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The Comparative Performance of the Public Enterprise Sector in Turkey: A Malmquist Productivity Index Approach

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The public enterprise sector in Turkey has grown appreciably since the 1950's and has made a marked impact on aggregate production, employment, and saving. However, since the early 1980's, public enterprises have been accused of absorbing the government's financial resources and are being held responsible for Turkey's large external debt. The purpose of this study is to compare the performance of the public sector with that of the private sector for the various subsectors of manufacturing in Turkey. The Malmquist productivity index, constructed using nonparametric linear programming methods, is employed for the relevant comparisons. *J. Comp. Econom.*, October 1997, **25**(2), pp. 129–157. Bilkent University, Bilkent, Ankara, Turkey 06533.

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1. INTRODUCTION

The public enterprise sector in Turkey, which was originally founded for the production of basic consumer goods in the early 1930's, has grown appreciably since the 1950's. Starting from the early 1960's, the public enterprise sector emphasized the production of intermediate goods such as paper, cement, iron and steel, fertilizer, and petrochemical products. Since then, it has accounted for a large proportion of gross domestic capital formation, and it has had a marked impact on aggregate production, employment, and saving. Subsectoral analysis of the public enterprise sector's production indicates that public enterprises' share in agriculture has been negligible, whereas their share in total industrial production was well above 30% between 1974 and 1990. The share of public enterprises is more than 50% in power production and banking. When various forms of government participation are taken into

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account, it is possible to say that more than half of the Turkish economy is government owned or controlled. However, since the early 1980's, public enterprises have been accused of absorbing a large share of government resources, and they are responsible for a major part of Turkey's external debt.

In recent years, because of privatization in both developed and developing countries, researchers have compared the performance of public and private enterprises on the basis of productive efficiency. However, these studies brought no clear evidence to suggest that public enterprises in developing countries have had lower levels of economic efficiency than do private firms. The purpose of this study is to compare the productivity growth of the public sector with that of the private sector for the various subsectors of manufacturing in Turkey. The main analytical tool employed is the Malmquist productivity index, which is constructed using nonparametric linear programming methods. An advantage of this approach over the total factor productivity method is its ability to distinguish between changes in efficiency and technological progress between two periods. The methodology adopted is similar in spirit to the one introduced by Fare et al. (1994b) and involves developing a manufacturing sector frontier for Turkey for each year between 1974 and 1991, based on data on 28 subsectors, which are defined at the three-digit level according to the International Standard Industrial Classification. Data on the public and private sectors are registered separately. Once these frontiers are constructed, examination of each subsector's distance from the frontier at each year for both ownership types enables us to see the changes in efficiency of the public and private sectors in each subsector. Furthermore, the measurement of the distance between two frontiers for each pair of years provides information about the rate of technological progress by ownership type. This method is superior to the total factor productivity approach where each sector and ownership type is compared only to itself in previous periods but not to a common benchmark. In the computation of the Malmquist index, an explicit benchmark, the manufacturing sector frontier constructed from data on all subsectors, is used.

The next section of the paper gives a brief sketch of pre-1980 development policy and industrialization to set the stage for post-1980 developments. This section also describes the relative weight of the public sector in manufacturing and summarizes the results of studies that examine productivity differences between public and private enterprises. The model specification is presented in the third section. Section four is reserved for the discussion of data sources and results, followed by conclusions in Section five.

2. MAJOR DEVELOPMENTS IN MANUFACTURING

Until the 1980's, successive Turkish governments took a strongly interventionist stance in their industrialization policies. The early 1920's was a period

TABLE 1

SHARE OF PUBLIC SECTOR IN LARGE MANUFACTURING INDUSTRY

Percent share of public sector in manufacturing	1976	1981	1986	1991
Value added	29	46	40	32
Employment	35	34	29	25
Investment	32	27	32	9

Source. Computed from various issues of ''Annual Manufacturing Industry Statistics,'' Turkish State Institute of Statistics.

in which substantial incentives were provided to create an entrepreneurial class. In the mid-1930's, the state assumed the role of the entrepreneurial class by creating public enterprises in a broad range of manufacturing activities, a process that continued even after the emergence of a private manufacturing sector in late 1940's. During the 1960's, with the introduction of central planning, state intervention reached its greatest intensity, not only with regard to state enterprises but also in guiding the course of the private sector.

Until the 1980's, industrialization policies were inward-looking, import-substituting, with extensive protection against foreign competition, including elements such as an overvalued exchange rate and exchange controls, tariffs, quantitative restrictions, guarantee deposits on imports, and generous tax and credit incentives for domestic manufacturing investments. Due to the rapid increase in manufacturing investment, the real growth of output averaged 7.5% during the 1965–1980 period, which resulted in an increase in the share of manufacturing in GDP from 14.1% in 1963 to 19.1% in 1979. An important feature of this period was a structural shift from the production of consumption goods toward the production of intermediate and capital goods, led by increased public-sector activity in basic metals, fertilizer, paper, and petrochemicals. As a result, the share of value added generated by public-sector enterprises in large manufacturing industry reached as high as 46% (Table 1).[1] The table also shows that the increased importance of public production was reflected in its share of employment and investment.

Toward the end of the 1970's, Turkey's import-substituting development reached a more difficult phase, and, at the end of the decade, Turkey went through a balance of payment and foreign debt crises that gave birth to the 1980 stabilization and adjustment program proposed by the IMF. During the early

[1] Large manufacturing industry covers all the establishments in the public sector and establishments with 10 or more employees in the private sector.

years of the adjustment program, public enterprises were given more autonomy in setting their prices, and those that operated in highly oligopolistic markets were able to pass increased costs to consumers and thus did not have the incentive to increase their productivity. Public investments were channeled away from manufacturing toward infrastructure sectors such as communication, transportation, and energy, directing public enterprises in the manufacturing sector to the credit market for day-to-day financing. This increased the debt of the public sector and led to lower levels of investment in an attempt to reduce public enterprise borrowing. The low level of public-sector investment was not offset by the private sector. The high real interest rates that resulted from financial liberalization, coupled with the crowding out effect of government borrowing, heavy currency depreciation, and macroeconomic instability, depressed private sector investment below the levels of the previous decade.

These policy developments gave rise to studies on the sources of growth in Turkish manufacturing. Among these are Krueger and Tuncer (1982) and Nishimuzu and Robinson (1984), who provide estimates for total factor productivity growth in Turkish manufacturing industries from the mid-1960's to the mid-1970's. These studies report the positive impact of export expansion and the negative impact of import tightening on total factor productivity (Celasun, 1994). Nishimuzu and Robinson compare the growth rates of total factor productivity in manufacturing for the period 1963–1976 in Japan, Korea, Turkey, and Yugoslavia and find that they are lower in Turkey than in Korea and Japan but higher than in Yugoslavia. Krueger and Tuncer find relatively higher total factor productivity growth in the public sector, a finding also supported by Yildirim (1989) and Uygur (1990) for nearly the same period.

The total factor productivity approach, though extensively used in the literature of growth accounting, has some deficiencies. First, although economic theory generally provides only loose restrictions on the distribution of observable quantities, much econometric work is based on tightly specified parametric models. Total factor productivity estimates based on an assumed functional form for the technology are sensitive to misspecification. Second, it is not so obvious what total factor productivity growth measures when the economic units deviate from efficiency properties that are implicitly assumed for them. If economic units are technically and allocatively inefficient, the total factor productivity growth measure is a composite measure that embodies both technological progress and change in efficiency. Third, in the total factor productivity approach each firm or sector is compared to only itself in previous periods and not to an explicit common benchmark.

3. MODEL

To investigate the relative productivity differences between public and private manufacturing we use the Malmquist productivity index constructed

using nonparametric programming methods. The foundations of the method go back to Farrell (1957), and it has been extended by Farrell and Fieldhouse (1962), Seitz (1970), and Afriat (1972). In more recent studies, Fare et al. (1982), Banker et al. (1984), and Fare et al. (1985) show how to decompose Farrell's measure of technical efficiency and extract information on the scale of the unit investigated. Subsequently, Fare et al. (1994a) and Fare et al. (1994b), inspired by the work of Caves et al. (1982a, 1982b), introduced multiperiod analysis to investigate productivity changes over time.

