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Does trade liberalization improve productivity? Plant level evidence from Turkish Manufacturing Industry

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December 2001

Abstract

Applying the methodology first introduced by Olley and Pakes (1996) and further developed by Levinsohn and Petrin (2001) on plant level data for Turkish manufacturing sector, we estimate production functions for 24 three-digit SIC industries over the 1983-96 period. Based on the production function parameter estimates we calculate plant level total factor productivities and analyze them in several different ways. First, we analyze their evolution over time and across industries by trade orientation. During periods of rapid decline in protection rates productivity gains are largest. Second, we show that productivity gains are largely due to reshuffling of resources from less to more productive plants. Third, we estimate plant level regressions of productivity on trade orientation of the plant. Plants in tradable sectors, in particular plants in import competing sectors have higher productivity gains. Fourth, we estimate regressions of productivity on nominal protection rates. Reduced protection improves productivity in import competing sectors, but not in others. Our main result, that trade liberalization leads to productivity gains, is robust to possible effects of the real exchange rate movements as well as the public sector wage hikes in the late 1980s and early 1990s.

** The database used in this study is the Turkish State Institute of Statistics (SIS) Industrial Analysis Data Base 1999/1. We thank many at the SIS for their efforts in establishing the procedures that has allowed us to use the data set at the SIS premises, and for providing me with the data set. Among those are President Sefik Yildizeli, former President Omer Gebizlioglu, Vice President Nurgul Ogut, Emine Kocberber, Selmin Altin, Ilhami Mintemur, Ali Gunes, and Akin Bodur. We also thank seminar participants at Bilkent University, and Middle East Technical University, and participants at GDN Annual Conference (2001) for helpful comments. This work has benefited from a financial grant from the Economic Research Forum for the Arab Countries, Iran and Turkey. The contents and recommendations do not necessarily reflect the views of the Economic Research Forum.

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I. Introduction

The theoretical trade literature provides conflicting predictions on the impact of liberalization on productivity. On the one hand, trade liberalization might improve productive efficiency through increased competition and shut down of unproductive firms, increasing scale efficiency, elimination of waste, reduction of managerial slack; or trade liberalization might improve productive efficiency through international transactions which generate increased access to higher quality intermediate inputs, or capital goods that embody improved technologies, thus enhancing opportunities for technology diffusion. On the other hand, if trade liberalization reduces domestic market shares of domestic producers, their incentives to invest in superior technologies might decrease as protection is lifted (Rodrik (1988, 91). Many empirical papers have investigated the impact of trade liberalization on industrial productivity using macro-level approaches, or industry level approaches yielding mixed evidence. While trade theory has focused on intra-industry gains from trade liberalization through economies of scale, it has not explored the implications of plant heterogeneity within an industry. Recent studies with plant level data find a significant degree of plant heterogeneity within an industry (for example (Olley Pakes (1996), Roberts and Tybout (1996), Aw, Chen and Roberts (1997)). Plant level heterogeneity may be quite important in productivity dynamics if trade liberalization yields productivity improvements by reshuffling resources from less productive to more productive plants. It is important to evaluate whether trade liberalization improves productivity from a policy perspective as well. Trade liberalization occurs with large reallocations of capital and labour thus generating costs to some groups, making the measurement of gains from liberalization an important policy issue.

In this study we use plant level data for Turkish manufacturing industry for the 1983-96 period, a period covering significant changes in trade policy. For our analysis we estimate plant level production functions for 24 three-digit SIC industries. Our primary estimation method is one developed by Levinsohn and Petrin (2001) (LP) which uses intermediate inputs as the proxy input to address the potential simultaneity bias in production function estimations (this is a modification of Olley and Pakes (1996) (OP) which use investment as the proxy). In the paper we compare the results from LP estimates to the more traditional OLS, fixed effects, IV and OP methods. As in LP, we find that estimation with the most commonly used conventional methods yield the expected biases.

The plant level total factor productivities obtained from production function estimations are analysed in a several different ways. First, we analyse their evolution over time and across industries by trade orientation. We find that during periods of most rapid decline in protection rates productivity gains are largest. We also find that productivity gains in import competing sectors during these periods are higher than other sectors. Second, we investigate productivity dynamics by separating productivity changes resulting from continuing plants' productivity changes from those resulting due to entry and exit. We find that productivity gains are largely due to reshuffling of resources from less to more productive plants. Third, we estimate plant level regressions of productivity on trade orientation of the plant. We find that plants in tradable sectors, in particular plants in import competing sectors have higher productivity gains. In these regressions we control for the impact of plant exit. We find that on average exiting plants are less productive. Forth, we estimate regressions of productivity on nominal protection rates. We find that decreases in protection rates improve productivity, especially in import competing sectors.

Our study is not the first paper that links trade liberalization and plant level productivity empirically. A number of studies report findings on productivity and trade liberalization, but the evidence is mixed (see Rodrik 1995, Tybout 1999 for reviews of this literature). Tybout 1989, Roberts and Tybout 1991, Tybout and Westbrook 1995 do not find evidence favouring industry rationalization or scale effects, while Levinsohn and Petrin 2000 cast doubt on some of these results by finding that rationalization case is empirically most important when industry productivity increases, and Dutz casts some doubt by finding that probability for exit in response to an increase in imports is significantly higher among small firms than it is among large firms. Finding in the available studies are generally favourable to the hypothesis that trade reform is conducive to gains in technical efficiency (see for example. Tybout, de Melo and Corbo (1991)) on the other hand there are studies that cast doubt on generality of these findings (Harrison (1990). In this paper we identify the impact of trade liberalization on productivity in two different ways. First, we exploit the variation in productivity over time and across sectors by trade orientation as in Pavcnik (2001). Second we identify the impact of trade reforms by relying on trade policy measures that show significant variation over time and across industries, nominal protection rates measured by tariffs and quantitative restrictions. Our contribution to this literature is that we estimate plant level productivities using intermediate inputs as a proxy input to obtain consistent estimates of productivity, and that we use time and cross section varying nominal protection rates to identify trade liberalization.[1]

II. Estimation Methods

In estimation of firm level production functions the potential contemporaneous correlation between inputs that are easily adjusted and the unobserved firm-specific shocks has been a source of concern for applied researchers since Marschak and Andrews (1944). The underlying intuition for this concern is that firms that have a large positive productivity shock may respond to it by increasing the inputs used. In such situations the OLS estimates of production function will yield biased parameter estimates and hence biased estimates of productivity. In an attempt to address this concern a number of solutions have been used including fixed effects, and instrumental variables estimates. In the recent literature methods that rely on a proxy that controls for correlation between the input levels and the unobserved productivity shock has been suggested (Olley and Pakes (1996), Levinsohn and Petrin (2001)). In this section we first provide a brief review of the simultaneity problem, then sketch out the methods in the recent literature.

Let us describe a Cobb-Douglas production function for firm *i* at time *t* (suppressing the firm index *i*):

$$y_t = \beta_0 + \cdot\beta_l \cdot l_t + \beta_k \cdot k_t + \omega_t + \eta_t, \tag{1}$$

where y_t is output, l_t is the variable input and k_t is the capital stock. All variables are represented in log-levels. Plant specific error term, ε_t, is composed of a plant-specific productivity component, ω_t, and an i.i.d. component, η_t. The latter term has no impact on the firm's decisions. The productivity term, ω_t, which is not observed by the econometrician, is known by the firm, and it impacts the firm's decision rules. A

[1] We have recently become aware of a study developed simultaneously with ours that relies on protection rates to identify the impact of trade reforms on productivity using Colombian data (Fernandes 2002).

simultaneity problem arises when there is contemporaneous correlation both within firm *i* and across time *t* between ε_t and the firm's inputs in the firm specific sequences.[2]

Olley and Pakes (1996) develop a novel approach by including a proxy for the productivity term. The proxy controls for the part of the error correlated with inputs; thus identification relies on variation in output and inputs unrelated to firm specific productivity. The motivation for the proxy is derived from a structural model of an optimizing firm. As in Ericson and Pakes (1995), Olley and Pakes (1996) provide a model of a profit maximizing plant behavior in a dynamic framework. Slightly simplifying we can describe their model as follows.[3] A plant's goal is to maximize the current profits plus the expected value of its future profits. Current profits is assumed to be functions of the firm's own state variables (capital, and plant specific productivity), factor prices, and a vector of state variables of other firms. Factor prices are assumed to be common across firms and evolve exogenously. However, firms are subject to uncertainty about future market structure (which consists of firm specific state variables for all active firms). Each period, the firm chooses its variable factors (labor) and a level of investment, which, together with the current capital stock, determine the capital stock of the next period.[4] Investment demand function is then written as follows.

$$i_t = i_t(\omega_t, k_t)\,.$$

For positive values of investment Pakes (1994) shows that investment is strictly increasing in the unobserved productivity shock. Hence, $i_t(\omega_t, k_t)$ can be inverted to yield ω_t as a function of capital and investment as $\omega_t = (i_t, k_t)$.

Using the above expression for the unobservable productivity, equation (1) can be

[2] As sketched out in Levinsohn and Petrin (2000), in the case of a two input production function, when both capital and labor are correlated with the productivity shock, but labor's correlation is significantly higher, and that labor and capital are correlated with each other, the parameter estimate of the labor coefficient will tend to be overestimated and the parameter estimate of capital will be underestimated. It is generally not possible to sign the biases of the coefficients when there are many inputs all of which potentially have varying degrees of correlation with the error term ε_t.

3 Olley and Pakes (1996) explicitly take into account firm's exit decision, which we leave out in this exposition.

4 In Olley and Pakes (1996) at the beginning of every period, each plant decides whether to exit, and receive a sell-off value or continue operation. If a plant exits it never reappears again. If it continues it makes the decisions on variable inputs and investment level. Exit rule is determined by the current state variables.

rewritten in terms of observable variables

$$y_t = l_t \cdot \beta_l + \phi_t(i_t, k_t) + \eta_t , \quad (2)$$

where $\phi_t(i_t, k_t) = \beta_0 + \beta_k \cdot k_t + \omega_t(i_t, k_t)$ [5].

Consistent parameter estimates of the coefficients on the variable inputs can then be obtained using a semi-parametric estimator (for example by modeling ϕ_t as a polynomial series expansion in capital and investment as in Olley and Pakes (1996)).

To obtain a separate effect of capital on output from its effect on a plant's investment, a second stage is required. In Olley and Pakes (1996), the identification of the effect of capital on output is obtained from the assumption that ω_t follows a first order Markov process and capital does not immediately respond to the innovations in productivity, where the innovation in productivity is defined as:

$$\xi_t = \omega_t - E[\omega_t \mid \omega_{t-1}].$$

Under these assumptions consistent estimates of β_k is obtained from the estimation of the following equation:

$$y_t^* = y_t - l_t \cdot \beta_l = \beta_0 + \beta_k \cdot k_t + E[\omega_t \mid \omega_{t-1}] + \eta_t^* . \quad (3)$$

Where, y_t^* is output net of labour's contribution and $\eta_t^* = \xi_t + \eta_t$. Since a by-product of the first stage is an estimate of ω_t a consistent estimate of $E[\omega_t \mid \omega_{t-1}]$ can be obtained and estimation of equation (3) will yield consistent estimates of β_k.[6]

Levinsohn and Petrin (2001) (**LP** from here on) introduce a new method by building on ideas developed in Olley and Pakes (1996). The authors use intermediate inputs, instead of investment as the proxy variable to solve the simultaneity problem. LP makes convincing arguments for potential advantages of their method over using investment. The authors point out that investment is a control on a state variable, which is by definition costly to adjust. Adjustment costs would lead firms to undertake

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[5] ϕ_t will always be used when discussing the non-parametric part of the first stage; it will always have capital, the endogenous state variable, and the proxy variable.

[6] Olley and Pakes (1996) use a series expansion as well as kernel estimator for this stage. Also note that a constant can not be identified separately from the polynomial expansion in investment and capital.

intermittent investment, yielding zero values for other periods. Since monotonicity condition does not hold for the zero observations they will be truncated from the estimation routine. These observations are often a large fraction of observations in manufacturing censuses (about 41% of our sample). LP also points out that adjustment costs may affect the responsiveness of investment to the transmitted shock due to kinks in the investment function (perhaps from indivisibilities of capital) even when investment is undertaken.

