticides, herbicides, labor, water use and acreage in one hand and output of sugar beet production on the hand were taken into account. Results showed that sugar beet production acquired good TFP growth (6 percent) in the study period.

Keywords: Malmquist index, nonparametric approach, sugar beet, total factor productivity

INTRODUCTION

Productivity is defined as the output of a determined amount of one or more inputs. This includes the influences of technology, scale and efficiency on using the inputs, i.e. the inclination toward the border productive function. As a whole, the factors of boosting economic productivity could be related to the effective use of sources, considering the specific technology of production, the technological growth, the economically optimum allocation of resources and also the production with scale-related efficiencies. Increasing productivity is the best and most effective way to access economic culmination. The productivity growth is the necessary element factor for the continuous growing of national economy in such an extent that in the developed economies more than half of production growth is fulfilled through it. The productivity growth is defined as a subtraction of the growth resulted from the utilized inputs growth, and in the limited conditions of growing factors, such as water and soil, the most important approach to improve production in agricultural section is productivity growth. The increase in productivity means reducing the costs of each unit of product and the total cost in order to improve the agricultural section efficiency, compared with other economic sections in global market (Salami, 1997)

Among the economic sections in a developing country, the agricultural section is considered to be highly important as a nutrition supplier of a society (Yazdani and Doorandish 2003). In order to grow productivity in Iran`s economy, the agricultural section should be regarded as one of the important active sections in the country because, at present, it consists of 15% of domestic gross production, 27% of employment, and 22% of non-oil exports. Also, this section provides 80.1% of nutrition supplies and fulfills 90% of requirements for processing industries (Tahamipour and Shahmoradi 2007). The productivity growth of all production factors includes changes in production scales, technical efficiency and technology improvement, which would be an appropriate criterion for policy-makers to recognize the weak points and restrictions (Nghiem and Coelle 2007).

Sugar beet is one of the basic products and the

*Corresponding author's email: p.khaligh@srbiau.ac.ir

primary material for the sugar industry in the country. Sugar is one of the nutritional sources which is counted as significant both for having high a level of energy and being used in food industries and also for its import aspect in the country. Sugar beet and sugar cane are the primary materials for the production of sugar, of which sugar beet is produced in vast areas of the country. Sugar is one of the strategic products which, in spite of development in production, a noticeable part of the country requirements are still met by importations (Mohammadi et al. 2005). So, it is highly noted to the augmentation of sugar productivity in the agricultural section, as one of the important agricultural products in Iran, because increasing productivity could be associated with the accessing to economical ideals. Therefore, considering productivity criterion and the indices calculation could be an appropriate scale by which one might recognize the correct way to the effective use of the production factors regarding the shortage of resources (Akbari and Ranjkesh 2003). Sugar beet cultivation areas in Iran in 2008-2009 are estimated to be 57,000 hectares. The Khorasan province, with 35.34% of total cultivation areas, is at the first rank. West Azerbaijan, Fars, Kermanshah, Semnan and Ardebil provinces, with 24.29%, 10.91%, 7.90%, 3.95% and 3.50% of total cultivation areas, are at second to sixth rank, respectively, which totally amount to 85.90% of the cultivation areas. The least cultivation area belongs to Ilam province with 26 hectare. The total sugar beet production in the country, in the so-called year, is calculated to 2 million tons. Khorasan province, with the production of 33.1%, is at first rank followed by the provinces of West Azerbaijan, Fars, Kermanshah, Ardebil and Semnan, with the production of 30.25%, 8.19%, 7.26%, 4.79% and 2.30% are at the second to sixth rank, respectively. It is necessary to mention that Ardebil, in comparison to Semnan province, with the less cultivation area, has a higher proportion of production in total. For the 6 provinces, the total production amounts to 86.80% (Database of Agriculture, Ministry of Agriculture 2009).

Average sugar yield in Iran in year 2008-2009 has been 35.9 ton/hectare. The highest and lowest root yields, in the country, belong to Ardebil and Zanjan provinces, respectively (Datebase of Agriculture, Ministry of Agriculture 2009).

The productivity fluctuation is one of the most controversial issues in the economic growth and many studies have been done in this regard. Zare et al. (2008) evaluated the effective factors influencing cotton productivity, by using Malmquist Index. The results show that the average annual growth of productivity for total production factors, just a small amount, was positive. Mazhari and Mohaddes (2007) measured and analyzed the total and partial productivities of Khorasan province strategic products, including irrigated crops such as wheat, barley, cotton and sugar beet, by using Tranquist-til. The outcome shows the positive growth of total productivity of production factors for the so-called products. Rafiyee and Mojaverian (2007) evaluated the total productivity for wheat production factors in 8 provinces. Gholizadeh and Saleh (2007) calculated the productivity fluctuations in 7 major sections of Iran`s economy by using Malmquist Index. The results showed that, in the agricultural section, the productivity of production factors has been increased because of the improvement of management efficiency. Yazdani and Doorandish (2003) calculated the productivity of production factors of rice varieties in Guilin, Mazandaran and Golestan provinces by using Tranquist-til non-parametric index. The results showed that, in all provinces, the high-yielding variety had the positive productivity growth whereas the quality (desired) variety had the negative productivity growth. Mojaverian (2003) calculated the Malmquist productivity index for wheat, barley, cotton, rice and sugar beet. The results of research showed that the productivity in irrigated production (except for barley) had been increased. Mohammadi et al. (2005) evaluated the factors and inputs of production in sugar beet fields in Eghlid, Fars, Iran. For measurement of inputs productivity, they used Cub-Doglas' production function. The results of study showed that the users of work forces inputs use mechanization and seeds more than economical optimum levels and use manures less than economical optimum limits.