The Malmquist index is based on the concept of the output distance function D_0^t ($D_0^t(X^t, Y^t) = \inf\{\theta: (X^t, Y^t/\theta) \in S^t\}$), which is defined on the production technology S^t ($S^t = \{(X^t, Y^t): X^t \text{ can produce } Y^t\}$). Here Y^t refers to the vector of outputs produced and X^t refers to the vector of inputs used at time period t. The distance function measures the reciprocal of the maximal ray expansion of the observed outputs (Y^t) given inputs (X^t) such that outputs (Y^t) are still feasible in relation to the production technology S^t. One advantage of the output distance function is its ability to provide the Farrell measure of technical efficiency directly. Using the output distance functions, Fare et al. (1994b) define the Malmquist output-based productivity as

$$M_0^{t+1}(X^{t+1}, Y^{t+1}, X^t, Y^t) = \left[\frac{D_0^t(X^{t+1}, Y^{t+1})D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^t(X^t, Y^t)D_0^{t+1}(X^t, Y^t)}\right]^{1/2} \quad (1)$$

or equivalently as

$$M_0^{t+1} = \frac{D_0^{t+1}(X^{t+1}, Y^{t+1})}{D_0^t(X^t, Y^t)}\left[\frac{D_0^t(X^{t+1}, Y^{t+1})D_0^t(X^t, Y^t)}{D_0^{t+1}(X^{t+1}, Y^{t+1})D_0^{t+1}(X^t, Y^t)}\right]^{1/2}, \quad (2)$$

where the superscripts show two adjacent time periods.[2] Note that in both expressions there are two mixed-period distance functions, i.e., $D_0^{t+1}(X^t, Y^t)$ and $D_0^t(X^{t+1}, Y^{t+1})$, where in each case the data being evaluated is from a period different from that of the technology relative to which it is being evaluated.[3] The second expression provides the decomposition of the Malmquist productivity index into its two components, change in technical efficiency and the geometric mean of the change in the production frontier. The change in technical efficiency between t and $t + 1$ is captured by the ratio outside the brackets, and the ratio inside the brackets provides a

[2] For a detailed exposition of the productivity measurement through Malmquist indexes which make use of distance functions see Chap. 9 of Fare et al. (1994a). For output based productivity measurement particularly, see pp. 233–235.

[3] For example D_0^t (X^{t+1}, Y^{t+1}) measures the reciprocal of the maximal ray expansion (or contraction) of the observed outputs (Y^{t+1}) given inputs (X^{t+1}) such that outputs (Y^{t+1}) are still feasible in relation to the production technology S^t.

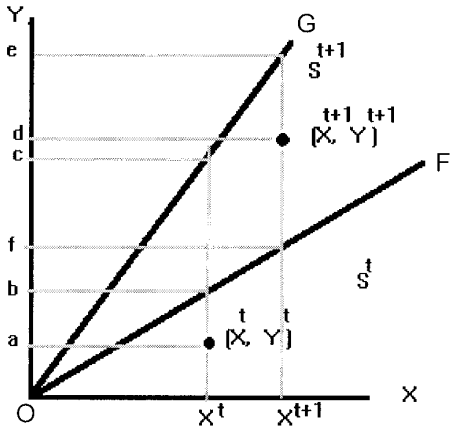

FIG. 1. The Malmquist productivity index.

measure of the shift in the frontier. These can best be illustrated with the aid of a figure.[4]

In Figure 1, the output vector Y^t is feasible under the production technology S^t and Y^{t+1} is feasible under S^{t+1}. Rays OF and OG represent constant returns to scale production frontiers constructed using data on inputs and outputs of time t and $t + 1$, respectively. The term outside the brackets in (2) shows

$$\left[\left(\frac{od}{oe}\right)\Big/\left(\frac{oa}{ob}\right)\right]$$

and measures the rate of change in efficiency between periods t and $t + 1$, i.e., how much closer to (or farther from) the frontier a producing unit has come from period t to $t + 1$. The term inside the bracket is

$$\left[\left(\frac{od}{of}\right)\Big/\left(\frac{od}{oe}\right)\right]\left[\left(\frac{oa}{ob}\right)\Big/\left(\frac{oa}{oc}\right)\right].$$

Thus, the Malmquist index defined in terms of the distances above is

$$\left(\frac{od}{oe}\,\frac{ob}{oa}\right)\left[\frac{oe}{of}\,\frac{oc}{ob}\right]^{1/2} \tag{3}$$

[4] The figure that we employ is a modified version of Fig. 1 in Fare *et al.* (1994b) and Fig. 9.3 of Fare et al. (1994a).

and it shows the change in efficiency index multiplied by the geometric mean of the change in frontier evaluated at X^t and X^{t+1}, respectively.

The output-based productivity index may be computed by solving four different linear programming problems. Suppose that for each t, $t = 1, \ldots, T$, there are $k = 1, \ldots, K$ observations on inputs, $X^{k,t} = (X^t_{k,1}, \ldots, X^t_{k,N})$, and outputs $Y^{k,t} = (Y^t_{k,1}, \ldots, Y^t_{k,M})$. By imposing constant returns to scale and strong disposability on the technology, for an observation $k^{0,t}$ we compute

$$[D^t_0(X^{k^0,t}, Y^{k^0,t})]^{-1} = \max \theta$$

subject to

$$\begin{aligned}
\sum_{k=1}^{K} z_k Y^t_{k,m} &\geqslant \theta Y^t_{k^0,m} \qquad m = 1, \ldots, M \\
\sum_{k=1}^{K} z_k X^t_{k,n} &\leqslant X^t_{k^0,n} \qquad n = 1, \ldots, N \qquad \text{(LP1)} \\
z_k &\geqslant 0 \qquad k = 1, \ldots, K,
\end{aligned}$$

where z_k is an intensity variable. This linear–programming problem measures the output-based Farrell technical efficiency of observation $k^{0,t}$ relative to the reference technology of the same period, namely, period t. The second component in the Malmquist productivity index, $D^{t+1}_0(X^{t+1}, Y^{t+1})$, also measures the Farrell technical efficiency of an observation at $t + 1$ relative to the technology of the same period. The computation of this component is similar in structure to that of (LP1) where $t + 1$ is substituted for t. The third component of M^{t+1}_0 $(X^{t+1}, Y^{t+1}, X^t, Y^t)$ considers observation $k^{0,t+1}$ relative to the technology at period t. This component is computed as

$$[D^t_0(X^{k^0,t+1}, Y^{k^0,t+1})]^{-1} = \max \theta$$

subject to

$$\begin{aligned}
\sum_{k=1}^{K} z_k Y^t_{k,m} &\geqslant \theta Y^{t+1}_{k^0,m} \qquad m = 1, \ldots, M \\
\sum_{k=1}^{K} z_k X^t_{k,n} &\leqslant X^{t+1}_{k^0,n} \qquad n = 1, \ldots, N \\
z_k &\geqslant 0 \qquad k = 1, \ldots, K. \qquad \text{(LP2)}
\end{aligned}$$

Note that the input and output constraints have the two periods t and $t + 1$ on opposite sides of the inequalities, indicating that the observation, here $k^{0,t+1}$, is compared to the reference technology of a different period, here t. The fourth component, $D^{t+1}_0(X^t, Y^t)$, which compares $k^{0,t}$ to the reference

technology of period $t + 1$, is similar in character to the third component and can be computed by interchanging t and $t + 1$ in (LP2).