We now turn to sketching the modification introduced by LP. The production function now has an additional variable input, ι_t, which represents an intermediate input:

$$y_t = \beta_0 + \beta_l \cdot l_t + \beta_k \cdot k_t + \beta_\iota \cdot \iota_t + \omega_t + \eta_t, \tag{4}$$

Continuing to assume that all input and output prices are identical across firms, intermediate input demand function is expressed as follows:

$$\iota_t = \iota_t(\omega_t, k_t),$$

where the intermediate input demand is monotonic in the productivity shock. The assumption of monotonicity allows one to invert the input demand function to obtain $\omega_t = \omega_t(\iota_t, k_t)$, with intermediate input proxy replacing the investment proxy.

Using this expression of productivity, the production function in (4) yields:

$$y_t = \beta_l \cdot l_t + \phi_t(\iota_t, k_t) + \eta_t, \tag{5}$$

where $\phi_t(\iota_t, k_t) = \beta_0 + \beta_k \cdot k_t + \beta_\iota \cdot \iota_t + \omega_t(\iota_t, k_t)$. As before consistent estimates of the coefficient on the variable input can be estimated using non-parametric methods (polynomial series expansion in capital and intermediate inputs (as in Olley Pakes (1996), or non-intercept OLS, as in LP).

With the above modification of ϕ_t function the second stage equation changes to

$$y_t^* = y_t - l_t \cdot \beta_l = \beta_0 + \beta_k \cdot k_t + \beta_\iota \cdot \iota_t + E[\omega_t \mid \omega_{t-1}] + \eta_t^*, \tag{6}$$

where $\eta_t^* = \xi_t + \eta_t$, as before. Equation (6) and (3) differ only by the inclusion of the term related to the intermediate input in equation (6). Despite this apparent similarity, the approach used in estimating (3) cannot be implemented here. While k_t is not correlated with η_t^* by assumption, the intermediate input, ι_t, is correlated with η_t^* because it responds to the innovation ξ_t in ω_t. Intermediate input of the previous period, ι_{t-1}, on the other hand is not correlated with η_t^* since it is chosen before either of the components of η_t^* are realized. Given the Markov process for productivity, ι_{t-1}, which depend on lagged capital and productivity is correlated with ι_t, satisfying conditions of defining an instrument. Thus, LP uses two moment conditions to identify β_k and β_ι.

$$E(\xi_t + \eta_t \mid k_t) = E(\xi_t \mid k_t) + E(\eta_t \mid k_t) = 0, \tag{7}$$

and

$$E(\xi_t + \eta_t \mid \iota_{t-1}) = E(\xi_t \mid \iota_{t-1}) + E(\eta_t \mid \iota_{t-1}) = 0, \tag{8}$$

LP obtains $\xi_t + \eta_t$ by using estimates of ω_t from the first stage combined with the candidate values of (β_ι^*, β_k^*) to approximate $E[\omega_t \mid \omega_{t-1}]$ and solve for $\omega_t \hat{+} \eta_t = y_t - \hat{\beta}_l \cdot l_t - \beta_\iota^* \cdot \iota_t - \beta_k^* \cdot k_t$. Finally, estimates ($\hat{\beta}_k$ $\hat{\beta}_\iota$) are obtained by minimizing the GMM criterion function:[7]

$$\min_\beta \left(\left(\sum_i \sum_{t=T_{i0}}^{T_{i1}} (\xi_{i,t} \hat{+} \eta_{i,t}) \cdot k_t \right)^2 + \left(\sum_i \sum_{t=T_{i0}}^{T_{i1}} (\xi_{i,t} \hat{+} \eta_{i,t}) \cdot \iota_{t-1} \right)^2 \right), \tag{9}$$

where T_{i0} and T_{i1} index the second and last period a firm is observed.

A second approach suggested in an earlier version of LP[8] is what is referred to as the restricted approach. This approach is valid if the revenue share of the input is observable and the production technology is separable in this input. Cost minimization under perfect competition implies that firms set the revenue share of an intermediate input equal to the elasticity of output with respect to that input, i.e, $\beta_\iota = s_\iota$. Combining this with separability, contribution of the intermediate input to output can be expressed as $\beta_\iota \iota_t = s_\iota \iota_t$. The estimation proceeds the same way after netting out from equation (6) an estimate of $\beta_\iota \iota_t$.

In this paper we use LP in estimation of firm level productivity because of its

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[7] LP also includes over identifying conditions, which we omit here.

[8] May 2000.

advantages outlined above. We specify the production function as follows:

$$y_t = \beta_0 + \beta_l \cdot l_t + \beta_m \cdot m_t + \phi(e_t, k_t) + \eta_t, \tag{10}$$

where

$$\phi(e_t, k_t) = \beta_0 + \beta_k \cdot k_t + \beta_e \cdot e_t + \omega_t(e_t, k_t).$$

y_t is output in year *t*, l_t is labor input, m_t is material inputs, k_t is the capital stock, and e_t is the energy input. All variables are represented in log-levels. η_t is the plant specific i.i.d. error term, and ω_t is the plant-specific productivity term.

As described above, the estimation has two stages (for further details and each step involved to implement this estimation see Appendix C in LP). In the first stage we estimate the coefficients on labor and materials, the freely variable inputs. We do this by modeling ϕ_t in equation (10) as a polynomial series expansion in capital and energy as in Olley and Pakes (1996)).[9] In the second stage, we obtain the coefficient on capital using the LP restricted approach. In other words, in the second stage we assume that production technology is separable in our proxy input, energy. Using the restricted approach has significant advantages in terms of computational costs,[10] and LP results suggest that this approach yields very similar results to the results of the unrestricted approach when used on Chilean data. The coefficients in the second stage are obtained using a Generalized Method of Moments estimator. We obtain standard errors by bootstrapping. Since the data is non-i.i.d. block bootstrap (treating the entire block of observations on a firm as one observation) is used, drawing from the empirical distribution 30 times. *(This paper is currently under revision where we report findings from estimations using the unrestricted approach, which yield qualitatively similar to the ones reported here)*.

In presenting the results from production function estimations we will be reporting comparisons of LP with other more commonly used estimators, OLS, Fixed

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[9] The difference from Olley and Pakes (1996) is that we use energy instead of investment. Levinsohn and Petrin (2000) use locally weighted least squares at this stage.

[10] The computational costs of the unrestricted approach are substantial. The estimation has several steps and it nests a two-dimensional grid search. Furthermore, we are estimating production functions for 24 industries, and comparing other methods of estimation with that of Levinsohn and Petrin.

Effects, Instrumental Variables and OP. For all these comparisons we will be using an unbalanced sample. As we will describe below there is both entry and exit in our sample. We note that we don't artificially balance the sample, but work with an unbalanced sample. We do not in general focus on selection issues that may arise from firm exit. We do, however, estimate OP also by incorporating plant exit in the estimation procedure (as in Pavcnik) and report the comparisons of OP with without exit.

III. Data

In this study we use a data set, collected by the Turkish State Institute of Statistics (SIS) for the Turkish manufacturing industry. SIS periodically conducts Census of Industry and Business Establishments (CIBE).[11] In addition, the SIS conducts Annual Surveys of Manufacturing Industries (ASMI) at establishments with 10 or more employees.[12] The set of addresses used during ASMI are those obtained during CIBE years. In addition, every non-census year, addresses of newly opened private establishments with 10 or more employees are obtained from the chamber of industry.[13] For this study we use a sample that matches plants from CIBE and ASMI for the 1983-96 period.[14] Unfortunately, not all the key variables needed for this study have been collected for establishments in the 10-24 size group.[15] Thus our sample consists of plants with 25 or more employees. Finally, we limit the sample to only on *private establishments*.[16] In the resulting sample we have 61, 647 plant years for 10, 522 plants in 24 three-digit SIC industries. The distribution of observations over the years, and the size distribution of plants are provided in Appendix I (Table A1).

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[11] Since the formation of the Turkish Republic CIBE has been conducted 7 times (in 1927, 1950, 1963, 1970, 1980, 1985, and 1992).

[12] SIS also collects data on establishments with less than 10 employees. However, up to 1992 data on these establishments were collected only during CIBE years. Since then SIS collects annual data for establishments with less than 10 employees but, using a sampling method.

[13] Thus plant entry can be observed in every year of the sample. Though not reported here, in the CIBE years we observe a larger number of new plants, and a higher fraction of smaller plants. Both of these observations reflect the concerted effort by the SIS to include all establishments in the CIBE years (Ozler (2001)).

[14] The ASMI and CIBE data are available in a machine-readable form starting from 1980. For this study we limited the sample for the post 82 period primarily because in the years prior to 1983 the quality of data is less reliable and much work is needed for its improvement.

[15] During the 1983-92 period 10-24 size group, and 24+ group were administered different survey forms.

[16] The unit observed in the data is a plant, not a firm. However, in Turkish manufacturing sector almost entirety of the plants is single plant establishments.

The data includes value of sales, number of employees, values of material inputs, electricity, fuels and investment. Details of variable construction are relegated to Appendix II. It suffices here to indicate several important features of variable construction. First, we create measure of energy use based on electricity and fuel usage. Second, we create the plant level capital series using a perpetual inventory method. Finally, sales, material inputs, energy, and capital each have their own price deflator and they are each measured in real 1990 Turkish Liras. Descriptive statistics of the variables are provided in Appendix I (Tables A2 and A3).

In Table A4 of the Appendix I we report percentages of non-zero levels of investment, fuels, and electricity to describe plant level usable observations. The investment problem in our data is quite severe. Over 30% of the observations in 21 out of 24 industries have zero investment. In 9 of the industries investment is zero for over 40% of the observations. Furthermore, these 9 industries include industries with highest number of observations, constituting about 62% of the sample. If we were to follow Olley and Pakes methods, we would have to truncate these observations from estimation. Instead we use energy use as our primary proxy for productivity. Energy use, which consists of electricity and fuel use, has positive value for every single plant year in the data, thus the data is not truncated. (For completeness, we report usable observations for fuel and electricity separately in Table A4).

Even though usable observations for materials are also quite high we choose energy as our primary proxy for productivity. Materials are easy to store over time and hence new purchases of these inputs may not exactly reflect the amount of these inputs used in any given year. Though fuel may be storable as well, the costs of storing fuel makes it much less likely to be stored. Furthermore, relying on the separability assumption in the second stage of the estimation makes the choice of energy a more sensible one. Energy constitutes only 5.8% of revenues in manufacturing sector, whereas labor and material inputs constitute about 17%, and 64% of revenues respectively (In Table A5 in Appendix I nominal revenue shares of various inputs are reported by industry). Alternatively, since materials represent a wide range of possible inputs, some of which may interact with others in a way that violates separability, energy is treated as the proxy.

The trade orientation of an industry is determined at a three-digit SIC level, on the basis of sector level export, import and sales values. Sectors that export more than 15% of their sales are classified as export oriented, sectors that have import penetration rate above 15% are classified as import competing, and others are classified as non-traded. When a sector has both export-output and import penetration rates above 15%, then the sector is classified as import competing or export oriented depending on whether import penetration rate is above export-output ratio or not**.** Since the definition of trade orientation involves a potential endogenity we inspected its stability over time. In other words, we computed the ratios using alternative sub samples. Interestingly, trade orientation of the three digit industries does not change much over time. In addition, we compared our classification with that of Erlat (1998) which is based on Krueger *et. all* (1981)'s criterion. [17] The two classification schemes yield remarkably similar results. As in our classification, this alternative is also stable over time, as reported in Erlat (1988). In Appendix I (Table A6) three digit industries and their trade orientation classification based on period averages are reported.

