TFP CHANGE IN THETURKISH MANUFACTURING INDUSTRY IN THE SELECTED PROVINCES: 1990-1998

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ABSTRACT

The main aim of this paper is to estimate total factor productivity (TFP) change of the private and public sectors in the manufacturing industry in the selected provinces of Turkey by using panel data for the period 1990-1998. We employ data envelopment analysis (DEA) to compute Malmquist productivity indices, which are decomposed into two component measures namely efficiency change and technical change for the purpose of the study. The results show that there is no significant improvement in TFP due to the instability in economy in 1990s. The improvement in TFP is mainly explained by the efficiency change. We find that there is not significant difference between public and private sectors as far as TFP change is concerned. The results reveal that provinces that are on the production frontier show less improvement, whereas some provinces with low efficiency levels at the beginning experience relatively high TFP changes due to catching up process.

Key words: Total factor productivity, data envelopment analysis, Malmquist productivity index, Turkish manufacturing industry, private and public sectors, regional performance.

JEL classification: C43, D24, L60, R00

1. Introduction

The Turkish economy has performed well in the developing world over the past 30 years until the onset of the 1994 currency crisis. Turkish economy grew at an average rate of around 5 % in the 1970s and of around 4 % during the 1980s and of 5 % between 1990-1998. This rapid economic growth has resulted from considerable changes in the structure of the economy. Also, the share of manufacturing industry in the Turkish economy has increased from 15% in 1968 to 22% in 1996 and the growth rate of this industry has been 6.3 % on average over these years[1].

With regard to Turkey, there have been a considerable number of studies dealing with productivity in the manufacturing sector. See, for example, UYGUR, 1990; AYDOĞUŞ, 1993; KRUEGER and TUNCER, 1982; YILDIRIM, 1989; GÖKCEKUŞ 1997, ÖNDER and LENGER, 2000). Despite a relatively extensive literature on total factor productivity (TFP) in Turkish manufacturing sector, there appears to be a shortage of studies at the 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 manufacturing industry at the regional level. Studying TFP changes in the Turkish manufacturing industry at regional level gains importance, as this will give some information which provinces are performing relatively better in Turkey. In this study, we also subdivide the manufacturing industry into public and private sectors in order to make some comparison between these two sectors. This is important because the public enterprises are being

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

blamed for absorbing the government's revenue and are being held responsible for some economic problems in Turkey (see also ZAİM and TAŞKIN, 1997).

Thus, the main aim of this paper is to compute total factor productivity change of the private and public sectors in the manufacturing industry in the selected provinces of Turkey by using panel data for the period 1990-1998. We employ the Malmquist productivity index developed by CAVES *et al.,* 1982. In this study, following the method developed by FÄRE *et al.,* 1994*,* TFP growth is considered as a joint effect of the shift in the production frontier (technological progress) and a movement towards the frontier (efficiency) by using the data envelopment analysis (DEA).

The remainder of this paper is organised as follows. Section two provides a discussion of the methodology. Section three gives information about the data set used in the study. Evaluation of the results are summarised and discussed in section four. The paper concludes with a summary analysis of the findings in section five.

2. Methodology

In this study the measure we use to analyse productivity performance of selected provinces of Turkish Manufacturing industry is the Malmquist productivity index introduced by CAVES *et al*.,1982.

Following COELLI *et al.*, 1998, p.158 and FÄRE *et al.*, 1994, we define a production technology at time t=1, …T, which represents the outputs, $y_t = (y_1 , ..., y_M)$, which can be produced using the inputs $x_t = (x_1 , ..., x_K)$, as:

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

Following SHEPHARD, 1970, the output distance function relative to technology of S^t can be defined as:

$$D_0^t(x_t, y_t) = \min\{\theta : (x_t, y_t / \theta) \in S^t\}. \qquad (2)$$

The distance function is the inverse of FARELL's, 1957, measure of technical efficiency, which calculates how far an observation is from the frontier of technology. Similarly,

$$D_0^t(x_{t+1}, y_{t+1}) = \min\{\theta : (x_{t+1}, y_{t+1} / \theta) \in S^t\}. \qquad (3)$$

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

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

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:

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

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

or

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

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 stressed that the returns to scale properties of technology is very crucial in TFP measurement as far as Malmquist index is concerned. As GRIFELL-TATJÉ and LOVELL, 1995 illustrated, a Malmquist TFP index might not correctly measure TFP changes when variable returns to scale (VRS) assumed for the technology. 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.

