TOTAL FACTOR PRODUCTIVITY GROWTH IN THE TURKISH REGIONAL MANUFACTURING INDUSTRIES

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1. Introduction

In recent years, there has been a considerable amount of research on the productivity growth in the manufacturing sector at the regional level in many countries. (See, for example, Mas *et al.,* 2000; Weber and Domazlicky, 1999; Melachroinos and Spence, 2001). Regarding Turkey, there have been a considerable number of studies dealing with productivity in the manufacturing sector. See, for example, Krueger and Tuncer, 1982; Yıldırım, 1989; Uygur, 1990; Gökcekuş 1997, Karadağ *et.al* 2004). In spite of the fact there is a relatively extensive literature on total factor productivity (TFP) in Turkish manufacturing sector, there appears to be a shortage of studies at regional level. To the authors' best knowledge, this study is the first attempt to measure changes in TFP and in its components in the Turkish private manufacturing industry in the geographic regions at the geographic regional level. Studying TFP changes in the Turkish private manufacturing industry at regional level gains importance, as this will give some information about the comparative advantage of each region in terms of productivity. Moreover, investigation of the causes of changes in productivity at regional level will be helpful in formulating economic policies for the reduction of disparities between the seven geographic regions. The elimination of regional disparities has been a crucial dimension of Turkish regional policies. Thus, the evaluation of productivity performance of the regions becomes an important concept.

Thus, the main objective of this study is to compute total factor productivity change of the Turkish private manufacturing industry in the geographical regions by using panel data for the period 1980-2000. We employ the Malmquist productivity index developed by CAVES *et al.,* 1982 for the aim of the study. In our study, following FÄRE *et al.,* 1994, productivity growth is considered as a joint effect of the shift in the production frontier (technological progress) and a movement towards the frontier (efficiency). Regarding this, the data envelopment analysis (DEA) technique is employed to calculate changes in productivity and in its components.

The remainder of this paper is organised as follows. Section two gives brief background information about regional economics of Turkey. In section three, Section the methodology used in the study is explained. Section four provides information about the data set used in the study. Evaluation of the results are summarised and discussed in section five. The paper concludes with a summary analysis of the findings in section six.

2. Background Information about Turkish Regional Economics

The Turkish economy grew at an average rate of around 4 % between 1990-2000. Moreover, the share of manufacturing industry in the Turkish economy has increased from 15% in 1970 to 20% in 2000 and the growth rate of this industry has been around

6 % on average over these years[1]. However, Turkey is still a country with inequalities across the regions in terms of economic activity. There is an excessive agglomeration of people and industry in the western part of the country. Thus, relatively developed regions in the western part of the country enhance inequalities between the regions. The regional disparities in the country have been an important issue in terms of regional economic policies.

Table 1 sheds a light on economical development of the seven geographical regions by providing some basic recent data.

Table 1: Basic Data for Turkish Geographical Regions

Regions	*Share of Total Population in 1997 (%)*	*Share of Total GDP on Average (1991-1997) (%)*	*Share of Total Value-added in the Manufacturing Industry on Average (%) (1980-2000)*
Aegean	13.44	15.61	15.73
Mediterranean	12.82	12.18	8.16
Marmara	25.75	36.56	59.60
Central Anatolia	16.83	16.57	9.38
Black Sea	12.48	9.55	4.65
South Eastern Anatolia	9.75	5.43	1.89
Eastern Anatolia	8.93	4.09	0.59

As the Table indicates, there is a clear existence of regional disparities in population, income distribution. As can be seen from the Table, Marmara region, as the dominant region in Turkey, has 59.60 % of output of Turkish manufacturing industry, 36.56 % of GDP on average, and 25.75 % of the total population in 1997. In spite of the fact that the share of Eastern Anatolia has around 9 % in total Turkish population, it has only 0.59 % share in total manufacturing output.

In this context, the performance of the manufacturing industry will have a positive contribution to reduce regional disparities, since the share of manufacturing industry in the Turkish economy is considerably high, and has increased in recent years.

3. Methodology

In this study, the Malmquist productivity index is used in order to measure productivity performance of the private manufacturing industries in the seven regions. This index was introduced by CAVES *et al*., 1982. As FÄRE *et al.*,1994, states, Malmquist index does not require specified functional form for technology and maintained hypotheses of technical and allocative efficiency.