As an alternative measure of exposure to trade we use three digit SIC level data on tariff rates and quantitative restriction to generate a protection measure. Unfortunately, there is not a single series that covers the entire period under consideration. The data we use are from three different sources Krueger and Aktan (1992), Togan ((1994) and (1997)). We use the existing sources in two different ways for two different purposes. Our first purpose is to see the change in the protection rates over different periods in our sample to identify sub-periods with low or high protection rates. Towards this end we combine the data from these sources and generate one series.[18] Since in generating this series we extrapolate and impute values the series is subject to

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[17] The criterion is based on the difference between domestic consumption C, and production Q, per unit of consumption: $T= (C-Q)/C$. Using $C \equiv Q-X+M$, T is calculated as $T=(M-X)/(Q-X+M)$, where M is imports, X is exports. Obviously, if a sector is a net exporter, then $T<0$. The analysis carried in Erlat (1998) leads her to use 0.40 as a cutoff value to separate non-tradeable from import competing sectors. The sectors with T values between 0 and 0.40 are classified as import competing and those with T values greater than 0.40 as non-tradeable.

[18] Togan (1994) provides tariff data for 1983,84, 88, 89, 90 and 91. Togan (1997) provides tariffs for 1994 and the projections for 2001 based on the Customs Union agreement with the EU. In both sources data are provided for 50 sectors used in the national input-output tables, most of which correspond to three-digit SIC codes. We convert these tariff data to three digit SIC series. Kruger and Aktan (1992) provide data for the 1980-89 period. Their data combines tariff rates and quantitative restrictions, which were eliminated by 1985. We use Togan's calculations for 1988 and extend the series to the pervious years using the yearly rate of changes based on Kruger and Aktan. For the years after 1988 we rely on Togan's series and impute values for missing years by linearly extrapolating the existing series.

measurement error. Thus when we do a regression analysis of the relation between productivity and protection rates we rely only on Togan (1994), which provides data for selected years through our entire sample period. We also adjust Togan (1994) tariff series using information from Krueger and Aktan (1992) on levels of quantitative restriction prior to 1995. The series are reported in Table A7 (A-C) in Appendix I. As can be seen in part A of this table (and Figure A1), during 1983-85 there is a dramatic decline in protection rates, bringing them to about 75 percent, which is half of what it was in 1983. The decline in the following several years is only about 6 percentage point, and more importantly an increase is observed during 1987 and 1988 in comparison to 1986. During 1988-93 protection rate decline by about one third reaching 24.8 Since elimination of trade barriers appears to have slowed down after initial onset in 1980s then followed with a further steady reduction through the 90s in our analysis we inspect whether productivity growth differs for these sub-periods.

Another important feature of the Turkish economy relevant to our undertaking is presence of macroeconomic cycles during the period under consideration. These cycles are apparent in the behavior of real GNP growth rate (Appendix I (Table A.8). In our estimations we take these cycles into account.

Finally we report plant entry and exit pattern by industries' trade orientation in Appendix I Table A9. Though we use an unbalanced sample for most of estimations, we take into account plant exit in the estimation process to check whether it has bearing on the results reported in this paper. As can be seen in Table A9 though there is some attrition of plants it is not at an overwhelming level. About 60% of the plants that were in the data set in the initial years continued staying in the sample through the end. The percentages do not appear to differ in a significant way when they are compared across sectors by trade orientation.

IV. Estimation Results

1. Estimates of the Production Function Coefficients

In this section we present a discussion of the results from our estimation of production functions using Levinshon and Petrin (2001) method (LP), and its comparisons with other commonly used estimators. In Table 1 coefficient and standard errors of LP estimates for the 24 three-digit SIC industries are presented. Parameters have the expected sign and are mostly statistically significant estimated.

Comparisons of OLS and LP parameter estimates are presented in Table 2, where the number of observations orders industries. In this table we present the differences between OLS and LP estimates for each coefficient across 30 bootstrapped samples. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which β_{OLS}-β_{LP} >0. The OLS is expected to overestimate variable factors and underestimate capital. SIC 352 provides a stark example. In 100% of the samples (in all 31) OLS underestimates capital; OLS overestimates labor in 84%, overestimates material inputs in 77% of the samples and overestimates energy in 90% of the samples. In general the results in the table are consistent with what is expected. Capital, on average, is underestimated when OLS is used in all the industries, except for 324. Similarly the difference between OLS and LP for variable inputs are also largely in the expected direction. There is only one industry (369) where, contrary to what we would expect, OLS estimate of energy is smaller than LP. There are four such industries for material inputs, and seven industries for labor.

In the column labeled with (RS) of Table 2 we present differences in returns to scale estimates when OLS and LP are compared. Since OLS underestimates capital, and usually overestimates variable factor inputs it is not clear whether OLS will underestimate or overestimate returns to scale. In fact, the findings are mixed. In half of the industries OLS overestimates returns to scale and it underestimates returns to scale in the remaining half.

We conduct similar types of comparisons with other commonly used estimators, and test the null hypothesis that the LP estimator and an alternative estimator are consistent with one another. Since LP is a relatively new estimator we conduct this investigation to see if our findings yield similar conclusions to LP on these comparisons with our data set. In fact we do reach similar conclusions. As in LP we reject the hypothesis that OLS, IV or Fixed Effects estimators give the same results as LP. The general pattern of IV and LP differences is in the direction predicted by theory. When IV is used the coefficients on variable inputs are usually overestimated and the coefficients on capital are underestimated. Fixed effects model does not yield a clear theoretical prediction, and the results offer a more mixed picture, especially for variable inputs. Since our primary purpose is this paper is not to provide a detailed discussion of comparisons of LP with alternative estimators, but to make the point that we reach similar conclusions as in LP, and hence chose the LP estimator for our productivity computations we relegate all these comparisons to a separate appendix. Interested reader can find, in Appendix III Tables A.III.1-A.III.2, comparisons of FE-LP, IV-LP, respectively. Instead, here we present a summary of these comparisons.

In Table 3. A, we present results for the following test. The null hypothesis is that the results from the LP estimator and an alternative estimator are consistent with each other. In other words, we ask whether any of the parameters is significantly different across to approaches. In Table 3 A the first column reports OLS LP comparison. At the 5% significance level we reject the null hypothesis in 95.8 industries. Comparisons with FE and IV also indicate that the null is rejected for a large percentage of the industries.

We also compared LP with OP. This comparison is subtler in that OP can only be estimated on the set of firms that report positive investment. In the remaining columns of the table we report some comparisons. First in column 4 we compare results from a sample that is restricted to firms with positive investment. At the 5% level we reject that LP and OP give the same parameters in about half of the industries. In column 5 we investigate presence of selection bias due to truncation of the sample to positive investment reporting firms. We compare LP for the whole sample with the truncated sample. At the 5% we find in 29% of the industries we reject the null hypothesis of no difference in the estimated coefficients. At the 20% significance level we reject if for 75% of the industries. These results suggest presence of some truncation bias, but the evidence is not overwhelming. In column 6 OP and LP are compared for the full sample. Again more often than not we reject the null hypothesis. OP and LP clearly give somewhat different results.

In Table 3 B we count how many of the estimated parameters are different across all industries. The first column of the table reports the comparisons for LP and OLS. With 3 parameters and 24 industries we have 72 pairs of parameter estimates. The first column indicates that at 5% significance level the difference between OLS and LP estimates is significantly different from zero in about 60% of the 72 cases. The comparisons with other estimators roughly yield similar results to comparisons with OLS, except that it is less pronounced for comparisons with OP.

Comparisons of estimated returns to scale are presented in part C of Table 3. In this table too we find that OLS, FE, IV give different results than LP for estimated returns to scale in most cases. Again, the difference between OP and LP are less pronounced.

Finally, for all these comparisons so far we have used an unbalanced sample. Since there is both entry and exit we next investigate whether incorporating plant exit in the estimation process alters the results in a significant way. As in Olley and Pakes (1996) and Pavcnik (2001) we estimate the coefficient on capital in the production function by taking into account the probability of a plant staying in the market. The OP comparisons with and without exit are presented in Appendix III Table A.III.4 As can be seen in the table in most cases (15 industries out of 24), on average OP with exit underestimates capital parameter in comparison to OP without exit. The difference between the two parameter values, however, is rather small. In fact as we will see in the next section, when we calculate total factor productivity based on these alternatives there is not a discernable difference in the results.

2. Total Factor Productivity Growth and its Decomposition

2. a) Total Factor Productivity Growth

Using the production function estimates presented in Table 2 based on LP, total factor productivity for plant *i*, in year *t* (in logarithms) is computed as follows:

$$TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_e e_{it} - \hat{\beta}_k k_{it} \qquad (11)$$

Sectoral level productivity in year *t* is then obtained as output share weighted average of plant level productivities:

$$TFP_t = \sum_i \theta_{it} \cdot TFP_{it}$$

where, θ_{it} is output share of plant i in total industry output in year *t.*

Growth rate of average TFP for the manufacturing sector as a whole is presented in the first row of Table 4 A. To compare these results obtained with LP estimates to OP estimates in section B and C of the same table we present the results obtained using OP without exit, and with plant exit, respectively. Figure 1 presents log TFP levels and average TFP growth rates for the manufacturing sector as a whole. The results obtained from these different methods are remarkably similar. We focus our discussion on LP based calculations of total factor productivity. The evidence indicates that on average the Turkish manufacturing industry attained 2.1 % TFP growth per annum between 1983 and 1996. There is, however, a substantial difference across sub-periods. As can be seen in Table 4, during 1984-88 period average TFP growth is –0.8%, while it is 3.9% during the 1989-96 period. In columns 4-7 of Table 4 we provide the growth rates for a finer division of the period. These sub-periods correspond to periods with different degrees of protection reduction described in the data section (50% during 1984-85, 0.06% during 86-88, 64% during 1989-93, and 23% during 1994-96.) It is evident that large productivity gains takes place during periods of large decreases in protection rates: during 1984-85, and 1989-93 productivity gains are 7.8% and 6% respectively. In the same table we also present TFP growth rates by sectors' trade orientation. The largest productivity gains during these periods are observed in import competing sectors. Productivity gains in import competing sectors average 8.6% during 1984-85 and it averages 7.7% during 1989-93. (TFP growth rates at three-digit SIC are presented in Appendix I, Table A8).

2. b) Decomposition of Total Factor Productivity Growth

To gain insights into the productivity dynamics we decompose the productivity growth and analyze the contribution of continuing, entering and exiting plants to the sectoral productivity. Changes in log productivity levels are decomposed using the approach in Haltiwanger (1997) as follows[19]:

$$\Delta TFP_t = TFP_t - TFP_{t-1}$$

$$\begin{aligned}\Delta TFP_t = &\sum_{i\in C}\theta_{i,t-1}\Delta TFP_{it} + \sum_{i\in C}\Delta\theta_{it}\left(TFP_{i,t-1} - TFP_{t-1}\right) + \sum_{i\in C}\Delta\theta_{it}\Delta TFP_{it} \\ &\sum_{i\in Ent}\theta_{it}\left(TFP_{it} - TFP_{t-1}\right) + \sum_{i\in Ext}\theta_{i,t-1}\left(TFP_{i,t-1} - TFP_{t-1}\right)\end{aligned} \qquad (12)$$

The first term, *within plant* component of productivity change weighs plant-level changes by the output shares of the previous year. The second term is the *between-plant* component of productivity change. It reflects changing output shares of firms, weighted

[19] Pavcnik (2001) decomposes the deviation of plant productivity from a reference plant in the base year as in Olley and Pakes (1996). Since we decompose the *changes* in productivity levels the reference plant drops out. We prefer this decomposition as we find it more informative.

by the deviation of previous year's plant productivity from the industry productivity. As such, an increase in the output share contributes positively to the between-plant component only if the plant has higher than average industry productivity in the previous year. The third term is the covariance term, which allows the output share to change along with the productivity from one period to another. The last term in this equation captures the effect of net entry by subtracting the productivity of exiting plants from productivity of entering plants.