The output-oriented DEA model for a single output used in this study is closely related to COELLI *et al.*, 1998, p 158. The model can be formalized as follows. Consider

the situation for the N industries, each producing a single output by using K inputs. For the i-th industry x_{it} is a column vector of inputs, while y_{it} is a scalar representing the output. X denotes the $K \times NT$ matrix of inputs and Y denotes $1 \times NT$ matrix of output. The CRS output-oriented DEA model is given by;

$$\max_{\phi,\lambda} \phi \qquad (8)$$

subject to

$$-\phi \; y_{it} + Y\lambda \geq 0 \,,$$

$$x_{it} - X\lambda \geq 0 \,,$$

$$\lambda \geq 0 \,,$$

where $1 \leq \phi < \infty$, λ is a $NT \times 1$ vector of weights. $1/\phi$ defines technical efficiency score, which varies between zero and one, with a value of one indicating any point on the frontier.

We can calculate the required distance measures for the Malmquist productivity index given in equation 4 by using DEA-like linear programs (see FÄRE *et al.*, 1994, for details).

3. Data

The data set employed in this study were provincial level manufacturing outputs and inputs of 18 provinces in Turkey over the 1990-1998. The data are annual and cover the public and the private sector establishments, which employ ten or more workers.

The data set related to manufacturing industry of each province were obtained from several issues of Annual Manufacturing Industry Statistics, published by State Institute of Statistics (SIS). Investment deflators for the private and public manufacturing industries were taken from several issues of Main Economic Indicators published by SPO. Manufacturing industry wholesale price index was taken from several issues of Monthly Bulletin of Wholesale Price Index, published by SIS.

Output is measured in value terms at constant 1981 prices. In our model labour, capital, and raw materials are the main inputs. Labour is measured as total number of hours worked in production, whereas the raw material includes expenditures on output, supplementary materials, packaging materials and the other raw materials required for production. Raw materials are measured in value terms at constant 1981 prices. However, data for physical capital stock were not available. Therefore, the capital input was calculated through perpetual inventory method (see ÖNDER and LENGER, 2000 for details).

Table 1 presents the main characteristics of data related to the provinces.

<Table 1 here>

As can be seen from the table, the overall value added created in the manufacturing industries in these provinces constitutes approximately 90% of the total value added created in the Turkish manufacturing industry and their contribution to GDP is around 70%. Total population size of all provinces is around 54% of the whole population in Turkey. We should mention that the data related to new provinces that were

formerly affiliated as a town to a province were included in the associated provinces in order to obtain comparable results[2].

According to the share in GDP and population size Istanbul, Ankara, and Izmir are the first three provinces in order. As far as the share of value added in manufacturing sector is concerned, Istanbul, Kocaeli, and Izmir are the first three provinces in order. As can be seen from the table these three provinces constitute around 52% of total value added created in the Turkish manufacturing sector.

4. Results

In this study, we employed the program DEAP 2.1 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 province. Following FÄRE *et al.,* 1994, productivity is decomposed in this way into changes in efficiency (catching up) and changes in technology (innovation).

Before presenting the detailed results for each province, we give the average performance of the Turkish manufacturing industry in aggregate for both public and private sector over the entire 1990-1998 time period. Table 2 presents our results in terms of annual change in TFP and its components in the manufacturing industry for the both sectors in aggregate based on DEA estimates.

<Table 2 here>

[2] After 1989 some towns were converted to provinces by the governments.

As mentioned before, if the value of the Malmquist index or any of its components is less than one there is a deterioration, while if the value is bigger than one, then there is improvement in the relevant performance. Therefore 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.

As can be seen from the table, TFP increased very slightly (around 0.2% for both public and private sectors) on average between 1990-1998. There are fluctuations regarding both efficiency and technical change throughout the years under consideration in both public and private sectors. As the table shows there is a decline in efficiency after 1994 due to the economic crises in that year. Also as the results indicate 1998 economic crises had a negative impact on efficiency. On can say that the negative effect of crises on efficiency was dampened by the improvements in technical efficiency.

As far technical change is concerned there is not much technical progress cumulatively. Hence, one can say that efficiency change plays a major role in contributing to the TFP growth during 1990-1998. The low improvement in TFP might be due to instability in the Turkish Economy in the 1990s. The cumulative progress in TFP is found to be 1.4% for the public and 1.2% for the private sectors. This means that the difference between these two sectors is negligible as far as TFP change is concerned. In spite of the fact that the difference is not very high, the results show us that public sector is performing better regarding efficiency change while private sector is better in technical progress.