Note that in all the linear programming problems we have imposed a constant returns to scale assumption on the technology. However, relaxing the assumption of constant returns to scale yields efficiency scores relative to other scale assumptions such as variable returns to scale or nonincreasing returns to scale.[5] The comparison of these scores decomposes the change in efficiency into changes in scale efficiency and pure efficiency. Because the frontier constructed with the constant returns to scale assumption on technology envelops the data more loosely than the frontiers under alternative scale assumptions, the resultant efficiency scores (θ) will be larger than those computed with respect to other frontiers. Then the degree of scale efficiency, which is the output loss from deviating from the constant returns to scale technology, can be computed by dividing the efficiency scores obtained from constant returns to scale technology by the efficiency scores obtained from variable returns to scale technology. That is, scale efficiency at time t is $SE^t = \theta^t_{CRS}/\theta^t_{VRS}$. Once the scale efficiency for each time period is obtained, the change in scale efficiency between t and $t + 1$ can be computed as SE^t/SE^{t+1}. The second component of efficiency change, the change in pure efficiency between t and $t + 1$, is calculated by dividing the change in efficiency by the change in scale efficiency.

4. DATA AND RESULTS

The methodology outlined above is applied to construct a manufacturing sector frontier for Turkey for each year between 1974 and 1991 using data on 28 subsectors, defined at the three-digit level of the International Standard Industrial Classification, where public and private sectors are reported separately. The data are compiled from Annual Manufacturing Industry Statistics published by the State Institute of Statistics, and they cover all establishments in the public sector and the establishments with 10 or more employees engaged in the private sector. All three-digit industries, except ISIC390, other manufacturing industry, are included in the analysis. A desirable feature of the data is that, except in few cases, both government and private activity coexists in all subsectors allowing for a comprehensive analysis of relative productivity growth between public and private enterprises during the period 1974–1991.[6] Table A1 in the Appendix lists the sectors included in the model.

[5] The variable returns to scale assumption is incorporated by adding the additional constraint $\sum_{k=1}^{K} z_k = 1$, and nonincreasing returns to scale is incorporated by adding the additional constraint $\sum_{k=1}^{K} z_k \leq 1$ in all the linear programming problems discussed above.

[6] No government activity exists in the following sectors: manufacture of leather and leather products, ISIC323, manufacture of furniture and fixtures, ISIC332, manufacture of rubber prod-

Our measure of the aggregate output of a subsector is the real value of the output of the industry.[7] The three input proxies chosen are number of individuals engaged in production, real value of the raw materials, fuels and electricity, and total capacity of power equipment installed at the end of the year in terms of horse power.[8] The usual difficulties associated with computation of the capital stocks at this disaggregate level forced us to use total capacity of power equipment installed as a proxy for the capital stock.

Leaving the disaggregated results to the Appendix, Tables A2–A6, the summary results are reported in Table 2. In constructing this table, we first calculated the total cumulated productivity change between 1974–1991 by the sequential multiplication of the annual indexes for each three-digit subsector and for each ownership status. The productivity index of a sector at the two-digit industrial classification is then computed as the geometric means of the indexes of the relevant subsectors at three-digit classification.

In Table 2, if the value of the Malmquist index or any of its components is less than 1, this denotes regression or deterioration in performance, and values greater than one denote improvement in performance relative to the best practice in the sample. In interpreting the numbers in the table, recall that best practice is a common manufacturing sector frontier defined over subsectors in manufacturing.[9]

Starting from the bottom of the table, with a productivity growth of 38% between the years 1974 and 1991, the private sector has performed better than the public sector, which had a productivity growth of around 15% for the same period.[10] An examination of the components of the Malmquist productivity index reveals the fact that, for both sectors, growth was due more to technological progress than to improvements in technical efficiency. The compounded efficiency change index shows that, for both ownership

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ucts, ISIC355, manufacture of plastic products not elsewhere classified, ISIC356, manufacture of glass and glass products, ISIC362, manufacture of professional and scientific equipment not elsewhere classified, ISIC385. Also no private activity exists for petroleum refineries, ISIC353.

[7] All nominal figures are deflated using a two-digit manufacturing price index and are expressed in 1988 prices.

[8] Since there is no price index for purchased inputs, nominal values are deflated by a two-digit manufacturing price index.

[9] The implicit assumption that all industries utilize the same production frontier and that this frontier can be constructed from the observations on subsectors is similar in nature to those employed by Caves (1992) and Torii and Caves (1992). In their approach, to find the productivity differentials between the subsectors of two countries, the observations on outputs and inputs of subsectors of these countries are used together while constructing a stochastic production frontier.

[10] It is interesting to note that, in terms of ranking according to annual average productivity increase between 1974 and 1991, nine out of ten subsectors that recorded the lowest productivity increase, actually they were negative, belonged to the public sector. These are ISIC314, ISIC342, ISIC322, ISIC354, ISIC351, ISIC353, ISIC312, ISIC331, and ISIC383.

TABLE 2

CUMULATIVE GROWTH BETWEEN 1974 AND 1991

	MALM	TCHCH	EFFCH	CHSEFF	CHPEFF
31 Food, beverage, and tobacco					
Public	1.1573	1.4386	0.8045	0.8132	0.9893
Private	1.4994	1.6861	0.8892	0.7849	1.1330
32 Textile, wearing, and leather					
Public	1.1867	1.9500	0.6086	0.8877	0.6855
Private	1.3960	1.8356	0.7605	0.7256	1.0480
33 Wood products, furniture					
Public	1.0807	2.1690	0.4982	0.9590	0.5196
Private	1.2698	1.9701	0.6445	0.9494	0.6788
34 Paper products, printing					
Public	1.0128	1.8780	0.5393	0.5798	0.9301
Private	1.1804	1.5691	0.7522	0.8764	0.8583
35 Chemicals, coal, rubber					
Public	0.8285	1.2184	0.6799	0.7370	0.9226
Private	1.1943	1.3054	0.9149	0.8451	1.0826
36 Non-metalic mineral products					
Public	1.2433	2.0293	0.6127	0.6442	0.9511
Private	1.4433	2.1471	0.6722	0.6690	1.0048
37 Basic metal					
Public	1.4286	2.4145	0.5917	0.8187	0.7226
Private	1.3094	1.4295	0.9160	0.8943	1.0242
38 Machinery and equipment					
Public	1.4351	2.0832	0.6889	0.7347	0.9377
Private	1.6483	1.9049	0.8653	0.8038	1.0765
Average					
Public	1.1483	1.7568	0.6536	0.7596	0.8605
Private	1.3848	1.7007	0.8142	0.8013	1.0162

Note. MALM, Malmquist index; TCHCH, technical change index; EFFCH, efficiency change index; CHSEFF, scale change index; CHPEFF, pure efficiency change index.

types, more and more enterprises are falling below the frontier, indicating a deterioration in the ability to keep up with best practice technology. In this respect, it is important to note that, in accordance with the expectations of the public choice and property rights schools, the public sector performs less well than the private sector. In fact, the weak performance of the public sector compared to its private counterpart is due to the loss in the efficiency component alone because in terms of technological progress, the public sector has a slight advantage. Further decomposition of the efficiency change into its multiplicative components, change in scale efficiency, a measure of moving toward the optimal scale over time, and change in pure efficiency, a measure

TABLE 3

MANUFACTURING SECTOR CUMULATED PRODUCTIVITY 1974–1991

	MALM	TCHCH	EFFCH	CHSEFF	CHPEFF
31 Food, beverage, and tobacco	1.3173	1.5574	0.8458	0.7989	1.0587
32 Textile, wearing, and leather	1.3021	1.8838	0.6912	0.7911	0.8737
33 Wood products, furniture	1.2033	2.0343	0.5915	0.9526	0.6210
34 Paper products, printing	1.0934	1.7166	0.6369	0.7128	0.8935
35 Chemicals, coal, rubber	1.0151	1.2660	0.8018	0.7952	1.0083
36 Non-metalic mineral products	1.3597	2.0992	0.6477	0.6590	0.9829
37 Basic Metal	1.3677	1.8578	0.7362	0.8557	0.8603
38 Machinery and equipment	1.5499	1.9822	0.7819	0.7723	1.0124
Manufacturing sector average	1.2731	1.7257	0.7378	0.7823	0.9431

of developments in managerial efficiency, indicates that the public enterprise sector suffers from the latter type of inefficiency because magnitudes of the former are similar for both ownership types.