The results of the above decomposition are presented in Table 5 for the manufacturing sector as a whole, as well as by sector's trade orientation. A couple key findings emerge from Table 5.[20] First, focusing on the decomposition of productivity for continuing plants reported in columns 2-4 we observe that both the within and the between component of productivity change are negative, while the covariance term is positive for the manufacturing sector as a whole. This indicates that improvements of aggregate productivity among continuing plants results from the reallocation of resources and market share from less to more productive plants. Second, comparing column 5 and 6 indicates that the contribution of net entry is negligible in comparison to the contribution of continuing plants. Contribution of entry and exit considered individually are also small as can be seen in columns 7 and 8. All these results largely hold for different sub-periods or different industries by trade orientation. Only during the 1989-96 period within productivity improvements are observed for import competing, and non-traded industries. In particular, for the 1989-96 period within plant productivity improvements are an important component of overall productivity improvements in these sectors. Presence of positive within plant productivity gains may indicate importance of plant level changes in technologies, or organization of production. Nevertheless, even in this instance it is the covariance term that largely explains productivity gains.

3. Estimation of Variation in Plant-Level Productivity

3. a) Trade Orientation and Plant Level Productivity Estimations

The evidence presented above suggests productivity increase during the trade liberalization period has been largest for plants that are in import competing sectors.

[20] The decomposition obtained from OP with and without exit are remarkably similar to the results in Table 5. Thus they are not reported here, but are available upon request.

Here we explore the impact of trade liberalization on plant productivity in a regression framework, as Pavcnik (2001) we identify the effects of trade reforms by relying on productivity variation over time and across sectors, which are distinguished by their trade orientations. We should note here that, as discussed earlier, our trade orientation classification of three-digit SIC industries is stable over time, alleviating concerns on potential endogeneity of trade orientation. Consider the following regression framework estimated by pooling plant productivity indices across industries:

$$PR_{it} = \alpha_0 + \alpha_1 \cdot (Time)_{it} + \alpha_2 \cdot (Trade)_{it} + \alpha_3 \cdot (Trade * Time)_{it} + v_{it} \quad , \qquad (13)$$

where, PR_{it} is TFP relative to an average plant in plant *i*'s industry in the base year (1983)[21], time is a vector of year indicators, trade is a vector of dummy variables indicating trade orientation of a plant. The year indicators control for omitted macroeconomic variables. We estimate the above equation with 3-digit industry indicators to control for variation of productivity between industries so that the other regressors capture the effects of within industry variation. Furthermore, we use plant fixed effects to control for omitted plant attributes. The non-traded goods sector, and the year 1983 are the excluded categories.

The above difference in difference framework, by exploiting the productivity variation over time and across plants with different trade orientations, separates the variation in productivity resulting from changes in the protection rates in the Turkish economy from the variation due to other potential sources of productivity change. The difference in difference estimates of the effects of trade is captured by the coefficients of α_3 in the above equation. If trade improves plant productivity in the import competing sector the coefficients should be positive.

The first set of regression results, reporting Huber-White standard errors, is presented in Table 6. The key result in this table concerns the interaction of a plant's trade status and the year indicator. Plants in the export-oriented sectors are on average

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[21] This index employed in Aw, Chen and Roberts (1977), Caves, Christensen and Tretheway (1981) and Lkette (1996) insures that the productivity index has the desirable properties such as insensitivity to the units of measurement and transitivity.

becoming more productive from 1991 onwards relative to the plants in the non-traded sectors. This difference in productivity ranges between 11% and 29%. Similarly plants in the import competing sectors are on average becoming more productive starting in 1990 relative to the plants in the non-traded sector. The productivity gains for the plants in import competing sectors attributable to liberalization range from 7% to 51%. When the incremental productivity difference of export sectors from non-traded sectors in a given year are compared to the incremental difference of import competing sectors from non-traded sectors in a given year, productivity increase in import competing sectors is found to be higher (compare α_3 for export oriented and import competing). For example in 1996 plants in the import competing sector were 47% more productive than plants in the non-traded sectors, while the plants in the export oriented sectors were about 22% more productive.

In the remaining columns of Table 6 we present results from estimations that include plant exit indicators. The results suggest that plants that are exiting are on average 4% less productive than surviving plants. The last set of results in this table is from a specification, which interacts the exit indicator with trade orientation of the industries. Exiting plants in tradeable sectors are relatively more productive in comparison to exiting plants in non-tradeable sectors. A comparison of exiting plants' productivity in exportable sectors with those in import competing sectors reveals that they are not statistically significantly different from each other. A comparison of the coefficients on the interaction terms across sectors indicates that the coefficients hardly change.

The results above indicate that the expected productivity changes in traded sectors did not take place until the early 1990s. At first instance this seems somewhat puzzling given that import liberalization program was onset in 1984 and was largely in place as of 1988. During the first four years of the program, however, protection rates did not decline steadily. (see Appendix I Table A.6) The initial decrease during the 1984-86 periods was followed by an increase in nominal protection rates during 87-88. In 1988 manufacturing average nominal protection rate was about 70%, though half of what it was in 1983, a regime with a 70% protection rate can hardly be called a "liberal trade regime". In the early 1990s, protection rates not only decline steadily but also reach 20% in 1994 coming much closer to what can call a "liberalized trade regime". Thus, next we turn to an investigation of the relation between protection rates and productivity.

3. b) Nominal Protection Rates and Plant-Level Productivity Estimations

To explore the linkage between protection rates and plant level productivity we pool plants according to their trade orientation and regress our productivity index on nominal protection rates (reported in Appendix I Table A7.C). A concern with estimations of productivity on measures of trade policy is endogeneity of trade policy. In other words, government authorities may increase trade protection in response pressures from industries with productivity disadvantage. To address this we would need a dynamic model of simultaneous determination of productivity and protection rates, which is beyond the scope of this paper. Furthermore, we are able to argue that endogeneity is not a major problem for our measures of protection for the Turkish manufacturing sector during the period under consideration. We find that the government does not asymmetrically change protection rates asymmetrically across industries during the period under consideration. The almost uniform movement of tariffs and quantitative restrictions in the same direction across industries indicates this.

Thus, we regress productivity on one period lagged protection rates:

$$PR_{it} = \lambda_0 + \lambda_1 \cdot (NPR)_{it-1} + u_{it} \ , \qquad (14)$$

where PR_{it} is TFP relative to an average plant in plant *i*'s industry in the base year (1983), and NPR is the measure of nominal protection rates varying over time and across industries. In these regressions we also include a time trend, industry indicators, and plant indicators.[22] The results of these estimations are reported in Table 7. As can be seen in Panel A of the table an increase in protection rate reduces productivity statistically significantly in import competing sectors. A one percent increase in protection reduces productivity by about 6%.

A concern with this identification of the impact of trade liberalization on productivity in the traded sectors, in general, may be with regard to the behaviour of the real exchange rate, as discussed in Pavcnik (2001). In particular, differential impact of changes in the real exchange rate on traded and non-traded sectors may will affect the

[22] We should also remind here that as was discussed in the data section we run these regressions only for those years for which we have the actual protection rates (1984, 88, 89, 90, 91 and 94).

estimates of λ_1 in equation (14). Real exchange rate (RER) appreciation might increase demand for nontradables and decrease demand for domestically produced traded goods. If plants do not adjust their inputs instantaneously and have some spare capacity, the demand fluctuations induced by RER (depreciation) could lead to an increase (decrease) in measured productivity for plants in the nontraded goods sector and a decrease (increase) in measured productivity for plants in the export oriented and import competing sectors. In the Turkish case we see a RER appreciation during the late 1980s as presented in Figure 2. Even though, the Turkish Lira experienced a real depreciation of 5% in the first couple of years in the 1990s, this was not sufficient to generate large shifts in demand towards tradeable goods.

We incorporate RER into equation (14) present these results in panel B Table 7. The parameter estimate has the expected sign that real exchange rate depreciation increases productivity in tradable sectors. At the same time findings regarding the impact of nominal protection continues to hold.

1983-96 also includes a period when both public and private sector wages increased rapidly without any increase in the productivity in the pervious years. Starting in the late eighties there has been a drastic increase in real wages. With the opening of the political competition in 1988, the Ozal government which was in power then started to follow populist economic policies. This was meant to give in the demands of various segments of the society, including the labor. Wages in the public sector companies about doubled between 1988 and 91, and continued with steep hikes into the mid nineties (see Appendix I Table A11). The public sector wage hikes were followed by similar increases in the private sector. It is likely that faced with the rapid increase in wages, many firms were forced to undertake replacement investment in order to keep the unit labor costs under control. In addition, there was managerial and organizational changes that would effectively reduce the X-inefficiencies. In panel C we introduced a measure of lagged public sector real wages (obtained at the three digit SIC level)[23]. The results panel C indicates indeed total factor productivity increased during the period of wage hikes.

[23] There are some industries with less than 10 public firms. In such cases we used the manufacturing sector public wage averages.

The last specification, presented in Panel D, includes all these variables protection rates, real exchange rates, lagged public wages. In this specification as well there is clear evidence that decreases in protection rates have improved productivity in import competing sectors.

IV. Conclusions

Applying the methodology first introduced by Olley and Pakes (1996) and further developed by Levinsohn and Petrin (2000) on plant level data, we estimate production functions for 24 three-digit SIC industries over the 1983-96 period. Based on the production function parameter estimates we calculated TFP measures at the sectoral level.

The plant level total factor productivities are analyzed in a couple different ways. First, we inspect their evolution over time and across industries by trade orientation. During periods of rapid decline in protection rates productivity gains are largest. Second, we investigate productivity dynamics by separating productivity changes resulting from continuing plants' productivity changes from those resulting due to entry and exit. Productivity gains are largely due to reshuffling of resources from less to more productive plants. Third, we estimate plant level regressions of productivity on trade orientation of the plant. Plants in tradable sectors, in particular plants in import competing sectors have higher productivity gains. On average exiting plants are less productive. Fourth, we estimate regressions of productivity on nominal protection rates. Decreases in protection rates improve productivity, in import competing sectors, and not in others.

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Tables and Figures

Table 1: Levinsohn-Petrin Production Function Estimates (1983-96)

SIC	Sector	Labor	Material Inputs	Energy	Capital	Labor Std. Error	Material input Std. Err.	Capital Std. Error	No of Obs.
311	**Food**	0.181**	0.785**	0.040	0.022	**0.018**	**0.025**	0.022	6801
312	**Food misc.**	0.009	0.873**	0.031	0.021	0.023	0.012	0.018	2058
313	**Beverages**	0.259**	0.699**	0.035	0.097**	0.046	0.030	0.029	657
321	**Textiles**	0.151**	0.749**	0.054	0.077**	0.012	0.011	0.009	9705
322	**Wearing Apparel**	0.294**	0.662**	0.012	0.119**	0.020	0.015	0.014	7084
323	**Leather prod.**	0.382**	0.560**	0.029	0.178**	0.067	0.056	0.041	872
324	**Footwear**	0.334**	0.726**	0.017	-0.001	0.055	0.030	0.027	538
331	**Wood products**	0.148**	0.716**	0.046	0.115**	0.031	0.042	0.041	1218
332	**Furniture**	0.228**	0.801**	0.016	-0.001	0.036	0.027	0.033	728
341	**Paper**	0.258**	0.684**	0.061	0.085*	0.055	0.037	0.028	1109
351	**Ind. Chemicals**	0.224**	0.615**	0.082	0.162**	0.051	0.026	0.022	782
352	**Oth. Chemicals**	0.297**	0.648**	0.022	0.152**	0.043	0.028	0.026	2214
355	**Rubber prod.**	0.179**	0.700**	0.087	0.090**	0.038	0.022	0.020	1196
356	**Plastics**	0.222**	0.751**	0.038	0.053*	0.029	0.019	0.021	2112
361	**Ceramics**	0.381**	0.546**	0.119	0.130*	0.080	0.040	0.050	360
362	**Glass**	0.222**	0.614**	0.085	0.175**	0.065	0.042	0.035	479
369	**Nonmetal min.**	0.290**	0.472**	0.275	0.119**	0.025	0.017	0.018	5069
371	**Iron and Steel**	0.196**	0.718**	0.083	0.075**	0.031	0.013	0.024	2396
372	**Nonfer. Metals**	0.180**	0.737**	0.047	0.086**	0.021	0.029	0.033	923
381	**Fab. metal**	0.251**	0.699**	0.026	0.126**	0.028	0.021	0.018	4888
382	**Nonelect. Mach**	0.296**	0.666**	0.019	0.122**	0.044	0.023	0.017	4118
383	**Electrical mach**	0.230**	0.711**	0.019	0.117**	0.032	0.031	0.022	3037
384	**Transport Eq.**	0.268**	0.645**	0.024	0.154**	0.025	0.013	0.013	2813
385	**Professional Eq.**	0.259**	0.737**	0.023	0.067	0.089	0.044	0.053	490

Notes: Standard errors are bootstrapped from 30 blocked sub-samples.