Having given the aggregated results, we turn to the results at provincial level. However we should mention that as it is difficult to summarize the disaggregated results

we just present the results as average and cumulative values for the entire time period in Table 3. One should note that since efficiency is the basic component of Malmquist productivity index, we also report technical efficiency values for the initial year, 1990.

<Table 3 here>

With regard to the public sector, as the table shows, average TFP changes for most of the provinces are negligible, the highest increase is in Zonguldak (1.5%). Cumulated TFP growth by 1998 ranges from 0.3% (Adana, Bolu) to 12.6% (Zonguldak) as far as public sector is concerned. As can be seen from the table the performance of some provinces namely Denizli, Kayseri, Kirklareli and Tekirdag deteriorated. The highest deterioration is in Tekirdag around 8% in cumulative. This is due to the fact that Tekirdag is the one of the two provinces that are on the production frontier and thus not have any improvement in efficiency (catching up). Also it has deterioration in technology (innovation). On the other hand some provinces such as Adana, Bolu, Icel and Istanbul has shown not much changes in either direction. Not surprisingly in line with aggregated results the improvement in TFP in many provinces is mainly due to the increase in performance of efficiency.

As far as private sector is concerned there exists no deterioration in provinces for the time period under consideration. The highest improvement is again in Zonguldak (6.7%) in cumulative. This is followed by Gaziantep (2.3%), Konya (1.9%), Ankara and Kayseri (1.7%). The existence of this catching up process can clearly be seen from their relatively low initial efficiency level in Table 3. Some provinces such as Kirklareli and Eskisehir (0.1%) have negligible increase in performance cumulatively over the years. For most provinces such as Zonguldak, Konya and Gaziantep the increase in TFP is

mainly explained by efficiency change while for some provinces such as Adana, Ankara and Bursa, and Icel it is explained by technical change.

By taking the information given in the table into consideration the results show us that Adana, Bolu, Gaziantep, Konya, and Tekirdag increase their performances more in private sector while the remaining provinces are better in public sector in cumulative.

5. Conclusion

In this study, we employed output oriented DEA method to measure efficiency change, technical change, and TFP change in the Turkish manufacturing industry at the regional level for the periods 1990-1998. In the study, we also subdivided manufacturing industry into the public and private sector in order to investigate whether there is a difference between the sectors at the regional level. The Malmquist productivity index was used to measure TFP growth.

The most important finding of this paper is that there is not much significant improvement in TFP for the time under consideration due to the instability in economy in 1990s. Although the improvement is small, the results of the study show that efficiency change plays a major role in contributing TFP growth for the time period. Also the results show that there is not significant difference between public and private sectors as far as TFP change is concerned.

At provincial level, among the total 18 provinces in Turkey only 6 provinces showed deterioration in terms of TFP change cumulatively as far public sector is concerned. Amongst the provinces that experienced improvement only 3 provinces are

above 5%. On the other hand all provinces experienced improvement in TFP cumulatively as far as private sector is concerned, but the highest is only 6.7%. Furthermore the results reveals that increase in TFP is mainly explained by the efficiency change for many provinces for both public and private sectors.

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Table 1. Characteristics of the Provinces

Region	Provinces	Share in GDP[a]	Share in Total Value Added[b]	Population Size[c]
Aegean	Denizli	1.48	1.27	1.30
	Izmir	7.76	12.07	4.95
	Manisa	2.70	1.76	1.96
Mediterranean	Adana	3.45	2.93	3.37
	Icel	2.60	3.32	2.40
Marmara	Balikesir	1.47	0.96	1.64
	Bursa	3.89	6.40	3.11
	Istanbul	22.49	24.80	14.89
	Kirklareli	0.81	1.21	0.50
	Koceli	4.64	15.27	1.87
	Tekirdag	1.21	3.32	0.90
Central Anatolia	Ankara	8.00	6.40	6.44
	Eskisehir	1.27	1.32	1.05
	Kayseri	1.12	1.52	1.55
	Konya	2.50	1.27	3.42
Black Sea	Bolu	3.89	0.95	0.87
	Zonguldak	1.71	3.94	1.63
South East Anatolia	Gaziantep	1.64	0.87	1.97
Total Percentage		69.42	89.58	53.82

a The percentage share of provinces in GDP in 1997

b The percentage share of province in total value added created in Turkish manufacturing industry in1997

c The percentage share of province in total population of Turkey in 1997

Table 2. Mean Technical, Efficiency and TFP Changes in Manufacturing Industry (for the sample of selected provinces), 1990-1998.