The subsectoral analysis of Table 2 also brings out some significant results. Note that, for both ownership types, three crucial sectors, manufacture of non-metallic mineral products, ISIC36, manufacture of basic metals, ISIC37, and manufacture of machinery and equipment, ISIC38, have had relatively higher productivity growth, stemming from their higher technological progress compared to other sectors.[11] The first two sectors are major suppliers of intermediate inputs such as cement, glass, and metals and the last one is the major supplier of the capital inputs to other industries, and therefore they seem to have provided linkage effects for sustained and high technological progress in the manufacturing sector as a whole. A second feature that attracts immediate attention in both ownership types is that efficiency loss has been relatively higher in industries that were able to expand their own frontier farthest. The cause of the efficiency losses seems to be the slow adjustment of variable inputs and the scale of operation to sudden changes in technology. These results become more evident when we disregard the ownership distinction, as in Table 3.

To observe the changes in the Malmquist productivity index and its components and to demonstrate the sensitivity of these indexes to major policy

[11] In fact, at three-digit classification, public manufacturing of fabricated products (ISIC381), public manufacturing of transport equipment (ISIC384), private manufacturing of electrical machinery, apparatus, appliances, and supplies (ISIC383), private manufacturing of professional and scientific and measuring and controlling equipment (ISIC385), and private manufacturing of machinery (ISIC382), all with average annual Malmquist productivity rates exceeding 2.9%, were among the most successful ten sectors.

TABLE 4

MALMQUIST INDEX (AVERAGE ANNUAL CHANGES)

Sectors	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
31 Food, beverage, and tobacco						
Public	1.0233	0.9282	1.0077	1.0342	1.0095	1.0768
Private	1.0187	1.0147	1.0390	1.0094	1.0278	1.0411
32 Textile, wearing, and leather						
Public	1.0610	0.9631	0.9743	0.9777	1.0259	1.0916
Private	1.0583	0.9400	1.0204	1.0486	0.9924	1.0883
33 Wood products, furniture						
Public	1.1073	0.9263	1.0049	1.0328	0.9978	0.9496
Private	0.9730	0.9559	1.0253	1.0318	1.0343	1.0976
34 Paper products, printing						
Public	1.0327	0.9153	1.0627	0.8650	1.0623	1.1349
Private	0.9660	0.9306	1.0380	1.0049	1.0020	1.1930
35 Chemicals, coal, rubber						
Public	0.9767	0.9364	0.9802	1.0275	0.9945	1.0380
Private	1.0584	0.9268	0.9742	1.0784	1.0139	1.0230
36 Non-metalic mineral products						
Public	1.0349	1.0051	1.0152	0.9817	0.9913	1.0703
Private	1.1127	0.9424	1.0055	1.0276	1.0170	1.0385
37 Basic metal						
Public	1.0686	0.9587	0.9760	1.0782	1.0633	0.9740
Private	1.0703	0.9066	1.0487	1.0312	1.0152	1.0408
38 Machinery and equipment						
Public	1.0900	0.9943	1.0391	0.9902	0.9795	1.0495
Private	1.0764	0.9478	1.0312	1.0374	1.0154	1.1004
Average						
Public	1.0486	0.9529	1.0071	0.9966	1.0151	1.0465
Private	1.0406	0.9452	1.0225	1.0334	1.0147	1.0766

changes, Tables 4–6 report the average annual changes of each component index for three-year sub-periods.[12] In our discussion of the tables, since the interpretation of the figures for the subsectors is self-evident, we will concentrate on the averages. A careful analysis of the column averages for different

[12] In order not to crowd the text with too many tables we provide the decomposition of the efficiency change in the Appendix, in Tables A7 and A8. The figures in Tables 4–6 are geometric averages of the indexes between these periods. Only the last period is a geometric average of two years, i.e., 1989–1990 and 1990–1991.

TABLE 5

TECHNOLOGICAL CHANGE INDEX (AVERAGE ANNUAL CHANGES)

Sectors	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
31 Food, beverage, and tobacco						
Public	1.0086	0.9532	0.9917	1.0969	1.0101	1.1047
Private	0.9883	0.9961	0.9970	1.1390	1.0053	1.0901
32 Textile, wearing, and leather						
Public	0.9993	1.0071	1.0075	1.1225	1.0017	1.1471
Private	0.9948	1.0049	0.9861	1.1534	1.0133	1.0956
33 Wood products, furniture						
Public	1.0384	1.0202	0.9891	1.1162	1.0310	1.1122
Private	1.0106	1.0126	1.0158	1.1066	1.0207	1.1034
34 Paper products, printing						
Public	1.0082	1.0119	0.9941	1.1054	1.0124	1.1335
Private	0.9955	1.0013	0.9841	1.1207	1.0037	1.0809
35 Chemicals, coal, rubber						
Public	0.9282	0.9690	1.0276	1.1332	0.9637	1.0886
Private	0.9797	0.9667	1.0066	1.1299	0.9860	1.0439
36 Non-metalic mineral products						
Public	1.0486	1.0122	1.0129	1.0625	1.0205	1.1319
Private	1.0502	0.9910	1.0022	1.1092	1.0327	1.1220
37 Basic metal						
Public	1.0639	1.0296	1.0133	1.1087	1.0228	1.1005
Private	0.9660	0.9815	1.0182	1.1316	0.9779	1.0829
38 Machinery and equipment						
Public	1.0565	1.0036	1.0007	1.0953	1.0062	1.1413
Private	1.0250	1.0148	0.9591	1.1427	1.0275	1.0886
Average						
Public	1.0181	1.0006	1.0045	1.1049	1.0084	1.1198
Private	1.0010	0.9960	0.9960	1.1290	1.0082	1.0882

sub-periods shows that average productivity growth rates are rather sensitive to the major policy changes outlined in Section 2. During the period 1974–1977, when the manufacturing sector enjoyed the benefits of the inward-looking import substitution era, productivity increased by over 4% per annum in the private sector and by almost 5% in the public sector. Note that during this period both component indexes are greater than one, implying that there is improvement both in efficiency and in technological progress. Nevertheless, the major impetus behind the productivity growth seems to be the increased efficiency during this period.

TABLE 6

EFFICIENCY CHANGE INDEX (AVERAGE ANNUAL CHANGES)

Sectors	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
31 Food, beverage, and tobacco						
Public	1.0146	0.9738	1.0161	0.9429	0.9994	0.9748
Private	1.0307	1.0188	1.0422	0.8862	1.0224	0.9550
32 Textile, wearing, and leather						
Public	1.0617	0.9563	0.9670	0.8710	1.0242	0.9517
Private	1.0639	0.9354	1.0347	0.9091	0.9795	0.9934
33 Wood products, furniture						
Public	1.0663	0.9079	1.0160	0.9253	0.9678	0.8538
Private	0.9628	0.9440	1.0093	0.9325	1.0134	0.9947
34 Paper products, printing						
Public	1.0244	0.9045	1.0690	0.7825	1.0493	1.0013
Private	0.9704	0.9294	1.0548	0.8967	0.9983	1.1037
35 Chemicals, coal, rubber						
Public	1.0523	0.9664	0.9539	0.9068	1.0320	0.9535
Private	1.0803	0.9588	0.9678	0.9545	1.0284	0.9800
36 Non-metalic mineral products						
Public	0.9869	0.9929	1.0023	0.9240	0.9714	0.9455
Private	1.0596	0.9510	1.0033	0.9264	0.9848	0.9256
37 Basic metal						
Public	1.0044	0.9311	0.9632	0.9725	1.0396	0.8850
Private	1.1080	0.9237	1.0299	0.9112	1.0382	0.9612
38 Machinery and equipment						
Public	1.0317	0.9907	1.0384	0.9040	0.9734	0.9196
Private	1.0501	0.9340	1.0751	0.9079	0.9883	1.0108
Average						
Public	1.0299	0.9524	1.0025	0.9020	1.0066	0.9346
Private	1.0396	0.9490	1.0267	0.9153	1.0064	0.9893

By the end of 1970's, which we characterize by the 1977–1980 period, the limit on the growth that could be attained using import substitution policies was reached, and, following a balance of payments crisis, manufacturing industry entered a difficult phase where imported raw materials were harder to obtain. It is during this period that we observe the deterioration in the performance of the public and private sectors.