Table 2: The OLS estimate minus the LP estimate

		k	l	m	e	RS	NOBS
321	Mean Diff.	-0.047	0.016	0.005	0.021	-0.005	9705
	% > 0	0	100	100	100	26	
322	Mean Diff.	-0.086	0.018	-0.006	0.034	-0.040	7084
	% > 0	0	100	0	100	0	
311	Mean Diff.	-0.008	0.008	0.007	0.019	0.026	6801
	% > 0	29	81	100	100	97	
369	Mean Diff.	-0.011	0.003	0.028	-0.023	-0.002	5069
	% > 0	26	65	100	3	35	
381	Mean Diff.	-0.062	-0.017	0.026	0.040	-0.014	4888
	% > 0	0	3	100	100	6	
382	Mean Diff.	-0.061	-0.014	0.030	0.008	-0.037	4118
	% > 0	0	32	100	68	0	
383	Mean Diff.	-0.064	-0.072	0.049	0.063	-0.024	3037
	% > 0	0	0	100	100	3	
384	Mean Diff.	-0.081	-0.026	0.017	0.073	-0.016	2813
	% > 0	0	0	100	100	3	
371	Mean Diff.	-0.031	0.000	0.009	0.001	-0.021	2396
	% > 0	0	52	94	55	0	
352	Mean Diff.	-0.068	0.016	0.005	0.015	-0.032	2214
	% > 0	0	84	77	90	3	
356	Mean Diff.	-0.016	-0.050	0.054	0.031	0.019	2112
	% > 0	13	3	100	100	94	
312	Mean Diff.	0.006	0.021	0.001	0.056	0.084	2058
	% > 0	65	97	61	100	100	
331	Mean Diff.	-0.044	0.011	0.010	0.044	0.020	1218
	% > 0	19	65	81	100	68	
355	Mean Diff.	0.000	0.037	0.013	0.003	0.053	1196
	% > 0	55	97	100	58	100	
341	Mean Diff.	-0.052	0.044	-0.006	0.025	0.012	1109
	% > 0	10	97	35	100	77	
372	Mean Diff.	-0.038	0.023	0.023	0.013	0.022	923
	% > 0	16	81	100	84	94	
323	Mean Diff.	-0.090	0.012	0.002	0.058	-0.018	872
	% > 0	0	65	55	100	35	
351	Mean Diff.	-0.087	0.001	0.014	0.038	-0.035	782
	% > 0	0	52	71	94	6	
332	Mean Diff.	-0.015	0.067	-0.027	0.044	0.069	728
	% > 0	35	100	0	100	100	
313	Mean Diff.	-0.049	-0.067	0.042	0.086	0.012	657
	% > 0	6	0	97	97	71	
324	Mean Diff.	0.022	0.055	-0.018	0.007	0.066	538
	% > 0	74	100	3	58	100	

Table 2 (cont'd). The OLS estimate minus the LP estimate

		k	l	m	e	RS	NOBS
385	Mean Diff.	-0.067	0.001	0.006	0.067	0.007	490
	% > 0	3	55	77	97	58	
362	Mean Diff.	-0.098	-0.042	0.057	0.070	-0.013	479
	% > 0	0	10	100	100	29	
361	Mean Diff.	-0.128	0.026	0.044	0.072	0.014	360
	% > 0	0	65	100	94	58	

Notes: This table presents the differences between OLS and LP estimates for each coefficient across 30 bootstrapped samples plus the original sample. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which β_{OLS}-β_{LP} >0.

Table 3. Summary of comparisons of LP with other estimators

Comparison of Estimators across all 24 industries: testing coefficients for k, l and m as a group

	OLS-LP	FE-LP	IV-LP	OP-LP(I>0)	LP-LP(i>0)	OP-LP
5%	95.8%	100.0%	79.2%	58.3%	29.2%	54.2%
10%	95.8%	100.0%	91.7%	79.2%	50.0%	79.2%
20%	100.0%	100.0%	100.0%	91.7%	75.0%	87.5%

Notes: This table provides the percent of industries for which the null hypothesis that none of the coefficient pairs in an industry are different is rejected in favor of the alternative that at least one of the coefficient pairs in the industry is different

Comparison of Estimators across all 24 industries: individual coefs for k, l, m

	OLS-LP	FE-LP	IV-LP	OP-LP(i>0)	LP-LP(i>0)	OP-LP
5%	59.7%	54.2%	50.0%	37.5%	9.1%	41.7%
10%	62.5%	70.8%	58.3%	58.3%	13.6%	62.5%
20%	72.2%	87.5%	62.5%	70.8%	31.8%	66.7%

Notes: This table contains the percent of significantly different coefficients between two estimators. For each pair of estimators, there are 3 coefficients, which are compared at the 5%, 10% and 20% significance levels across 24 industries, for a total of 72 coefficients; the table presents the percentage of these 72 coefficients that are significantly different for each of the three levels.

Comparison of Estimators across all 24 industries: Returns to Scale

	OLS-LP	FE-LP	IV-LP	OP-LP(i>0)	LP-LP(i>0)	OP-LP
5%	66.7%	54.2%	43.1%	40.3%	6.9%	26.4%
10%	66.7%	66.7%	52.8%	45.8%	15.3%	34.7%
20%	79.2%	77.8%	68.1%	69.4%	30.6%	55.6%

Notes: This table contains the percent of significantly different estimates of returns to scale between two estimators. For each pair of estimators, there are 24 industries, which are compared at the 5%, 10% and 20% significance; the table presents the percentage of these 24 observations on returns to scale that are significantly different for each of the three significance levels.

Figure 1. Total Factor Productivity in the Turkish Manufacturing Industry (1983-96)

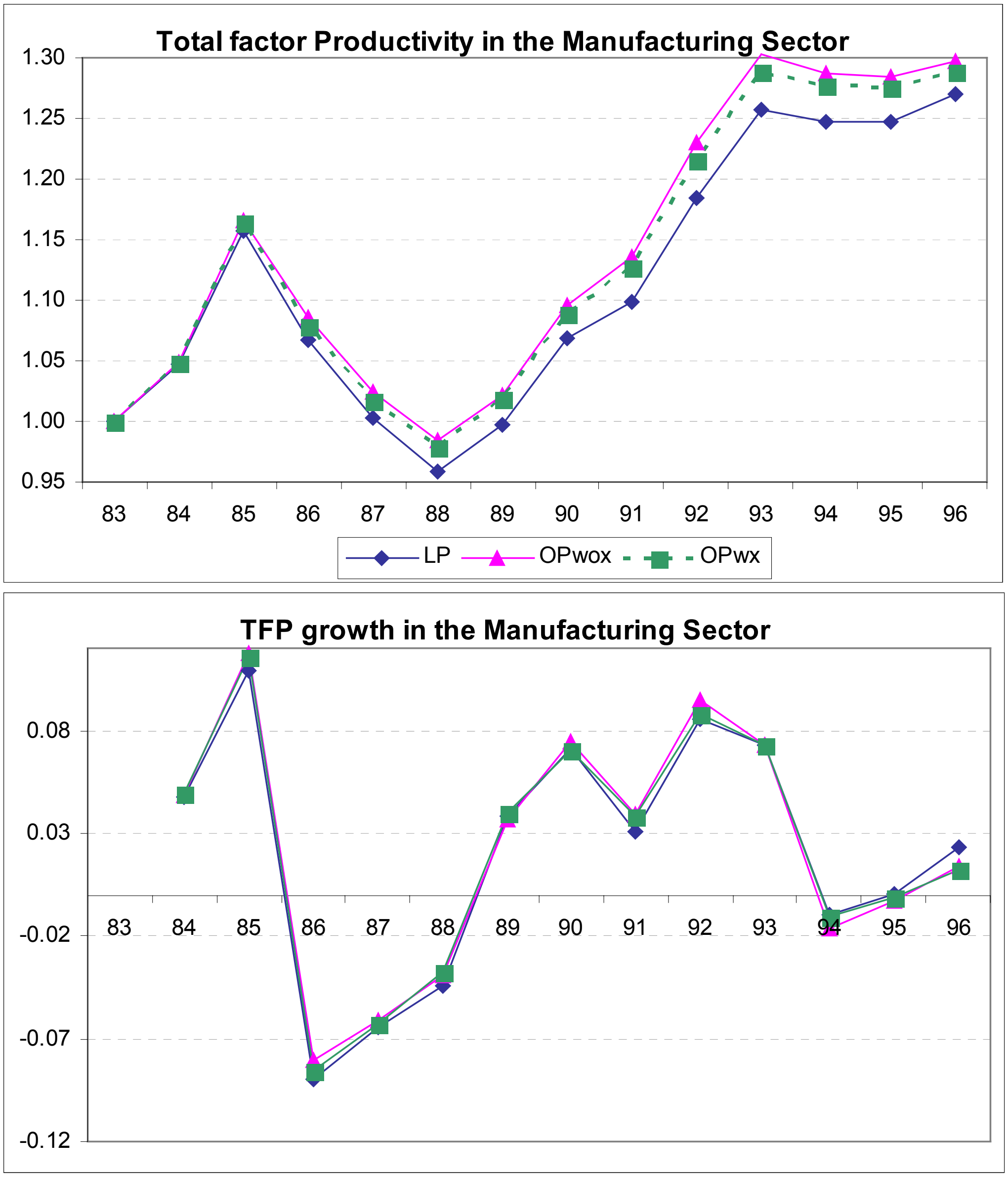


Table 4A: Average LP-TFP growth Rates (1983-96)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sector	**84-96**	**84-88**	**89-96**	**84-85**	**86-88**	**89-93**	**94-96**
Manufacturing	2.1	-0.8	3.9	7.8	-6.6	6.0	0.4
Import Competing	3.2	-0.3	5.3	8.6	-6.2	7.7	1.2
Export Oriented	1.0	-1.2	2.4	7.6	-7.0	4.0	-0.4
Non-traded	2.4	-2.0	5.1	0.9	-4.0	5.7	4.1

Table 4B: Average OP(without exit)-TFP growth Rates (1983-96)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sector	**84-96**	**84-88**	**89-96**	**84-85**	**86-88**	**89-93**	**94-96**
Manufacturing	2.2	-0.4	3.9	8.2	-6.2	6.2	-0.003
Import Competing	3.3	0.2	5.2	9.0	-5.6	7.8	0.8
Export Oriented	1.1	-0.8	2.4	8.0	-6.7	4.3	-0.8
Non-traded	2.8	-1.7	5.6	1.2	-3.6	6.3	4.5

Note: When the probability of survival is not incorporated the number of total observations dropped to 36428 (because of zero investment).

Table 4C: Average OP(with exit)-TFP growth Rates (1983-96)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sector	**84-96**	**84-88**	**89-96**	**84-85**	**86-88**	**89-93**	**94-96**
Manufacturing	2.3	-0.3	3.9	8.3	-6.0	6.4	-0.176
Import Competing	3.5	0.7	5.2	9.5	-5.2	8.1	0.4
Export Oriented	1.1	-1.0	2.3	7.7	-6.8	4.2	-0.7
Non-traded	2.9	-1.3	5.5	1.5	-3.2	6.2	4.3

Note: When the probability of survival is incorporated, the number of total observations dropped to 36428 (because of zero investment).

