Non Parametric Approach for Wheat Production in Egypt and Spain

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Abstract

This study has focused on comparison the total factor productivity (TFP) of wheat production in Egypt and Spain during the time period 1995-2013. The study applies the Malmquist TFP index [model of DEA (Data envelopment analysis)]. The results indicate that the mean of TFP for wheat production in Spain higher than Egypt.

Keywords: wheat, TFP, DEA, Egypt, Spain.

Introduction

Wheat is one of the most important cereals grown successfully in Egypt. Wheat in Egypt cultivated in the old lands that found in Nile Valley and Delta; and in the new lands that have been reclaimed (Gowayed, 2009). Wheat can be grown all over Spain. In higher areas it is often the only crop possible. Wheat, as well as barley, is mainly grown as a winter crop. Sowing is done in autumn and Northern European spring-wheat varieties may be used for this purpose. In the higher areas of the central plateau, sowing in spring may be preferred because the risk of winter killing (Belderok et al., 2000). Measuring efficiency is the popular approach to understand the performance of farmers in mobilizing their resources in the given technology (Khanal et al., 2012). This paper is organized as follows: the next section deals with the methodology; section 3 indicates the data and results. The final section presents the conclusions.

Methodology

The nonparametric approach to measure TFP growth uses a linear programming method, in this method Malmquist index is defined using distance function. Malmquist index, does not require any assumptions regarding efficiency and functional form, and is therefore able to distinguish between the factors causing changes in productivity. According to Coelli (1996), Malmquist TFP index [model of DEA (Data envelopment analysis)] may be used to measure productivity change and to decompose the productivity change into technical change and technical efficiency in the presence of panel data. The Malmquist TFP index was introduced as a theoretical index by Caves et al. (1982) and popularized as an empirical index by Färe et al. (1994). They defined the TFP index using Malmquist input and output distance functions, and thus the resulting index came to be known as the Malmquist TFP index (Chaudhary, 2012). The Malmquist TFP change index between period *t* (the base period) and period *t+1* is given by equation (1):

$$M^t = \frac{D_o^t\ (x^{t+1}, y^{t+1})}{D_o^t\ (x^t, y^t)} \qquad (1)$$

where, $D_o^t\ (x^{t+1}, y^{t+1})$ is the output distance function at the observed input vector x and the observed output vector y. $D_o^t\ (x^{t+1}, y^{t+1})$ represents the distance from the period *t+1* observation to the period *t* technology; i.e., they define the productivity index as the ratio of two output distance functions taking technology at time *t* as the reference

technology. Instead of using period *t*'s technology as the reference technology it is possible to construct output distance functions based on period (*t+1*)'s technology and thus another Malmquist productivity index can be laid down as equation (2):

$$M^{t+1} = \frac{D_o^{t+1}\ (x^{t+1}, y^{t+1})}{D_o^{t+1}\ (x^t, y^t)} \qquad (2)$$

Färe et al (1994) specify Malmquist productivity change index as the geometric mean of two-period indices that is (3):

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\left(\frac{D_o^t\ (x^{t+1}, y^{t+1})}{D_o^t\ (x^t, y^t)}\right)\left(\frac{D_o^{t+1}\ (x^{t+1}, y^{t+1})}{D_o^{t+1}\ (x^t, y^t)}\right)\right]^{1/2} \qquad (3)$$