The upswing of the Turkish economy, which started in 1981 under the impetus of the stabilization and economic adjustment program of 1980, is reflected in the Malmquist productivity index. The period 1980–1983 was

characterized by hesitant resumption of GDP growth, rapid increase in manufacturing exports, and decline in private investment, along with intensification of capacity use in manufacturing. During this period, under more autonomous management, the public sector performed better than it had in the previous period. Public enterprises, with their initially improved financial position, were able to invest in technology that showed its impact as improved rates of technological change. Private enterprises, on the other hand, with the generous export incentives provided to them, relied on increased capacity utilization for output growth, which translated in our indexes as increased efficiency.[13] The importance of technological progress to productivity growth increased in the 1983–1986 period to offset the deterioration in efficiency change in both ownership types. Nevertheless, the gain in productivity due to technological progress was not enough to compensate for the loss incurred due to reduced efficiency in the case of the public sector.

During the 1986–1989 period, due the policy of decreasing the share of the public sector in total investments, the expected increase in fixed capital investments was not achieved. Manufacturing output growth was maintained through utilization of the excess capacity, which increased the capacity utilization rate to 75%, its highest level since 1980, when it was 51%. In terms of our performance measures, all these developments showed up as a deterioration in technological progress and an improvement in efficiency change. The last period, which spans the years 1989–1991, was a period during which positive and significant increases in investment were registered. Real fixed investments increased by 61% for the private sector and 26% for the public sector, and the impact has been a remarkable increase in the Malmquist index stemming from increased technological progress.

5. CONCLUSION

The privatization efforts and the debates about the poor performance of the public sector have focused on the different incentives facing the public and private sectors and the effect of the ownership structure on productivity differentials. This paper, using a Malmquist productivity index approach, analyzes the difference between the rate of change of productivity in public and private Turkish manufacturing industries, during 1974–1991. The main finding is that, in terms of overall productivity growth, the public sector performed less well than did the private sector. The breakdown of the Malmquist productivity index into its components reveals that the weak performance

[13] In our application we would also expect to see variation in capacity utilization to be reflected in changes in the efficiency component (Fare et al., 1994b).

of the public sector was due to a larger loss in efficiency as both sectors achieved similar rates of technological progress. A more detailed analysis of the loss in efficiency component showed that public enterprises in fact suffered from managerial inefficiency.

APPENDIX

TABLE A1

DESCRIPTION OF INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION CODES

311 Food manufacturing
312 Manufacture of food products not elsewhere classified
313 Beverage industries
314 Tobacco manufactures
321 Manufacture of textiles
322 Manufacture of wearing apparel (except footwear)
323 Manufacture of leather and leather products (except footwear and wearing apparel)
324 Manufacture of footwear
331 Manufacture of wood and cork products (except furniture)
332 Manufacture of furniture and fixtures
341 Manufacture of paper and paper products
342 Printing, publishing, and allied industries
351 Manufacture of basic industrial chemicals
352 Manufacture of other chemical products
353 Petroleum refineries
354 Manufacture of petroleum and coal derivatives
355 Manufacture of rubber products
356 Manufacture of plastic products not elsewhere classified
361 Manufacture of pottery, china, and earthenware
362 Manufacture of glass and glass products
369 Manufacture of other non-metallic mineral products
371 Iron and steel basic industries
372 Non-ferrous metal basic industries
381 Manufacture of fabricated metal products
382 Manufacture of machinery (except electrical)
383 Manufacture of electrical machinery apparatus, appliances, and supplies
384 Manufacture of transport equipment
385 Manufacture of professional and scientific measuring and controlling equipment not elsewhere classified

TABLE A2

MALMQUIST INDEX (AVERAGE ANNUAL GROWTH RATES)

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
311 Food manufacturing						
Public	1.0174	0.9701	0.9799	0.9956	1.0566	1.1242
Private	1.0312	0.9916	0.9972	1.0048	1.0437	1.0484
312 Food products (n.c.e)						
Public	1.0570	0.9026	1.0154	1.0095	1.0485	0.9776
Private	1.0007	0.9969	1.0096	1.0341	0.9880	1.0331
313 Beverage industries						
Public	1.0630	0.9987	0.9520	1.0934	1.0433	1.1184
Private	1.0450	1.0278	1.0456	1.0225	1.0374	1.0779
314 Tobacco						
Public	0.9592	0.8489	1.0886	1.0413	0.8984	1.0941
Private	0.9988	1.0436	1.1072	0.9770	1.0430	1.0062
321 Textiles						
Public	1.0263	1.0065	0.9293	1.0265	1.0127	1.1166
Private	0.9888	0.9885	0.9649	1.0296	1.0081	1.0861
322 Wearing apparel						
Public	1.0834	0.9309	1.0660	0.7992	1.0765	1.0106
Private	1.1566	0.8214	1.0936	0.9786	1.0060	1.1998
323 Leather						
Public						
Private	1.0025	1.0012	1.0447	1.0589	1.0002	0.9687
324 Footwear						
Public	1.0742	0.9534	0.9336	1.1392	0.9905	1.1527
Private	1.0943	0.9602	0.9833	1.1332	0.9565	1.1114
331 Wood and cork products						
Public	1.1073	0.9263	1.0049	1.0328	0.9978	0.9496
Private	0.9990	0.9405	1.0145	1.0404	1.0386	1.1073
332 Furniture						
Public						
Private	0.9477	0.9715	1.0361	1.0233	1.0301	1.0880
341 Paper						
Public	1.1137	0.8390	1.0649	0.9721	1.0284	1.0735
Private	1.0377	0.9453	0.9767	1.0625	1.0026	1.0877
342 Printing and publishing						
Public	0.9576	0.9985	1.0605	0.7697	1.0973	1.1999
Private	0.8992	0.9162	1.1032	0.9504	1.0014	1.3085
351 Industrial chemicals						
Public	1.0043	0.9441	0.9050	1.0400	1.1316	0.8508
Private	1.0430	0.9578	0.9814	1.0409	0.9918	1.1112
352 Chemical products						
Public	1.0694	0.9747	0.9234	1.0001	1.0175	1.2368
Private	1.0416	0.9028	0.9878	1.0534	1.0732	0.9971