Table 5. LP Total Factor Productivity Growth (annual average, %)

		(1)	(2)	(3)	(4)	(5)	(6)
		Total	**Within**	**Between**	**Covariance**	**Continuing Total**	**Net Entry**
Manufacturing	**84-96**	2.08	-1.13	-2.63	5.85	2.09	-0.01
	84-88	-0.84	-3.30	-2.83	5.66	-0.47	-0.36
	89-96	3.91	0.23	-2.51	5.97	3.69	0.21
Import	**84-96**	3.15	0.29	-2.04	4.66	2.91	0.24
Competing	**84-88**	-0.28	-2.37	-2.07	4.19	-0.24	-0.04
	89-96	5.30	1.95	-2.02	4.95	4.88	0.42
Export	**84-96**	1.01	-2.63	-3.31	7.21	1.27	-0.27
Oriented	**84-88**	-1.17	-3.98	-3.49	7.01	-0.46	-0.71
	89-96	2.37	-1.79	-3.19	7.33	2.35	0.01
Non-Traded	**84-96**	2.37	0.07	-1.72	3.92	2.27	0.09
	84-88	-2.03	-3.90	-2.08	3.23	-2.75	0.72
	89-96	5.11	2.55	-1.50	4.36	5.41	-0.30

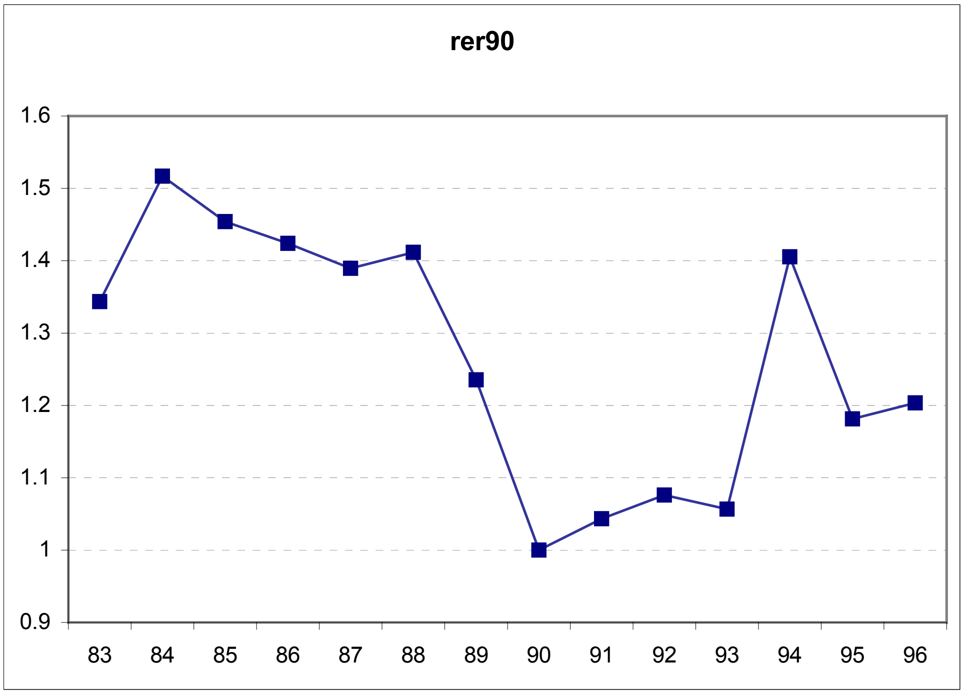
		(7)	(8)
		Entry	**Exit**
Manufacturing	**84-96**	0.19	0.20
	84-88	0.00	0.36
	89-96	0.31	0.09
Import	**84-96**	0.30	0.05
Competing	**84-88**	-0.05	-0.01
	89-96	0.51	0.09
Export	**84-96**	0.08	0.34
Oriented	**84-88**	-0.03	0.68
	89-96	0.14	0.13
Non-Traded	**84-96**	0.20	0.11
	84-88	0.67	-0.06
	89-96	-0.09	0.21

Table 6: Productivity and trade orientation

	Coef	S.E.	Coef	S.E.	Coef	S.E.
Constant	0.930**	0.166	0.999**	0.170	1.020**	0.166
Export indicator	0.08	0.194	-0.024	0.210	-0.045	0.207
exp_84	-0.009	0.037	-0.008	0.036	-0.013	0.036
exp_85	-0.06	0.041	-0.06	0.040	-0.070+	0.040
exp_86	0.065+	0.038	0.062+	0.037	0.05	0.037
exp_87	0.011	0.039	0.008	0.038	-0.006	0.038
exp_88	0.025	0.038	0.025	0.036	0.011	0.037
exp_89	0.04	0.038	0.041	0.036	0.027	0.036
exp_90	0.056	0.037	0.055	0.036	0.037	0.037
exp_91	0.170**	0.040	0.170**	0.040	0.151**	0.040
exp_92	0.268**	0.041	0.267**	0.041	0.249**	0.041
exp_93	0.291**	0.044	0.288**	0.044	0.271**	0.044
exp_94	0.166**	0.042	0.160**	0.042	0.138**	0.042
exp_95	0.112**	0.041	0.102*	0.041	0.072+	0.042
exp_96	0.218**	0.047	--	--	--	--
Import indicator	-0.057	0.197	-0.212	0.204	-0.243	0.210
imp_84	0.019	0.037	0.021	0.036	0.016	0.036
imp_85	-0.021	0.042	-0.021	0.041	-0.03	0.041
imp_86	0.02	0.038	0.018	0.037	0.006	0.037
imp_87	-0.018	0.039	-0.019	0.038	-0.032	0.038
imp_88	-0.008	0.038	-0.004	0.037	-0.017	0.037
imp_89	0.039	0.038	0.043	0.037	0.03	0.037
imp_90	0.077*	0.037	0.081*	0.037	0.064+	0.037
imp_91	0.223**	0.041	0.228**	0.040	0.211**	0.041
imp_92	0.372**	0.041	0.377**	0.041	0.361**	0.042
imp_93	0.508**	0.044	0.512**	0.044	0.497**	0.045
imp_94	0.335**	0.042	0.335**	0.042	0.315**	0.043
imp_95	0.329**	0.041	0.323**	0.042	0.296**	0.043
imp_96	0.473**	0.048	--	--	--	--
Exit	--	--	-0.047**	0.007	-0.153**	0.031
Exit*exp	--	--	---	---	0.114**	0.032
Exit*imp	--	--	---	---	0.107**	0.033
Industry indicator	yes		yes		Yes	
Plant Indicator	yes		yes		Yes	
Year indicator	yes		yes		Yes	
N	61647		57893		57893	
Adjusted-R^2	0.442		0.439		0.439	

Notes: Huber White standard errors are reported

Figure 2: Real exchange rate



Notes: Real exchange rate is defined as the U.S. consumer price index converted to Turkish Lira divided by the domestic consumer price index, 1990=1.

Table 7. Productivity, nominal protection rates (NPRs), real exchange rate and wages

	A			B			C		
	IC	EO	NT	IC	EO	NT	IC	EO	NT
NPR	-0.059**	0.012	0.038	-0.053**	0.014+	0.039	-0.068**	0.012	0.107**
	(0.016)	(0.007)	(0.029)	(0.016)	(0.008)	(0.029)	(0.019)	(0.008)	(0.038)
Real exc. rate	---	---	---	0.440**	0.208**	0.194	---	---	---
	---	---	---	(0.093)	(0.080)	(0.269)	---	---	---
Lagged public sector wage	---	---	---	---	---	---	0.352**	0.142**	0.125+
	---	---	---	---	---	---	(0.028)	(0.024)	(0.064)
Constant	0.663**	0.765**	0.719**	0.485**	0.679**	0.643**	1.097**	0.539**	0.196
	(0.084)	(0.051)	(0.129)	(0.093)	(0.061)	(0.161)	(0.126)	(0.070)	(0.246)
Observations	11511	17342	1046	11511	17342	1046	8939	13415	825
Adj-R2	0.447	0.413	0.463	0.449	0.413	0.463	0.444	0.412	0.470

	D		
	IC	EO	NT
NPR	-0.068**	0.012	0.107**
	(0.019)	(0.008)	(0.038)
Real exc. rate	0.839**	0.370*	-1.175
	(0.208)	(0.177)	(0.834)
Lagged public sector wage	0.352**	0.142**	0.125+
	(0.028)	(0.024)	(0.064)
Constant	0.747**	0.385**	0.685**
	(0.121)	(0.074)	(0.204)
Observations	8939	13415	825
Adj-R2	0.444	0.412	0.470

Notes: Standard errors in parenthesis. Three-digit SIC indicators, a trend indicator, and plant indicators are included.

Appendix I : Data

Table A1. Panel information

Years in the panel

Number of plant observations per year

year	Number of plants	Percent	Cumulative
83	3,775	6.1	6.1
84	3,786	6.1	12.3
85	3,730	6.1	18.3
86	3,867	6.3	24.6
87	4,103	6.7	31.2
88	4,221	6.9	38.1
89	4,332	7.0	45.1
90	4,395	7.1	52.3
91	4,313	7.0	59.2
92	4,202	6.8	66.1
93	4,834	7.8	73.9
94	5,077	8.2	82.1
95	5,333	8.7	90.8
96	5,679	9.2	100
Total	61,647	100	

Plant size

Plant Size	Plant-years	Percent of Total plant-years
25-49	27,578	44.7
50-99	15,428	25.0
100-249	11,195	18.2
250-	7,446	12.1
Total	61,647	100.0

Table A2. Means of key variables over plants and years (1983-96)

	Output	Labor	Capital Stock	Value Added	Material Inputs	Energy	Skilled Labor
3	25,545	138	13,624	7,891	16,179	1004	20
311	23,823	122	8,783	5,738	18,551	640	17
312	21,916	83	4,037	3,556	18,968	434	13
313	40,653	159	37,695	16,741	23,208	844	23
321	25,833	222	18,940	7,914	15,498	1,195	25
322	12,835	106	4,324	2,745	9,896	99	12
323	9,516	69	2,625	1,298	7,144	184	8
324	7,888	78	2,425	2,126	6,821	70	10
331	11,106	77	4,991	2,591	8,015	551	11
332	8,421	88	2,853	3,032	5,244	88	13
341	21,316	108	16,753	7,172	14,043	1,227	20
351	76,013	237	64,745	24,929	58,897	5,117	55
352	44,295	140	15,846	17,083	28,536	492	26
355	24,570	124	15,658	10,487	12,343	887	17
356	14,923	81	10,181	4,132	9,513	388	14
361	57,147	340	51,071	34,113	14,009	4,741	49
362	61,275	350	62,170	32,539	19,933	5,412	57
369	13,341	92	11,448	6,370	3,462	2,622	15
371	50,779	124	22,389	10,100	36,036	4,285	18
372	33,492	109	18,722	8,399	23,281	1,304	20
381	14,520	96	5,901	5,091	7,030	276	14
382	21,899	116	9,003	6,758	13,884	251	19
383	44,433	167	16,827	16,109	25,243	350	31
384	54,425	227	28,065	15,162	36,315	701	34
385	11,679	77	6,622	4,635	6,045	160	12

Note: Quantities are in million 1990 TLs. Labor is measured by the number of employees.

Table A3. Standard deviation of key variables over plants and years (1983-96)

	Output	Employment	Capital Stock	Value Added	Material Inputs	Energy	Skilled Labor
3	86,574	279	54,542	32,146	57,498	5,267	47
311	59,331	208	27,254	22,980	40,821	1,576	32
312	33,946	104	9,771	12,402	28,155	1,476	20
313	72,162	169	100,988	33,401	44,997	1,472	31
321	57,678	425	55,039	22,243	33,596	3,091	55
322	22,694	150	24,885	7,898	17,061	314	21
323	12,991	69	3,540	4,538	9,047	482	9
324	11,642	72	2,664	4,686	11,100	114	20
331	23,484	68	11,787	7,346	17,547	1,198	14
332	17,721	99	4,707	8,356	11,404	212	16
341	35,480	109	45,151	15,347	21,865	2,938	33
351	154,310	482	185,718	62,829	133,402	14,465	95
352	85,439	187	35,101	40,947	55,803	1,007	37
355	99,470	256	59,164	47,587	47,493	3,408	34
356	31,056	104	28,772	12,247	18,482	916	21
361	105,515	477	82,553	63,967	28,571	8,492	74
362	106,860	572	115,477	63,942	31,039	9,889	133
369	44,316	123	44,699	25,031	10,189	9,693	31
371	124,976	197	75,123	40,580	85,612	17,486	33
372	84,701	184	62,109	31,035	57,019	3,397	40
381	38,338	128	16,303	16,985	17,681	864	18
382	113,070	279	34,744	36,008	77,818	1,057	37
383	148,606	321	48,423	64,771	85,354	827	87
384	224,394	541	123,800	61,655	162,664	2,252	97
385	36,755	72	18,206	18,052	15,153	382	14

Note: Quantities are in million 1990 TLs. Labor is measured by the number of employees.