Following COELLI *et al.*, 1998, and FÄRE *et al.*, 1994, a production technology at time is defined as t=1, …T, which represents the outputs, $y_t = (y_1, \ldots, y_M)$, which can be produced using the inputs $x_t = (x_1, \ldots, x_K)$, as:

$$R^t = \{(x_t, y_t) : x_t \text{ can produce } y_t\}. \tag{1}$$

By following SHEPHARD, 1970, the output distance function relative to technology of R^t can be defined as:

$$D_0^t(x_t, y_t) = \min\{\varphi : (x_t, y_t / \varphi) \in R^t\}. \tag{2}$$

The distance function is the inverse of FARELL's, 1957 and calculates how far an

[1] See State Planning Organization (SPO), Main Economic Indicators, (http://www.dpt.gov.tr)

observation is from the frontier of technology. Distance $D_0^t(x_t, y_t) = 1$ if and only if (x_t, y_t) is on the frontier of the technology, $D_0^t(x_t, y_t) \leq 1$ if and only if $(x_t, y_t) \in R^t$. Similarly,

$$D_0^t(x_{t+1}, y_{t+1}) = \min\left\{\varphi : (x_{t+1}, y_{t+1} / \varphi) \in R^t\right\}. \tag{3}$$

Following FÄRE *et al.*, 1994, Malmquist index of productivity change between period *t* and *t+1* is defined as

$$M_0^{t,t+1} = \left[\left(\frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)}\right)\left(\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_t, y_t)}\right)\right]^{1/2}, \tag{4}$$

where $D_0^{t+1}(x_t, y_t)$ denotes the distance from the period *t* observation to the period *t+1* technology.

Efficiency and technical changes are the two components of TFP change (see NISHIMIZU and PAGE, 1982; and FÄRE *et al.*, 1994, for pioneering studies) as defined below:

$$\text{Efficiency Change } (EC) = \frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)}, \tag{5}$$

$$\text{Technical Change } (TC) = \left[\left(\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_{t+1}, y_{t+1})}\right)\left(\frac{D_0^t(x_t, y_t)}{D_0^{t+1}(x_t, y_t)}\right)\right]^{1/2}, \tag{6}$$

Hence productivity change defined in equation 4 becomes

$$M_0^{t,t+1} = EC \cdot TC. \tag{7}$$

So, when there is an increase in the level of productivity from period *t* to *t+1* then $M_0^{t,t+1} > 1$.

It should be mentioned that the returns to scale properties of technology is very important in TFP measurement as far as Malmquist index is concerned. Malmquist index might not correctly measure TFP changes when variable returns to scale (VRS) assumed for the technology as Grifell-Tatjé and Lovell, 1995, illustrated. Therefore, it is important to impose constant returns to scale (CRS) on any technology which is used to estimate distance functions regarding the calculation of Malmquist TFP index.

4. Data

In this study, we used output, employment, and capital data related to private manufacturing industry at regional levels for the aim of the study. The data covers the time period of 1980 to 2000 for Turkey and the seven regions.

The data set related to private manufacturing industry of each region was obtained from several issues of Annual Manufacturing Industry Statistics published by State

Institute of Statistics (SIS). Manufacturing industry wholesale price index was obtained from several issues of Monthly Bulletin of Wholesale Price Index, published by SIS. Investment deflators for public investments were taken from Main Economic Indicators published by State Planning Organisation (SPO).

The private output is calculated by subtracting the value of the stock at the beginning of a year from the total sales plus the value of the stock at the end of that year, and was measured in constant prices by taking 1994 as the base year. Inputs used in our model are labour and capital at regional levels. The labour input is measured as total number of workers in production. The private capital input is measured as the total horsepower[2].

5. Results

In this study, we employed the DEAP 2.1 program described in COELLI, 1996, to compute the distance functions through linear programming technique and then used them to calculate Malmquist productivity index as well as efficiency change and technical change for each region. Productivity is decomposed into changes in efficiency (catching up) and changes in technology (innovation) by following FÄRE *et al.,* 1994,

Before presenting the results for each region, we give the annual average performance of the Turkish private manufacturing industry in aggregate for the entire time period. Table 2 presents the results regarding annual change in TFP and in its components in the Turkish private manufacturing industry for Turkey. As mentioned before, if the value of the Malmquist index or any of its components is less than one, then there is deterioration. On the other hand, if the value is bigger than one, then there is improvement in the relevant performance. Hence, subtracting one from the numbers reported in Table 2 gives percentage increase or decrease per year for the relevant time period and relevant performance measurement.