TABLE A2—*Continued*

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
353 Petroleum refineries						
Public	0.7888	1.0222	1.0363	1.1759	0.9123	1.0469
Private						
354 Petroleum and coal						
Public	1.0742	0.8173	1.0662	0.9113	0.9313	1.0537
Private	1.1026	0.9003	0.9346	1.2518	0.9222	0.8871
355 Rubber products						
Public						
Private	1.0692	0.9664	0.9788	1.0212	1.0633	1.0691
356 Plastic products (n.c.e)						
Public						
Private	1.0372	0.9091	0.9895	1.0407	1.0268	1.0665
361 Pottery and china						
Public	1.0855	0.9801	1.0242	0.9273	0.9722	1.1012
Private	1.2103	0.8901	0.9539	1.1032	0.9616	1.0558
362 Glass and glass products						
Public						
Private	1.1054	0.9420	1.0479	0.9793	1.0665	0.9842
369 Non-metallic mineral products						
Public	0.9867	1.0307	1.0064	1.0392	1.0108	1.0402
Private	1.0299	0.9984	1.0170	1.0043	1.0257	1.0780
371 Iron and steel						
Public	1.0321	0.9085	1.0531	1.0447	1.0535	0.9727
Private	1.0799	0.9201	1.0498	1.0390	1.0091	1.0540
372 Non-ferrous metal industry						
Public	1.1064	1.0116	0.9045	1.1129	1.0732	0.9753
Private	1.0609	0.8933	1.0475	1.0234	1.0213	1.0278
381 Fabricated metal products						
Public	1.0377	1.0193	1.1407	1.0301	0.9895	1.0339
Private	1.1887	0.9572	0.9872	1.0840	1.0365	0.9500
382 Machinery						
Public	1.0869	0.9226	1.1125	0.9345	1.0757	0.9176
Private	1.0557	0.9414	1.0312	1.0379	1.0210	1.1378
383 Electrical machinery						
Public	1.0614	1.0236	0.9924	1.0698	0.8594	1.0072
Private	1.0578	0.9567	1.0389	1.0810	0.9407	1.2156
384 Transport equipment						
Public	1.1791	1.0153	0.9256	0.9336	1.0062	1.2698
Private	1.0541	0.9010	1.0787	1.0018	1.0198	1.0890
385 Scientific equipment						

TABLE A3

TECHNICAL CHANGE INDEX (AVERAGE ANNUAL GROWTH RATES)

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
311 Food manufacturing						
Public	0.9919	1.0061	0.9971	1.0911	1.0614	1.1008
Private	0.9787	1.0033	0.9939	1.1148	1.0235	1.0981
312 Food products (n.c.e)						
Public	1.0232	0.9678	0.9360	1.1655	1.0463	1.1056
Private	0.9319	1.0055	1.0163	1.1210	0.9949	1.0914
313 Beverage industries						
Public	1.0630	0.9987	0.9520	1.0934	1.0433	1.1184
Private	1.0522	1.0119	0.9781	1.1506	1.0572	1.0953
314 Tobacco						
Public	0.9592	0.8489	1.0886	1.0413	0.8984	1.0941
Private	0.9943	0.9643	0.9998	1.1702	0.9486	1.0757
321 Textiles						
Public	1.0430	1.0138	0.9223	1.1642	1.0207	1.1471
Private	0.9648	1.0271	0.9608	1.1365	1.0536	1.1050
322 Wearing apparel						
Public	0.9667	0.9285	1.0831	1.0749	0.9946	1.1471
Private	1.0023	0.9571	1.0072	1.1241	0.9659	1.0880
323 Leather						
Public						
Private	0.9882	1.0196	1.0141	1.1569	1.0252	1.1061
324 Footwear						
Public	0.9898	1.0852	1.0239	1.1303	0.9900	1.1471
Private	1.0249	1.0172	0.9636	1.1976	1.0104	1.0834
331 Wood and cork products						
Public	1.0384	1.0202	0.9891	1.1162	1.0310	1.1122
Private	1.0051	1.0207	1.0199	1.1013	1.0456	1.0990
332 Furniture						
Public						
Private	1.0161	1.0046	1.0118	1.1118	0.9963	1.1078
341 Paper						
Public	0.9906	1.0053	1.0185	1.0960	1.0205	1.1200
Private	0.9736	1.0052	1.0179	1.1336	1.0105	1.0986
342 Printing and publishing						
Public	1.0261	1.0185	0.9703	1.1148	1.0044	1.1471
Private	1.0178	0.9974	0.9515	1.1079	0.9970	1.0634
351 Industrial chemicals						
Public	0.9731	1.0002	1.0178	1.1056	1.0121	1.0976
Private	0.9447	0.9981	1.0169	1.1206	0.9882	1.0935
352 Chemical products						
Public	1.0267	1.0206	1.0101	1.1074	0.9946	1.1471
Private	0.9789	0.9329	0.9758	1.1619	0.9648	1.0559

TABLE A3—*Continued*

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
353 Petroleum refineries						
Public	0.7888	1.0222	1.0363	1.1759	0.9123	1.0469
Private						
354 Petroleum and coal						
Public	0.9418	0.8448	1.0465	1.1452	0.9393	1.0655
Private	1.0157	0.9003	1.0011	1.1685	0.9222	0.8871
355 Rubber products						
Public						
Private	0.9832	1.0116	1.0199	1.1040	1.0255	1.1000
356 Plastic products (n.c.e)						
Public						
Private	0.9775	0.9954	1.0199	1.0961	1.0335	1.1005
361 Pottery and china						
Public	1.0894	0.9899	0.9903	1.0359	0.9946	1.1471
Private	1.0865	0.9617	0.9921	1.1321	0.9946	1.1321
362 Glass and glass products						
Public						
Private	1.0347	0.9952	0.9792	1.1177	1.0646	1.1060
369 Non-metallic mineral products						
Public	1.0093	1.0350	1.0360	1.0898	1.0470	1.1170
Private	1.0301	1.0170	1.0363	1.0786	1.0401	1.1282
371 Iron and steel						
Public	1.0457	1.0330	1.0211	1.1228	1.0172	1.0967
Private	0.9631	0.9936	1.0175	1.1397	0.9680	1.0847
372 Non-ferrous metal industry						
Public	1.0824	1.0262	1.0055	1.0947	1.0284	1.1043
Private	0.9688	0.9696	1.0189	1.1236	0.9878	1.0811
381 Fabricated metal products						
Public	1.0597	1.0384	0.9829	1.1535	1.0375	1.1471
Private	1.0243	1.0328	0.9568	1.1354	1.0567	1.1007
382 Machinery						
Public	1.0064	1.0568	1.0075	1.0724	0.9988	1.1471
Private	1.0096	1.0328	0.9549	1.1359	1.0383	1.0901
383 Electrical machinery						
Public	1.0697	0.9560	0.9871	1.1064	0.9947	1.1241
Private	1.0195	1.0090	0.9574	1.1717	0.9992	1.0668
384 Transport equipment						
Public	1.0921	0.9670	1.0259	1.0517	0.9946	1.1471
Private	1.0076	0.9956	0.9708	1.1514	1.0196	1.0849
385 Scientific equipment						

TABLE A4

EFFICIENCY CHANGE INDEX (AVERAGE ANNUAL GROWTH RATES)

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
311 Food manufacturing						
Public	1.0257	0.9643	0.9827	0.9125	0.9955	1.0213
Private	1.0537	0.9884	1.0033	0.9013	1.0197	0.9547
312 Food products (n.c.e)						
Public	1.0331	0.9326	1.0848	0.8661	1.0021	0.8842
Private	1.0739	0.9914	0.9934	0.9225	0.9931	0.9466
313 Beverage industries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	0.9931	1.0158	1.0690	0.8887	0.9812	0.9841
314 Tobacco						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	1.0045	1.0822	1.1074	0.8349	1.0995	0.9354
321 Textiles						
Public	0.9840	0.9928	1.0077	0.8817	0.9922	0.9734
Private	1.0248	0.9624	1.0042	0.9059	0.9569	0.9829
322 Wearing apparel						
Public	1.1208	1.0027	0.9843	0.7435	1.0823	0.8811
Private	1.1539	0.8582	1.0858	0.8705	1.0415	1.1027
323 Leather						
Public						
Private	1.0145	0.9819	1.0302	0.9153	0.9756	0.8758
324 Footwear						
Public	1.0853	0.8785	0.9118	1.0079	1.0005	1.0049
Private	1.0677	0.9440	1.0204	0.9462	0.9466	1.0258
331 Wood and cork products						
Public	1.0663	0.9079	1.0160	0.9253	0.9678	0.8538
Private	0.9940	0.9214	0.9947	0.9447	0.9933	1.0076
332 Furniture						
Public						
Private	0.9327	0.9671	1.0240	0.9204	1.0339	0.9821
341 Paper						
Public	1.1243	0.8345	1.0456	0.8869	1.0078	0.9585
Private	1.0658	0.9404	0.9596	0.9373	0.9922	0.9900
342 Printing and publishing						
Public	0.9333	0.9803	1.0930	0.6904	1.0925	1.0461
Private	0.8835	0.9186	1.1595	0.8578	1.0045	1.2305
351 Industrial chemicals						
Public	1.0321	0.9439	0.8892	0.9407	1.1181	0.7751
Private	1.1040	0.9596	0.9651	0.9289	1.0036	1.0161
352 Chemical products						
Public	1.0415	0.9551	0.9141	0.9031	1.0231	1.0783
Private	1.0640	0.9677	1.0122	0.9066	1.1124	0.9444