The equation (3) can be written as the product of two distinct components, technical change and efficiency change (Färe et al. 1994), as it is shown in equation (4):

$$M_o\ (x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_o^{t+1}\ (x^{t+1}, y^{t+1})}{D_o^t\ (x^t, y^t)}\left[\left(\frac{D_o^t\ (x^{t+1}, y^{t+1})}{D_o^{t+1}\ (x^{t+1}, y^{t+1})}\right)\left(\frac{D_o^t\ (x^t, y^t)}{D_o^{t+1}\ (x^t, y^t)}\right)\right]^{1/2} \qquad (4)$$

where,

$$Efficiency\ change = \frac{D_o^{t+1}\ (x^{t+1}, y^{t+1})}{D_o^t\ (x^t, y^t)}$$

$$Technical\ change = \left[\left(\frac{D_o^t\ (x^{t+1}, y^{t+1})}{D_o^{t+1}\ (x^{t+1}, y^{t+1})}\right)\left(\frac{D_o^t\ (x^t, y^t)}{D_o^{t+1}\ (x^t, y^t)}\right)\right]^{1/2}$$

Hence the Malmquist productivity index is simply the product of the change in relative efficiency that occurred between period's *t* and *t+1*, and the change in technology that occurred between period's *t* and *t+1*. A value of Malmquist TFP index equal to one implies there has been no change in total factor productivity across the two time periods, greater than one implies a growth in TFP and a value less than one is interpreted as deterioration in TFP. A similar interpretation applies to the two components as well. To estimate the Malmquist TFP index the study use DEAP (Data envelopment analysis program) version 2.1 of Coelli (1996).

Data and results

Table 1 shows the production and area of wheat in Egypt and Spain during the time period 1995-2013. In Egypt, the wheat production increased from 5722.44 thousand ton in 1995 to 9460.20 thousand ton in 2013. The annual average percentage growth rate of wheat production for the time period 1995-2013 is 2.83%. The wheat area increased from 1055.38 thousand hectare in 1995 to 1418.71 thousand hectare in 2013. The annual average percentage growth rate of wheat area for the time period 1995-2013 is 1.66%. In Spain, the wheat production increased from 3138.70 thousand ton in 1995 to 7602.60 thousand ton in 2013. The annual average percentage growth rate of wheat production for the time period 1995-2013 is 5.04%. The wheat area decreased from 2126.40 thousand hectare in 1995 to 2121.90 thousand hectare in 2013. The annual average percentage growth rate of wheat area for the time period 1995-2013 is -0.01%.

Table 2 shows a decomposition of Malmquist Index (TFPCH) for wheat production in Egypt and Spain during the time period 1995-2013 into two components, efficiency change (EFFCH) and technical change (TECHCH).

Table 1. Production and area of wheat in Egypt and Spain (1995-2013).

	Egypt		Spain	
Year	Wheat Production (Thousand Ton)	Wheat Area (Thousand Hectare)	Wheat Production (Thousand Ton)	Wheat Area (Thousand Hectare)
1995	5722.44	1055.38	3138.70	2126.40
1996	5735.37	1017.19	6040.50	2012.40
1997	5849.13	1044.59	4676.29	2078.55
1998	6093.15	1017.28	5436.30	1912.56
1999	6346.64	999.10	5083.80	2422.40
2000	6564.05	1034.99	7293.62	2353.03
2001	6254.58	983.74	5007.70	2177.01
2002	6624.87	1029.59	6822.16	2406.64
2003	6844.69	1053.02	6290.10	2151.50
2004	7177.86	1094.74	7096.72	2175.03
2005	8140.96	1253.82	4026.69	2274.11
2006	8274.23	1286.75	5521.58	1920.23
2007	7379.00	1140.98	6436.36	1803.31
2008	7977.05	1226.65	6714.30	2067.00
2009	8522.10	1335.30	4804.77	1772.75
2010	7177.40	1287.63	5941.20	1948.07
2011	8407.13	1284.95	6876.66	1994.65
2012	8795.48	1336.23	4650.30	1758.90
2013	9460.20	1418.71	7602.60	2121.90
Mean	7228.80	1152.71	5761.07	2077.71
Rate[a]	2.83	1.66	5.04	-0.01

([a]) Annual average percentage growth rate (1995-2013)

Source: FAOSTAT and own elaboration

Table 2. Malmquist Indices of wheat production in Egypt and Spain (1995-2013).