Table A4. Plant-year observations with zero value

		Percent of Observations with zero value for		
	No of Obs	Investment	Fuel	Electricity-
3	61,647	40.9	22.1	0.1
311	6,801	46.7	19.7	0.04
312	2,058	56.4	20.0	0.10
313	657	37.3	3.8	0
321	9,705	42.3	23.5	0.10
322	7,084	44.8	38.9	0.08
323	872	37.5	14.0	0
324	538	43.7	41.4	0
331	1,218	50.7	34.0	0
332	728	42.9	44.5	0
341	1,109	32.9	16.1	0
351	782	25.7	8.6	0
352	2,214	27.7	13.7	0
355	1,196	39.7	17.0	0
356	2,112	31.7	34.3	0
361	360	33.9	12.5	0
362	479	25.7	20.9	0
369	5,069	49.3	7.2	0
371	2,396	35.2	10.0	0.04
372	923	35.3	7.0	0.11
381	4,888	40.9	23.0	0.16
382	4,118	38.3	24.7	0.02
383	3,037	32.7	21.9	0.07
384	2,813	30.8	18.1	0.04
385	490	38.0	24.3	0

Table A5. Average nominal revenue shares (percentages)

	Labor	Material Input	Fuels	Electricity	Energy
3	17.3	63.7	3.0	2.8	5.8
311	8.7	75.9	2.2	1.8	4.0
312	8.6	77.2	2.0	1.1	3.1
313	13.8	58.1	2.5	1.3	3.8
321	16.2	64.5	2.5	3.3	5.8
322	13.3	68.6	0.5	0.8	1.2
323	12.1	74.1	1.7	1.6	3.3
324	14.3	69.4	0.4	1.2	1.6
331	14.9	67.3	1.6	3.2	4.8
332	18.9	65.1	0.5	1.2	1.7
341	11.4	65.4	3.0	2.5	5.5
351	11.9	59.1	4.3	3.6	7.9
352	12.6	62.1	1.5	1.0	2.5
355	19.1	58.4	3.2	4.5	7.8
356	11.6	69.3	0.9	2.8	3.7
361	25.9	33.8	9.4	5.7	15.1
362	29.9	48.5	6.2	4.0	10.3
369	18.5	31.9	6.5	10.6	27.0
371	11.2	68.2	3.2	4.5	7.8
372	10.1	72.1	2.8	2.2	4.9
381	29.6	58.9	1.2	2.0	3.2
382	17.7	63.7	0.8	1.1	1.9
383	15.8	64.6	0.7	1.5	2.2
384	17.7	58.8	1.0	1.7	2.7
385	19.9	58.9	1.1	1.3	2.5

Table A.6 Classification of sectors by trade orientation

1983-96	Average Import Penetration rate	Average Export-Output ratio	Trade Orientation
311	0.074	0.210	EO
312	0.016	0.261	EO
313	0.007	0.036	NT
321	0.064	0.542	EO
322	0.004	0.758	EO
323	0.285	0.086	IC
324	0.120	0.296	EO
331	0.114	0.150	EO
332	0.070	0.177	EO
341	0.122	0.066	NT
351	0.492	0.297	IC
352	0.206	0.086	IC
355	0.434	0.231	IC
356	0.194	0.087	IC
361	0.040	0.073	NT
362	0.064	0.266	EO
369	0.154	0.167	EO
371	0.196	0.243	EO
372	0.260	0.156	IC
381	0.184	0.126	IC
382	0.480	0.164	IC
383	0.282	0.157	IC
384	0.220	0.083	IC
385	0.774	0.257	IC

Note: IC, EO and NT indicate import competing, export oriented and non-tradable sectors, respectively.

Table A7. Output weighted average nominal protection rates

A. Imputed values*

	Manuf.	IC	EO	NT
83	149.5	110.5	176.0	256.8
84	117.4	101.9	124.8	203.8
85	74.5	81.8	67.4	89.8
86	63.5	69.5	57.8	74.0
87	69.7	63.1	73.2	96.7
88	70.4	66.1	72.6	82.8
89	51.7	49.5	50.8	83.6
90	41.5	33.2	43.5	93.3
91	39.6	30.8	42.8	90.0
92	34.4	27.1	38.2	75.3
93	24.8	19.4	28.3	50.7
94	20.6	15.2	23.3	38.2
95	18.1	12.9	21.3	32.1
96	15.4	10.6	19.1	26.7

* See footnote (14) in the text

B. Togan (1994) tariff series with output weights

	Manuf.	IC	EO	NT
83	76.3	61.6	89.9	67.5
84	77.6	64.9	89.1	69.6
88	70.4	66.1	72.6	82.8
89	51.7	49.5	50.8	83.6
90	41.5	33.2	43.5	93.3
91	39.6	30.8	42.8	90.0
94	20.6	15.2	23.3	38.2

C. Togan (1994) nominal protection rates with output weights

	Manuf.	IC	EO	NT
83	106.3	91.6	119.9	97.5
84	97.6	84.9	109.1	89.6
88	70.4	66.1	72.6	82.8
89	51.7	49.5	50.8	83.6
90	41.5	33.2	43.5	93.3
91	39.6	30.8	42.8	90.0
94	20.6	15.2	23.3	38.2

Note: Manuf. indicated manufacturing as a whole, IC, EO and NT indicate import competing, export oriented and non-tradeable sectors, respectively.

Table A8. Real GNP growth rates

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
4.2	7.1	4.3	6.8	9.8	1.5	1.6	9.4	0.3	6.4	8.1	-6.1	8.0	7.1

Source: Central Bank of Turkey

Figure A1. Output weighted average nominal protection rates

A. Imputed values

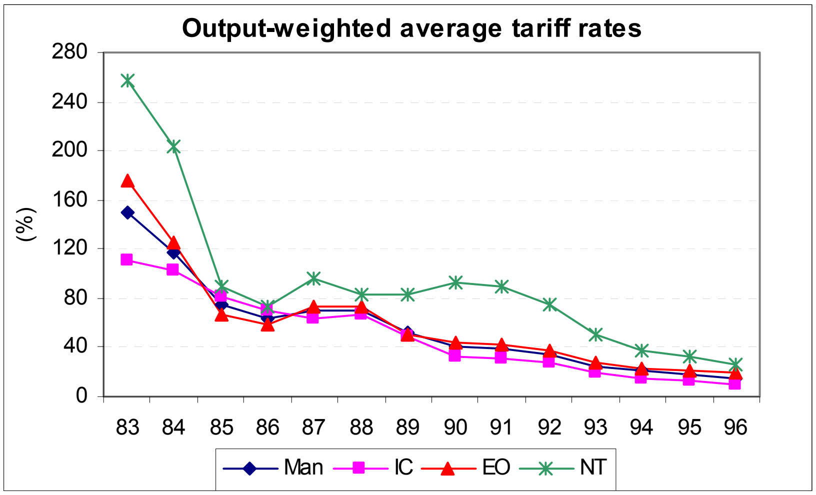


Table A9. Plant entry and exit

A. Percent of plants entered in respective years and did not exit before 96				
	All	Import-Competing	Export-Oriented	Non-Traded
83	65.1	64.0	65.8	67.1
84	54.1	64.6	60.0	74.4
85	61.6	76.3	68.2	77.9
86	61.9	78.3	80.8	80.6
87	61.7	56.0	52.8	55.9
88	66.5	60.6	62.6	56.1
89	71.4	64.4	59.1	78.9
90	75.2	70.7	65.7	33.3
91	77.2	77.2	74.6	69.0
92	80.1	79.9	75.9	61.5
93	82.8	83.8	82.6	76.9
94	82.6	86.2	80.9	75.6
95	87.9	91.5	86.7	72.7
B. Total number of plants entered in respective year				
	All	Import-Competing	Export-Oriented	Non-Traded
83	33,898	14,185	18,398	1,315
84	3,073	1,166	1,796	111
85	2,246	834	1,314	98
86	2,822	804	1,889	129
87	2,774	1,092	1,606	76
88	2,396	669	1,685	42
89	2,457	875	1,505	77
90	2,195	597	1,540	58
91	1,840	721	1,080	39
92	1,275	364	880	31
93	3,081	962	2,054	65
94	1,844	654	1,149	41
95	1,017	319	686	22
96	729	203	504	22

Table A10: Average TFP growth Rates (sorted by trade orientation) (1983-96)

SIC	Sector	nobs	84-96	84-88	89-96	84-85	86-88	89-93	94-96	
3			1.9	-0.8	3.6	7.6	-6.5	5.7	0.2	
323	Leather products	872	4.0	-6.4	10.5	5.6	-14.4	10.4	10.6	IC
351	Industrial chemicals	782	2.4	-1.2	4.7	-1.0	-1.3	8.9	-2.4	IC
352	Other chemicals	2214	1.3	-1.5	3.1	12.1	-10.6	4.8	0.4	IC
355	Rubber products	1196	1.0	3.9	-0.9	14.1	-2.9	3.7	-8.5	IC
356	Plastics	2112	6.2	5.1	6.9	19.8	-4.6	8.4	4.3	IC
372	Nonferrous metals	923	2.4	-2.6	5.6	4.2	-7.1	7.3	2.6	IC
381	Fabricated metal	4888	3.1	-0.9	5.7	8.1	-6.9	9.9	-1.4	IC
382	Nonelectrical mach	4118	3.8	1.8	5.0	12.1	-5.1	8.4	-0.6	IC
383	Electrical mach	3037	4.7	1.9	6.4	12.4	-5.1	9.0	2.0	IC
384	Transport equip.	2813	1.8	-2.9	4.8	4.4	-7.8	6.6	1.8	IC
385	Professional equip.	490	0.8	-7.8	6.1	7.2	-17.8	13.2	-5.7	IC
311	Food	6801	1.0	-0.8	2.2	0.2	-1.6	3.1	0.7	EO
312	Food miscellaneous	2058	0.9	-3.8	3.9	0.5	-6.7	6.4	-0.3	EO
321	Textiles	9705	1.3	1.6	1.2	12.5	-5.6	2.6	-1.2	EO
322	Apparel	7084	-2.0	-5.1	-0.1	-0.3	-8.3	1.5	-2.8	EO
324	Footwear	538	-4.1	-1.4	-5.8	1.1	-3.0	-1.0	-13.7	EO
331	Wood products	1218	2.2	1.7	2.4	4.8	-1.4	0.6	5.5	EO
332	Furniture	728	-0.1	1.6	-1.2	9.5	-3.6	2.6	-7.5	EO
362	Glass	479	3.0	-2.9	6.7	2.1	-6.2	6.9	6.5	EO
369	Nonmetal minerals	5069	3.3	-0.9	6.0	13.3	-10.4	7.1	4.2	EO
371	Iron and Steel	2396	1.2	-3.9	4.4	11.6	-14.3	8.1	-1.7	EO
313	Beverages	657	0.2	-3.2	2.4	-4.8	-2.1	4.5	-1.2	NT
341	Paper	1109	2.4	-1.0	4.5	7.5	-6.7	4.5	4.4	NT
361	Ceramics	360	4.9	-2.0	9.3	-0.8	-2.8	9.2	9.4	NT

Table A11. Real Wages
(Manufacturing Sector and Trade-orientation based Sector Groups)

year	All	Importers	Exporters	Nontraded
83	1	1	1	1
84	0.912	0.933	0.904	0.784
85	0.914	0.950	0.893	0.784
86	0.909	0.922	0.909	0.738
87	0.935	0.950	0.934	0.778
88	0.872	0.867	0.877	0.779
89	1.026	1.056	0.998	0.978
90	1.331	1.438	1.254	1.264
91	1.663	1.805	1.559	1.583
92	1.908	2.201	1.685	1.677
93	1.960	2.327	1.649	1.847
94	1.385	1.673	1.169	1.417
95	1.400	1.697	1.151	1.544
96	1.615	1.955	1.330	1.663

Appendix II: Variable description

Variables used in production function estimations:

Real value of **output** is obtained by deflating the total annual sales revenues of a firm with a three-digit price deflator constructed by State Institute of Statistics (SIS). This construction has the usual problems of having "one price" for all firms, and relies on price-taking behaviour at the firm level.[24] As such the deflator controls for changes due to industry level demand shocks and changes arising from inflation.