TABLE A4—*Continued*

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
353 Petroleum refineries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private						
354 Petroleum and coal						
Public	1.1406	0.9674	1.0188	0.7958	0.9914	0.9889
Private	1.0856	1.0000	0.9335	1.0712	1.0000	1.0000
355 Rubber products						
Public						
Private	1.0874	0.9554	0.9597	0.9250	1.0369	0.9719
356 Plastic products (n.c.e)						
Public						
Private	1.0610	0.9133	0.9702	0.9494	0.9935	0.9691
361 Pottery and china						
Public	0.9964	0.9900	1.0343	0.8952	0.9775	0.9600
Private	1.1139	0.9255	0.9615	0.9745	0.9668	0.9327
362 Glass and glass products						
Public						
Private	1.0683	0.9465	1.0702	0.8763	1.0018	0.8899
369 Non-metallic mineral products						
Public	0.9776	0.9958	0.9714	0.9536	0.9655	0.9312
Private	0.9998	0.9817	0.9813	0.9312	0.9861	0.9555
371 Iron and steel						
Public	0.9870	0.8795	1.0313	0.9304	1.0357	0.8869
Private	1.1212	0.9260	1.0318	0.9116	1.0424	0.9717
372 Non-ferrous metal industry						
Public	1.0221	0.9858	0.8995	1.0166	1.0435	0.8831
Private	1.0950	0.9213	1.0281	0.9108	1.0340	0.9507
381 Fabricated metal products						
Public	0.9792	0.9816	1.1606	0.8930	0.9537	0.9013
Private	1.1605	0.9269	1.0318	0.9547	0.9808	0.8630
382 Machinery						
Public	1.0800	0.8730	1.1043	0.8714	1.0769	0.8000
Private	1.0457	0.9115	1.0800	0.9137	0.9833	1.0437
383 Electrical machinery						
Public	0.9922	1.0707	1.0054	0.9669	0.8640	0.8961
Private	1.0376	0.9481	1.0852	0.9226	0.9415	1.1395
384 Transport equipment						
Public	1.0796	1.0500	0.9022	0.8877	1.0117	1.1070
Private	1.0461	0.9051	1.1112	0.8701	1.0003	1.0038
385 Scientific equipment						

TABLE A5

SCALE CHANGE INDEX (AVERAGE ANNUAL GROWTH RATES)

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
311 Food manufacturing						
Public	0.9764	0.9270	1.0616	1.0270	0.8811	0.9897
Private	0.9682	0.9671	1.0238	0.9766	0.9603	0.9641
312 Food products (n.c.e)						
Public	0.9483	0.9438	1.1207	0.9953	0.8958	0.9744
Private	0.9828	0.9646	1.0237	1.0088	0.9305	1.0136
313 Beverage industries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	0.9859	0.9979	1.0165	0.9808	0.9519	0.9852
314 Tobacco						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	0.9901	1.0103	0.9994	0.9961	0.9609	1.0222
321 Textiles						
Public	1.0094	0.9059	1.1551	0.9725	0.9185	0.9633
Private	0.9391	0.9624	1.0183	0.9189	0.9414	0.9777
322 Wearing apparel						
Public	1.1208	1.0027	0.9843	0.7435	1.2309	0.9888
Private	0.9874	0.9838	1.0530	0.9702	0.9068	0.9266
323 Leather						
Public						
Private	1.0017	1.0003	1.0006	0.9881	0.9923	1.0293
324 Footwear						
Public	1.0198	0.9973	1.0020	1.0024	0.9226	1.0283
Private	1.0090	1.0048	1.0030	0.9942	0.9141	1.0748
331 Wood and cork products						
Public	1.0013	0.9983	1.0012	0.9890	1.0059	0.9856
Private	0.9940	0.9595	1.0169	1.0163	0.9492	1.0267
332 Furniture						
Public						
Private	1.0035	1.0108	1.0067	1.0002	1.0006	0.9891
341 Paper						
Public	1.0036	0.9400	1.0321	1.0259	0.9171	0.9651
Private	1.0019	0.9907	0.9823	1.0064	0.9610	0.9685
342 Printing and publishing						
Public	0.9333	1.0333	1.0370	0.9869	0.8579	0.8795
Private	0.9640	0.9869	1.0503	0.9860	0.9869	1.0305
351 Industrial chemicals						
Public	1.0045	0.9471	1.1711	1.0190	0.9550	0.9642
Private	0.9753	0.9758	1.0222	1.0138	0.9571	0.9867
352 Chemical products						
Public	1.0024	1.0095	0.9990	0.9941	0.9374	0.9622
Private	0.9474	0.9994	1.0705	0.9940	0.9494	1.0057

TABLE A5—*Continued*

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
353 Petroleum refineries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private						
354 Petroleum and coal						
Public	1.0222	0.9919	1.0017	0.9782	0.8000	0.9889
Private	1.0036	1.0000	0.9993	1.0007	1.0000	1.0000
355 Rubber products						
Public						
Private	1.0055	0.9582	1.0104	1.0273	0.9234	1.0206
356 Plastic products (n.c.e)						
Public						
Private	1.0030	0.9409	1.0136	1.0312	0.9260	0.9706
361 Pottery and china						
Public	0.9395	1.0281	1.0093	0.9960	0.8464	0.9600
Private	1.0003	0.9963	0.9966	0.9809	0.9922	0.8944
362 Glass and glass products						
Public						
Private	0.9738	1.0254	1.0289	0.9630	0.9082	0.9935
369 Non-metallic mineral products						
Public	0.9892	0.9740	1.0139	1.0150	0.9517	0.9827
Private	0.9960	0.9227	1.0426	1.0320	0.8614	0.9678
371 Iron and steel						
Public	0.9633	0.9124	1.0917	1.0408	0.9070	0.9864
Private	0.9839	0.9658	1.0449	0.9986	0.9727	1.0024
372 Non-ferrous metal industry						
Public	0.9754	0.9864	0.9998	1.0457	0.9446	1.0399
Private	0.9716	0.9864	1.0202	1.0082	0.9632	1.0181
381 Fabricated metal products						
Public	1.0114	0.9982	1.0030	0.9993	0.9153	0.9827
Private	1.0823	0.9296	1.1066	1.0215	0.8821	0.8739
382 Machinery						
Public	0.9974	0.9220	1.0748	1.0248	1.0188	0.8916
Private	0.9591	0.9237	1.1328	0.9701	0.8934	1.0996
383 Electrical machinery						
Public	1.0167	1.0282	1.0036	1.0005	0.7345	0.8961
Private	0.9448	0.9519	1.1299	0.9848	0.8779	1.0985
384 Transport equipment						
Public	0.9462	1.1069	0.9984	1.0180	0.9757	1.0270
Private	0.9511	0.9577	1.0980	0.9655	0.9253	1.0180
385 Scientific equipment						

TABLE A6

PURE EFFICIENCY CHANGE INDEX (AVERAGE ANNUAL GROWTH RATES)