A. PUBLIC

Year	Efficiency Change	Technical Change	TFP Change
1990/91	1.022	0.982	1.003
1991/92	0.987	1.023	1.010
1992/93	1.034	0.965	0.997
1993/94	0.987	1.005	0.993
1994/95	0.979	1.031	1.009
1995/96	0.967	1.037	1.003
1996/97	1.051	0.950	0.998
1997/98	0.990	1.012	1.001
Average	1.002	1.000	1.002
Cumulative	1.014	1.000	1.014

B.PRIVATE

Year	Efficiency Change	Technical Change	TFP Change
1990/91	1.014	0.989	1.003
1991/92	0.992	1.014	1.005
1992/93	1.021	0.983	1.004
1993/94	1.007	0.993	1.000
1994/95	0.970	1.029	0.999
1995/96	0.971	1.028	0.998
1996/97	1.037	0.967	1.003
1997/98	0.998	1.003	1.001
Average	1.001	1.001	1.002
Cumulative	1.009	1.004	1.012

Table 3. TFP Change in the Manufacturing Industries of the Selected Provinces of Turkey for 1990-1998

A.PUBLIC

	Efficiency	Efficiency Change		Technical Change		TFP Change	
Provinces	1990	Average	Cumulative	Average	Cumulative	Average	Cumulative
Adana	0.915	1.000	0.991	1.002	1.011	1.001	1.003
Ankara	0.902	1.008	1.062	1.001	1.005	1.008	1.067
Balikesir	0.885	1.001	1.002	1.002	1.011	1.002	1.013
Bolu	0.855	1.006	1.040	0.997	0.964	1.001	1.003
Bursa	0.888	1.000	0.995	1.001	1.002	1.000	0.998
Denizli	0.881	1.001	0.997	0.999	0.981	0.998	0.979
Eskisehir	0.892	1.001	1.005	1.002	1.009	1.002	1.012
Gaziantep	0.934	1.001	1.007	1.001	1.000	1.001	1.008
Icel	1.000	1.000	1.000	1.000	0.994	1.000	0.994
Istanbul	0.934	1.000	0.994	1.001	1.005	1.000	1.000
Izmir	0.953	1.002	1.014	1.002	1.014	1.004	1.028
Kayseri	0.876	0.998	0.971	1.001	1.002	0.997	0.975
Kirklareli	0.867	0.998	0.972	1.002	1.010	0.998	0.981
Kocaeli	0.971	1.004	1.030	1.004	1.032	1.008	1.062
Konya	0.901	1.000	0.999	1.002	1.014	1.002	1.012
Manisa	0.851	1.013	1.078	0.999	0.983	1.009	1.060
Tekirdag	1.000	1.000	1.000	0.991	0.919	0.991	0.919
Zonguldak	0.907	1.013	1.102	1.003	1.021	1.015	1.126
Average	0.912	1.002	1.014	1.000	0.999	1.002	1.013

B. PRIVATE

	Efficiency	Efficiency Change		Technical Change		TFP Change	
	1990	Average	Cumulative	Average	Cumulative	Average	Cumulative
Adana	0.919	1.000	0.997	1.002	1.013	1.001	1.011
Ankara	0.915	1.001	1.005	1.002	1.011	1.002	1.017
Balikesir	0.92	1.000	1.000	1.001	1.004	1.001	1.005
Bolu	0.915	1.001	1.006	1.001	1.005	1.002	1.012
Bursa	0.922	1.000	0.996	1.002	1.012	1.001	1.004
Denizli	0.896	1.001	1.008	1.001	1.003	1.001	1.009
Eskisehir	0.912	1.000	0.997	1.001	1.002	1.000	1.001
Gaziantep	0.883	1.003	1.022	1.001	1.004	1.003	1.023
Icel	0.914	1.000	0.995	1.002	1.012	1.001	1.009
Istanbul	0.934	1.002	1.011	0.999	0.993	1.001	1.004
Izmir	0.925	1.001	1.006	1.000	0.999	1.001	1.005
Kayseri	0.899	1.002	1.014	1.001	1.002	1.002	1.017
Kirklareli	0.921	1.000	0.996	1.001	1.004	1.000	1.001
Kocaeli	0.944	0.999	0.993	1.001	1.007	1.000	1.003
Konya	0.896	1.002	1.012	1.001	1.007	1.002	1.019
Manisa	0.916	1.001	1.002	1.001	1.009	1.001	1.010
Tekirdag	0.915	1.002	1.010	1.000	0.994	1.001	1.007
Zonguldak	0.892	1.011	1.087	0.998	0.981	1.008	1.067
Average	0.913	1.001	1.009	1.001	1.003	1.002	1.012