Many studies have been done, in other countries, regarding the productivity growth of production factors in agricultural section. Suhariynto (2004) calculated productivity of total production factors by using Malmquist Index for 18 Asian countries. The results showed that, in spite of the rapid growth of agricultural production, in half of these countries, during 1960-1996, the productivity was being reduced. Thirtle et al. (2003) calculated the multi-factor efficiency and productivity by using chain Malmquist Index in 18 areas of Botsoana and obtained 1.7% for the total productivity

index growth. Jayasuriya (2003) showed that the decrease of tea production costs in Srylanka is affected by technology changes, so that, in spite of noticeable reduction of inputs quantities, the production was constant during this period. Coli and Prasada Roa (2003) evaluated the productivity trend in Agricultural section in 93 developed and developing countries, including Iran, by using Malmquist Index. The results showed that China and Colombia had the utmost productivity growth and Iran was at the rank of 54 among 93 countries from the productivity growth fluctuation standpoint and the analysis represented that the major part of productivity growth is based upon the technology changes. Bayarsaihan and Coli (2002), in a study in Mongolia, showed that the technological changes for grains had a decline. Lall et al. (2002), by using Malmquist Index, calculated productivity growth in 30 countries located in the west bank of Atlantic Ocean. On the basis of the obtained results, the average productivity growth in North America was 1.019, in Latin America 0.997 and in Caribbean areas was 0.986. The evaluation showed that the total production factors productivity growth has direct relation to economical, political and social conditions of the countries. Nighem and Coeli (2001) calculated the productivity growth of total production factors in 8 states of Vietnam, by using the Malmquist Index, which showed the annual growth of 3.3% in rice production.

So many studies in the country and abroad, in the field of the productivity of total production factors of different crops, display the importance of this discussion. Additionally, paying attention to the fact that sugar beet is one of the basic products in agronomy and economy and considering that, until now, there is no research or any review of literature in this regard for sugar beet, the present study deals with productivity growth of total production factors of sugar beet in Iran, by using non-parametric Malmquist Index, during the years of 1989-1990 to 2007-2008. By analyzing this index, researchers could evaluate the influence of changes on production scale, technology and technical efficiency and the major factors of productivity growth in sugar beet.

MATERIALS AND METHODS

Improvement of productivity, considering the scarcity of production resources, is the best and most effective method to achieve the economical growth. Through the calculation of productivity index of production factors, the efficiency of economical sections in using production resources could be evaluated. Productivity can be calculated in two ways, which are total productivity and detailed productivity of total production factors. The problem with using detailed productivity for analyzing productivity, in a system or organization, is that the influences of other factors on productivity process are ignored. But total productivity approach could reveal the influences of all of the common inputs applied in production (Mc Erlean and Wu 2003).

For calculation of total productivity growth, parametric (econometry) and non- parametric methods are proposed. In parametric method, the productivity growth is measured by the techniques of econometry. In non-parametric method, the total productivity of production factors could be calculated by using Index number method or mathematical programming. In this method, an index is made of output and input, on the basis of which the productivity index would be calculated. Malmquist Index is one of the indices for calculation of productivity of total production factors (Emami and Meybodi 2000). The index in question, for the first time, was represented in 1953 and then was used for productivity calculation by Cavez et al. (1982). In the following years, many researchers, such as Thirtel et al. (2003), Jayasorya (2003), Coli and Parasad Roa (2003), Bayarsyahan and Coli (2002), Lall et al. (2002), Zare et al. (2008), Rafiyee and Mojaverian (2007), Gholizadeh and Saleh (2007) and Mojaverian (2003) have used this index for the calculation of productivity of total production factors. This index is defined on the basis of distance function and includes a vector of products, which could be produced through a constant technology and using a definite vector of inputs. Shepherd (1970) defined the distance function of the product as the Equation (1), considering the total products as p(x):

$$d_0 (x,y) = \min [\delta : (y/\delta) \in (p(x)] \quad (1)$$

In this case *p(x)* represents all the vectors of product (y) that could be produced by using input *(x)*. d_0 *(x,y)* has a plateau , non-descending relation with *y* and the Distance Function has a rising relation with *x*. If *y* was on the utilities curve, the distance function quantity would be equal to 1. In the above equation, δ is a scalar quantity and the representative of distance of real production from the border production. Therefore, the distance function could measure the possible utmost production, at a definite level of utilization inputs,

showing the technical efficiency. Considering the identity of Distance Function, the Malmquist productivity index could be defined as the Equation 2 as below (Fare et al., 1994):

$$m_0(y_s, x_s, y_t, x_t) = \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} \times \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)}\right]^{1/2} \quad (2)$$