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
311 Food manufacturing						
Public	1.0505	1.0402	0.9257	0.8885	1.1298	1.0319
Private	1.0883	1.0220	0.9800	0.9229	1.0619	0.9903
312 Food products (n.c.e)						
Public	1.0893	0.9881	0.9680	0.8703	1.1186	0.9074
Private	1.0927	1.0279	0.9703	0.9144	1.0672	0.9339
313 Beverage industries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	1.0074	1.0179	1.0516	0.9060	1.0308	0.9989
314 Tobacco						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private	1.0145	1.0711	1.1080	0.8381	1.1442	0.9151
321 Textiles						
Public	0.9748	1.0960	0.8724	0.9066	1.0803	1.0105
Private	1.0913	1.0000	0.9861	0.9859	1.0164	1.0053
322 Wearing apparel						
Public	1.0000	1.0000	1.0000	1.0000	0.8793	0.8911
Private	1.1686	0.8723	1.0311	0.8973	1.1485	1.1901
323 Leather						
Public						
Private	1.0127	0.9816	1.0296	0.9263	0.9831	0.8508
324 Footwear						
Public	1.0642	0.8809	0.9099	1.0055	1.0844	0.9772
Private	1.0582	0.9395	1.0174	0.9517	1.0356	0.9544
331 Wood and cork products						
Public	1.0649	0.9094	1.0148	0.9356	0.9621	0.8663
Private	1.0000	0.9603	0.9782	0.9295	1.0464	0.9814
332 Furniture						
Public						
Private	0.9294	0.9567	1.0172	0.9203	1.0333	0.9929
341 Paper						
Public	1.1203	0.8878	1.0131	0.8645	1.0989	0.9931
Private	1.0637	0.9492	0.9768	0.9313	1.0324	1.0223
342 Printing and publishing						
Public	1.0000	0.9488	1.0540	0.6996	1.2734	1.1894
Private	0.9165	0.9307	1.1039	0.8700	1.0178	1.1940
351 Industrial chemicals						
Public	1.0274	0.9967	0.8742	0.9231	1.1707	0.8039
Private	1.1320	0.9834	0.9442	0.9162	1.0486	1.0299
352 Chemical products						
Public	1.0391	0.9460	0.9150	0.9084	1.0914	1.1207
Private	1.1231	0.9683	0.9456	0.9121	1.1717	0.9390

TABLE A6—*Continued*

ISIC code and description	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
353 Petroleum refineries						
Public	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Private						
354 Petroleum and coal						
Public	1.1159	0.9753	1.0170	0.8135	1.2392	1.0000
Private	1.0817	1.0000	0.9342	1.0705	1.0000	1.0000
355 Rubber products						
Public						
Private	1.0815	0.9971	0.9499	0.9005	1.1229	0.9523
356 Plastic products (n.c.e)						
Public						
Private	1.0579	0.9707	0.9572	0.9207	1.0729	0.9984
361 Pottery and china						
Public	1.0606	0.9630	1.0247	0.8988	1.1548	1.0000
Private	1.1136	0.9290	0.9648	0.9934	0.9744	1.0427
362 Glass and glass products						
Public						
Private	1.0970	0.9231	1.0402	0.9100	1.1030	0.8957
369 Non-metallic mineral products						
Public	0.9883	1.0225	0.9581	0.9396	1.0145	0.9476
Private	1.0038	1.0639	0.9412	0.9023	1.1449	0.9873
371 Iron and steel						
Public	1.0246	0.9640	0.9447	0.8939	1.1419	0.8991
Private	1.1396	0.9588	0.9874	0.9129	1.0716	0.9694
372 Non-ferrous metal industry						
Public	1.0479	0.9994	0.8997	0.9722	1.1048	0.8493
Private	1.1269	0.9340	1.0078	0.9034	1.0734	0.9338
381 Fabricated metal products						
Public	0.9682	0.9834	1.1571	0.8936	1.0419	0.9172
Private	1.0722	0.9970	0.9324	0.9346	1.1119	0.9876
382 Machinery						
Public	1.0828	0.9469	1.0274	0.8503	1.0570	0.8972
Private	1.0904	0.9868	0.9533	0.9418	1.1006	0.9492
383 Electrical machinery						
Public	0.9760	1.0414	1.0018	0.9664	1.1763	1.0000
Private	1.0982	0.9961	0.9604	0.9368	1.0724	1.0373
384 Transport equipment						
Public	1.1410	0.9486	0.9036	0.8720	1.0368	1.0779
Private	1.0999	0.9450	1.0119	0.9012	1.0810	0.9861
385 Scientific equipment						

TABLE A7

SCALE CHANGE INDEX (AVERAGE ANNUAL CHANGES)

Sectors	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
31 Food, beverage, and tobacco						
Public	0.9810	0.9672	1.0444	1.0055	0.9426	0.9910
Private	0.9817	0.9848	1.0158	0.9905	0.9508	0.9960
32 Textile, wearing, and leather						
Public	1.0488	0.9676	1.0444	0.8983	1.0141	0.9931
Private	0.9839	0.9877	1.0185	0.9674	0.9381	1.0006
33 Wood products, furniture						
Public	1.0013	0.9983	1.0012	0.9890	1.0059	0.9856
Private	0.9987	0.9848	1.0118	1.0082	0.9746	1.0077
34 Paper products, printing						
Public	0.9678	0.9855	1.0345	1.0063	0.8870	0.9213
Private	0.9828	0.9888	1.0158	0.9961	0.9739	0.9990
35 Chemicals, coal, rubber						
Public	1.0072	0.9868	1.0044	0.9977	0.9199	0.9787
Private	0.9867	0.9746	1.0229	1.0133	0.9508	0.9966
36 Non-metalic mineral products						
Public	0.9640	1.0006	1.0116	1.0055	0.8975	0.9713
Private	0.9900	0.9805	1.0225	0.9915	0.9190	0.9510
37 Basic metal						
Public	0.9693	0.9487	1.0447	1.0432	0.9256	1.0128
Private	0.9777	0.9760	1.0325	1.0034	0.9680	1.0102
38 Machinery and equipment						
Public	0.9925	1.0116	1.0195	1.0106	0.9042	0.9476
Private	0.9824	0.9567	1.0985	0.9879	0.9116	1.0000
Average						
Public	0.9912	0.9831	1.0254	0.9937	0.9360	0.9748
Private	0.9855	0.9792	1.0295	0.9947	0.9481	0.9950

TABLE A8

PURE EFFICIENCY CHANGE INDEX (AVERAGE ANNUAL CHANGES)

Sectors	1974–1977	1977–1980	1980–1983	1983–1986	1986–1989	1989–1991
31 Food, beverage, and tobacco						
Public	1.0343	1.0069	0.9729	0.9377	1.0603	0.9837
Private	1.0500	1.0345	1.0260	0.8947	1.0752	0.9589
32 Textile, wearing, and leather						
Public	1.0123	0.9884	0.9259	0.9696	1.0099	0.9583
Private	1.0812	0.9471	1.0159	0.9397	1.0441	0.9928
33 Wood products, furniture						
Public	1.0649	0.9094	1.0148	0.9356	0.9621	0.8663
Private	0.9641	0.9585	0.9975	0.9249	1.0398	0.9871
34 Paper products, printing						
Public	1.0584	0.9178	1.0333	0.7776	1.1830	1.0868
Private	0.9874	0.9399	1.0384	0.9001	1.0251	1.1048
35 Chemicals, coal, rubber						
Public	1.0447	0.9793	0.9497	0.9088	1.1218	0.9743
Private	1.0949	0.9838	0.9462	0.9420	1.0816	0.9833
36 Non-metalic mineral products						
Public	1.0238	0.9923	0.9908	0.9189	1.0824	0.9734
Private	1.0703	0.9699	0.9812	0.9343	1.0716	0.9733
37 Basic metal						
Public	1.0362	0.9815	0.9219	0.9322	1.1232	0.8739
Private	1.1333	0.9463	0.9976	0.9082	1.0725	0.9514
38 Machinery and equipment						
Public	1.0395	0.9793	1.0185	0.8946	1.0766	0.9705
Private	1.0689	0.9763	0.9787	0.9190	1.0841	1.0108
Average						
Public	1.0391	0.9688	0.9777	0.9077	1.0754	0.9587
Private	1.0549	0.9691	0.9973	0.9202	1.0616	0.9943

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