Table 3. Annual Average Changes in TFP and in its Components on Average

Year	Efficiency Change	Technical Change	TFP Change
1980/81	0.874	1.173	1.024
1981/82	1.163	0.801	0.931
1982/83	1.015	0.956	0.969
1983/84	1.046	0.947	0.991
1984/85	0.934	1.105	1.032
1985/86	0.990	1.064	1.053
1986/87	1.074	0.935	1.005
1987/88	0.995	1.022	1.017
1988/89	1.007	0.997	1.004
1989/90	0.988	1.046	1.034
1990/91	1.006	1.061	1.067
1991/92	0.999	1.009	1.008
1992/93	0.981	1.047	1.027
1993/94	1.001	0.983	0.985
1994/95	1.010	0.956	0.966
1995/96	0.998	0.976	0.974
1996/97	0.992	1.022	1.014
1997/98	1.020	1.002	1.022
1998/99	0.977	1.019	0.996
1999/2000	1.018	0.975	0.992
Average	1.003	1.002	1.005

[2] Total horsepower of installed equipment can also be used as a proxy for capital. (see, Taymaz and Saatçi, 1997).

As can be seen from the table, TFP in Private manufacturing industry increased slightly (0.5% on average) over the entire period in aggregate. Increase in productivity is Efficiency change plays more important role in productivity growth. There are fluctuations regarding both efficiency and technical change for the entire time period. This might be explained by business cycle effect experienced by the Turkish economy between 1980 and 2000[3]. The highest increase in TFP is in between 1990-1991, while there is an dramatic decrease in productivity between 1981-1982.

After giving the aggregated results, the results at the regional level are presented in Table 3. However, as it is difficult to summarize the disaggregated results, the results on average for the entire time period is given in the Table. The technical efficiency values for the initial year, 1980 is also given in the table in order to see whether there is a catching up process for the regions.

Table2: Average Annual Changes in TFP and in its Components *in the Turkish Private Manufacturing Industries of the Regions over 1980-1998*

Region	Efficiency Level (1980)	Efficiency Change	Technical Change	TFP Change
Marmara	1.000	1.000	1.013	1.013
Aegean	0.910	1.005	1.010	1.015
Mediterranean	1.000	1.000	1.004	1.004
Central Anatolia	0.878	1.007	0.997	1.003
Black Sea	0.841	1.002	1.003	1.005
South Eastern Anatolia	0.822	1.006	0.995	1.001
Eastern Anatolia	0.829	1.003	0.993	0.995
Mean		1.003	1.002	1.005

As the table shows, the divergence of technical change rather than efficiency change among the regions seems to be the major factor underlying regional disparity in the Turkish private manufacturing industry. As can be seen from the table, apart from the Eastern Anatolia region, all regions had an increase in productivity on average for the entire period. The highest average TFP increase is in Aegean (1.5 %), followed by the Marmara region (1.3%). The increase in productivity in Marmara region is explained by the technological progress. The increase in Marmara region is not surprising as this region has around 60 % of value-added created by the manufacturing industry (see also Table 1). On the other hand, the increase in the Aegean region might be due to the catching up process. The catching up process can be clearly seen for other regions such as Central Anatolia and Black Sea regions.

On the other hand, Eastern Anatolia has decrease in productivity (0.5 % on average. This decrease is explained by deterioration in technology. South Eastern Anatolia has the second worst performance The low performance of this region is also explained by deterioration in technology. The relatively low performance of these two regions is not surprising, since these regions are the least developed regions in Turkey. They have only 2.5 % of value added created by the manufacturing industry.

Hence, one can say that increasing has had a considerably positive contribution to aggregate private sector output performance but has had a negative effect on the balanced regional development dramatically as far as the manufacturing industry is concerned.

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[3] BOISSO *et al.*, 2000, pointed out the effects of business cycle on productivity slowdown for United States economy.

6. Conclusion

In this study, we have employed output oriented DEA method to measure efficiency change, technical change, and TFP change in the Turkish private manufacturing industries at the regional level for the time period 1980-2000. The Malmquist productivity index was used to measure changes in TFP and in its components.

The results indicate that efficiency change plays a main role in contributing TFP change in aggregate in the Turkish private manufacturing sector for the time period. The findings of the study also indicate that the divergence of efficiency change between the regions appears to be the main reason for the regional disparity in productivity. Amongst the regions, only one region showed deterioration in terms of TFP change on average regarding the regions that experienced improvement, only two provinces had an over 1 % increase on average.

Hence, one can say that specific guidance is required to promote productivity in the seven regions. For example, regions that have deterioration in TFP or relatively small TFP growth require the introduction of new frontier technology. In regions in which technical efficiency is small a policy to enhance the efficient use of existing technology is required to catch up frontier technology. In spite of the fact that the manufacturing sector is not the whole economy, the public policies to narrow the gap between the regions of Turkey regarding this sector will make a positive contribution to reduce regional disparities.

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