In the above equation, $d_0^s (y_t, x_t)$ is the representation of Distance Function of the production which could be obtained on the basis of the quantity of input utilization of period $(x_t)t$ and by using technology *s* and considering the amount of period production (y_t) *t*. If the amount of m_0 is more than 1, the production growth of total factors could be met during *t* to *s*, while if the amount is less than 1 the productivity of total production factors would have the descending trend. The pitfall of the equation (2) is that the changes of productivity growth of the total production factors, which are a series of changes in technology, production scale and technical efficiency, are shown as one figure. Fare et al. (1994), for resolving the problem, raised this point that the Equation (3) is equal to Equation (2):

$$m_o(y_s, x_s, y_t, x_t) = \frac{d_o^t(y_t, x_t)}{d_o^s(y_s, x_s)}, \left[\frac{d_o^s(y_t, x_t)}{d_o^t(y_t, x_t)} \cdot \frac{d_o^s(y_s, x_s)}{d_o^t(y_s, x_s)}\right]^{1/2} \quad (3)$$

In the above equation, the fraction outside the bracket measures the changes in technical efficiency in the durations of *t* and *s*. The fraction inside the bracket measures the changes of technological efficiency and is equal to the geometric average of the technological changes during the periods of *t* and *s*.

The required data for conducting the present study consisting of the production quantity and the sugar beet cultivation areas around the country were obtained from the Statistics and Information Technology Office (the Database of Agronomy Section) in the Ministry of Jihad-e-Agriculture and the production factors including consumptive seeds, manure, chemical fertilizers, herbicides, pesticides and, work forces and consumptive water during the years of 1989-1990 to 2007-2008 were gained from the agricultural crops production costs calculation system of Ministry of Jihad-e- Agriculture.

Table 1. The average changes of total productivity of production factors in sugar beet crop in Iran during the years of 1989-90 to 2007-2008.

Changes in the Total Productivity of Factors	Changes in Quantities	The Net Change in Efficiency	Changes in Technology	Changes in Technical Efficiency
1.06	1	0.998	1.062	0.988

RESULTS AND DISCUSSION

Considering the importance of sugar beet in agricultural section and in the sub-division of agronomy in Iran, in this study, the productivity of total sugar beet production factors in the country was evaluated during the years of 1989-1990 to 2007-2008. For evaluation of changes in productivity of total factors for sugar beet production, the used inputs were classified in 8 groups, including working forces, cultivation areas, chemical fertilizers and manure utilization, herbicides, insecticides, water consumption and the seed consumption. In this study, at first the sugar productivity growth of total factors of sugar beet production was calculated, then the effective factors in changing the growth of the total factors were determined through Malmquist Index for these sowing years.

As the Table 1 shows, the productivity growth is the outcome of the changes in technical efficiency, the technological changes, the net changes in efficiency and the changes of measurements efficiency. According to Table 1, the average productivity growth of total factors and the average technological growth for sugar beet in Iran during the years of 1989-2008 are 6% and 6.2%, respectively. Also, the average productivity growth and its features during this period are negative and the scale growth is estimated to 0. According to Table 1, the results related to changes in efficiency, technology and productivity of total factors in sugar beet production show that sugar beet, during these years, has had positive growth in productivity of total factors of production.

Considering the alternative features of total productivity and calculation of these features for the studied crop, one could observe that in sugar beet, changes in the technology has caused improvement of productivity of total factors of sugar beet production, although the crop has been faced with the lack of efficiency (change in efficiency: 0.988) in production. The study of the rec-

orded researches and articles in this regards, including Nigham and Coli (2007), Mojaverian (2003), Rafiyee and Majaverian (2007), Gholizadeh and Saleh (2007) and Zareh et al. (2008), represents the improvement in productivity of total factors of production of agricultural crops, depending on the type of which this improvement is resulted from, the positive changes in efficiency or technology, or both.

Consequently, the results of the research showed that sugar beet, from the productivity growth standpoint, is in a good condition and the average productivity growth during years of 1989-2008 is 60%.

According to the obtained results, further studies are recommended to improve the sugar beet productivity growth. The efficiency of sugar beet has a negative growth. This matter necessitates doing the inclusive and specific studies to clarify if the farmers, from the beginning, have been equipped with the high level of efficiency and the increase of production is possible just through the new inputs, or, because of the weak management of production, farmers have acted weakly in using inputs and no changes have been done in their management during the period. So, development of extension programs for better application of inputs and, therefore, boosting the efficiency of sugar beet production, is advised.

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