	Egypt			Spain		
Period	Efficiency Change (EFFCH)	Technical Change (TECHCH)	Total Factor Productivity Change (TFPCH)	Efficiency Change (EFFCH)	Technical Change (TECHCH)	Total Factor Productivity Change (TFPCH)
1995-1996	1.000	1.040	1.040	1.956	1.040	2.034
1996-1997	1.000	0.993	0.993	0.755	0.993	0.750
1997-1998	1.000	1.070	1.070	1.181	1.070	1.263
1998-1999	1.000	1.060	1.060	0.697	1.060	0.738
1999-2000	1.000	0.999	0.999	1.478	0.999	1.477
2000-2001	1.000	1.002	1.002	0.740	1.002	0.742
2001-2002	1.000	1.012	1.012	1.218	1.012	1.232
2002-2003	1.000	1.010	1.010	1.021	1.010	1.031
2003-2004	1.000	1.009	1.009	1.106	1.009	1.116
2004-2005	1.000	0.990	0.990	0.548	0.990	0.543
2005-2006	1.000	0.990	0.990	1.640	0.990	1.624
2006-2007	1.000	1.006	1.006	1.234	1.006	1.241
2007-2008	1.000	1.006	1.006	0.905	1.006	0.910
2008-2009	1.000	0.982	0.982	0.850	0.982	0.834
2009-2010	1.000	0.873	0.873	1.288	0.873	1.125
2010-2011	1.000	1.174	1.174	0.963	1.174	1.130
2011-2012	1.000	1.006	1.006	0.762	1.006	0.767
2012-2013	1.000	1.013	1.013	1.338	1.013	1.355
Mean[a]	1.000	1.012	1.012	1.038	1.012	1.050

([a]) **Geometric mean (1995-2013)**

Source: FAOSTAT and own elaboration

Table 2, illustrates the following, the mean of TFPCH of wheat production in Egypt during the time period 1995-2013 has a value more than one and shows a progress, this progress is due mainly to the behavior of technical change component than the efficiency change component. The period 2009-2010 in Egypt has the more declining in TFPCH by 12.7%. The mean of TFPCH of wheat production in Spain during the time period 1995-2013 has a value more than one and shows a progress, this progress is due mainly to the behavior of efficiency change component than the technical change component. The period 2004-2005 in Spain has the more declining in TFPCH by 45.7%.

Conclusions

This study is intended to compare the total factor productivity change of wheat production in Egypt and Spain over the time period 1995-2013. The study use Malmquist TFP index (DEA model) to decompose the total factor productivity of wheat production in Egypt and Spain into efficiency change and technical change. The data of this study are obtained from FAOSTAT. The mean of TFPCH of wheat production in Egypt during the time period 1995-2013 has a value more than one and shows a progress, this progress is due mainly to the behavior of technical change component than the efficiency change component. The mean of TFPCH of wheat production in Spain during the time period 1995-2013 has a value more than one and shows a progress, this progress is due mainly to the behavior of efficiency change component than the technical change component. The study suggests the following recommendations, increase the area of wheat production and improve the technology of wheat production.

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الملخص

الهدف من هذة الدراسة مقارنة تغير معدل االانتاجية الكلية لانتاج القمح في مصر و اسبانيا خلال الفترة الزمنية ١٩٩٥-٢٠١٣. استخدمت الدراسة طريقة Malmquist TFP index (DEA model) لتحليل معدل االانتاجية الكلية لانتاج القمح في مصر و اسبانيا الي تغير الكفاءة و التغيرالتقني. البيانات المستخدمة في تلك الدراسة تم الحصول عليها من FAOSTAT. اوضحت النتائج ان معدل االانتاجية الكلية لانتاج القمح في اسبانيا اعلى من مصر خلال فترة الدراسة. اوصت الدراسة بزيادة مساحة القمح المزروعة وتحسين تقنية انتاج القمح.