Material inputs include all purchases of intermediate inputs. The nominal value of firm level annual inputs are deflated using a three-digit material input price deflator constructed by SIS.

Energy series is the sum of electricity usage and fuel consumption. Real value of electricity and fuel consumed is obtained by deflating the nominal values with the respective price deflators obtained from the SIS.

Labor is the number of paid employees in a given year.

Capital stock series is constructed by using perpetual inventory method. The database contains only information on investment. Detailed subcategories of investment are aggregated to buildings and structure, transportation equipment, and machinery. Since the data does not contain information on capital stock in any year we constructed initial capital stock series for each establishment. Initial capital stock series is computed by assuming that average real investment undertaken in the first seven years of a plant represent its average investment behaviour in the seven years before the plant is included in the database. Using 5%, 10%, and 20% as the depreciation rates for buildings, machinery and transportation equipment, respectively, we calculated the initial capital stock.. For those establishments that are not in the data for seven years we imputed initial capital stock series. The imputed values are generated by using initial capital stocks of establishments in the same four-digit SIC activity in that year, which have similar attributes (such as similar usage of energy per worker).

[24] See Griliches and Mairesse (1995) for a discussion of problems arising from use of one price.

Appendix III: Comparisons of LP estimators with FE, IV and OP

Table A.III.1 The FE estimate minus the LP estimate

		k	l	m	e	RS	NOBS
321	Mean Diff.	-0.063	0.071	-0.078	0.020	-0.050	9705
	% > 0	0	100	0	94	0	
322	Mean Diff.	-0.110	-0.029	-0.100	0.024	-0.215	7084
	% > 0	0	10	0	100	0	
311	Mean Diff.	-0.002	0.017	-0.050	0.002	-0.033	6801
	% > 0	35	71	0	48	10	
369	Mean Diff.	-0.101	-0.043	-0.239	-0.044	-0.426	5069
	% > 0	0	10	0	3	0	
381	Mean Diff.	-0.066	-0.057	-0.039	0.035	-0.128	4888
	% > 0	3	3	13	100	0	
382	Mean Diff.	-0.116	-0.073	0.016	0.037	-0.136	4118
	% > 0	0	0	90	100	0	
383	Mean Diff.	0.024	-0.090	0.071	0.094	0.099	3037
	% > 0	68	0	97	100	100	
384	Mean Diff.	-0.091	-0.032	-0.016	0.080	-0.059	2813
	% > 0	0	16	26	100	10	
371	Mean Diff.	-0.014	-0.145	0.035	0.032	-0.092	2396
	% > 0	29	0	94	97	0	
352	Mean Diff.	-0.076	0.082	-0.079	0.014	-0.059	2214
	% > 0	0	90	0	81	16	
356	Mean Diff.	0.019	-0.065	0.083	0.054	0.092	2112
	% > 0	81	6	100	100	100	
312	Mean Diff.	0.048	0.103	-0.071	0.027	0.108	2058
	% > 0	90	100	0	100	97	
331	Mean Diff.	-0.002	0.017	-0.160	0.071	-0.074	1218
	% > 0	42	65	0	100	6	
355	Mean Diff.	-0.115	0.116	-0.155	0.045	-0.109	1196
	% > 0	0	100	0	94	0	
341	Mean Diff.	-0.003	-0.032	-0.093	-0.035	-0.163	1109
	% > 0	48	32	0	0	0	
372	Mean Diff.	-0.057	0.054	-0.053	0.002	-0.054	923
	% > 0	10	74	0	55	13	
323	Mean Diff.	-0.061	-0.008	-0.086	0.065	-0.090	872
	% > 0	19	48	3	94	13	
351	Mean Diff.	0.081	0.134	-0.115	-0.027	0.073	782
	% > 0	68	90	0	32	68	
332	Mean Diff.	-0.025	0.168	-0.179	0.033	-0.003	728
	% > 0	35	100	0	90	52	
313	Mean Diff.	-0.132	0.056	-0.053	0.056	-0.073	657
	% > 0	0	81	0	100	16	
324	Mean Diff.	-0.034	-0.094	-0.061	-0.033	-0.222	538
	% > 0	32	3	6	6	0	

Table A.III.1 (cont'd): The FE estimate minus the LP estimate

		k	l	m	e	RS	NOBS
385	Mean Diff.	-0.136	0.095	-0.190	0.071	-0.160	490
	% > 0	6	84	0	100	3	
362	Mean Diff.	0.112	-0.165	-0.063	0.095	-0.022	479
	% > 0	94	3	13	100	45	
361	Mean Diff.	0.315	-0.043	-0.061	0.022	0.233	360
	% > 0	100	42	6	58	94	

Notes: This table presents the differences between FE and LP estimates for each coefficient across 30 bootstrapped samples plus the original sample. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which β_{FE}-β_{LP} >0.

Table A.III.2 The IV estimate minus the LP estimate

		K	l	m	e	RS	NOBS
321	Mean Diff.	-0.048	0.011	0.012	0.023	-0.002	9705
	% > 0	0	87	97	100	48	
322	Mean Diff.	-0.092	-0.008	0.015	0.040	-0.044	7084
	% > 0	0	16	97	100	0	
311	Mean Diff.	-0.004	0.009	0.003	0.019	0.027	6801
	% > 0	32	81	68	100	97	
369	Mean Diff.	-0.002	0.004	0.019	-0.021	0.000	5069
	% > 0	48	68	100	6	45	
381	Mean Diff.	-0.061	-0.034	0.036	0.041	-0.017	4888
	% > 0	0	0	100	100	6	
382	Mean Diff.	-0.057	-0.016	0.031	0.006	-0.036	4118
	% > 0	0	39	100	61	0	
383	Mean Diff.	-0.059	-0.086	0.050	0.067	-0.028	3037
	% > 0	0	0	100	100	0	
384	Mean Diff.	-0.077	-0.041	0.019	0.080	-0.019	2813
	% > 0	0	0	100	100	0	
371	Mean Diff.	-0.022	-0.006	0.001	0.002	-0.025	2396
	% > 0	6	42	61	55	0	
352	Mean Diff.	-0.073	0.016	0.020	0.012	-0.025	2214
	% > 0	0	87	97	74	6	
356	Mean Diff.	-0.010	-0.054	0.047	0.029	0.013	2112
	% > 0	19	0	100	100	81	
312	Mean Diff.	0.003	0.024	-0.007	0.061	0.081	2058
	% > 0	48	100	13	100	100	
331	Mean Diff.	-0.033	-0.018	0.017	0.045	0.011	1218
	% > 0	29	26	100	97	55	
355	Mean Diff.	0.007	0.016	0.011	0.008	0.042	1196
	% > 0	65	74	94	61	100	
341	Mean Diff.	-0.048	0.041	-0.017	0.026	0.002	1109
	% > 0	13	81	13	100	45	
372	Mean Diff.	-0.041	0.005	0.046	0.012	0.023	923
	% > 0	13	65	97	74	94	
323	Mean Diff.	-0.096	0.027	-0.014	0.073	-0.010	872
	% > 0	0	71	35	100	45	
351	Mean Diff.	-0.088	0.018	0.002	0.037	-0.031	782
	% > 0	0	61	48	97	10	
332	Mean Diff.	-0.021	0.066	-0.010	0.039	0.074	728
	% > 0	26	97	19	94	100	
313	Mean Diff.	-0.049	-0.065	0.031	0.096	0.013	657
	% > 0	6	6	87	97	68	
324	Mean Diff.	0.023	0.042	-0.017	0.007	0.055	538
	% > 0	74	90	26	58	94	

Table A.III.2 (cont'd). The IV estimate minus the LP estimate

		K	l	m	e	RS	NOBS
385	Mean Diff.	-0.052	0.050	-0.022	0.066	0.043	490
	% > 0	10	97	6	97	74	
362	Mean Diff.	-0.101	-0.057	0.066	0.077	-0.014	479
	% > 0	0	6	90	100	29	
361	Mean Diff.	-0.134	0.031	0.002	0.123	0.021	360
	% > 0	0	61	42	100	65	

Notes: This table presents the differences between IV and LP estimates for each coefficient across 30 bootstrapped samples plus the original sample. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which $\beta_{IV}-\beta_{LP} > 0$.

Table A.III.3: The OP estimate minus the LP estimate using only firms with positive investment

		K	I	M	e	RS	NOBS
321	Mean Diff.	-0.050	0.007	-0.008	0.031	-0.019	4719
	% > 0	0	81	0	87	6	
311	Mean Diff.	-0.018	-0.004	-0.001	0.018	-0.005	3090
	% > 0	29	23	32	90	42	
322	Mean Diff.	-0.111	-0.009	-0.008	0.029	-0.098	3069
	% > 0	0	3	0	97	0	
381	Mean Diff.	-0.112	0.003	-0.007	0.037	-0.080	2426
	% > 0	0	71	0	97	0	
369	Mean Diff.	-0.164	-0.007	0.003	-0.061	-0.228	2235
	% > 0	0	26	71	0	0	
382	Mean Diff.	-0.121	-0.017	-0.011	0.006	-0.143	2121
	% > 0	0	0	0	68	0	
383	Mean Diff.	-0.121	-0.011	-0.006	0.036	-0.102	1747
	% > 0	3	0	3	97	3	
384	Mean Diff.	-0.187	-0.009	-0.003	0.047	-0.152	1655
	% > 0	0	13	19	97	0	
352	Mean Diff.	-0.044	-0.004	-0.014	0.012	-0.049	1382
	% > 0	10	35	13	84	13	
371	Mean Diff.	-0.031	-0.002	-0.002	-0.016	-0.052	1337
	% > 0	32	42	29	16	0	
356	Mean Diff.	-0.091	0.010	-0.010	0.030	-0.062	1177
	% > 0	3	81	6	97	10	
312	Mean Diff.	0.025	0.026	-0.024	0.040	0.066	750
	% > 0	74	90	0	94	97	
341	Mean Diff.	-0.057	0.011	-0.038	0.015	-0.069	626
	% > 0	19	68	0	77	10	
355	Mean Diff.	-0.127	-0.008	-0.025	0.016	-0.144	612
	% > 0	10	42	0	74	6	
331	Mean Diff.	-0.056	0.013	-0.010	0.038	-0.015	505
	% > 0	16	81	16	97	58	
372	Mean Diff.	-0.094	0.019	-0.013	0.008	-0.080	499
	% > 0	13	68	3	58	16	
351	Mean Diff.	-0.024	0.028	-0.028	0.007	-0.017	496
	% > 0	29	81	3	65	29	
323	Mean Diff.	-0.064	-0.001	-0.014	0.042	-0.037	441
	% > 0	13	39	19	97	35	
313	Mean Diff.	-0.171	-0.087	0.017	0.059	-0.182	372
	% > 0	0	3	81	84	0	
332	Mean Diff.	0.049	0.014	-0.017	0.023	0.069	337
	% > 0	90	81	10	84	87	
362	Mean Diff.	-0.118	0.011	-0.016	0.055	-0.068	312
	% > 0	6	65	19	97	32	

Table A.III.3 (cont'd): The OP estimate minus the LP estimate

		k	l	M	e	RS	NOBS
385	Mean Diff.	-0.132	0.014	-0.009	0.044	-0.084	252
	% > 0	6	58	32	90	16	
324	Mean Diff.	0.012	-0.010	0.009	-0.012	0.000	251
	% > 0	35	19	45	19	29	
361	Mean Diff.	-0.028	0.028	-0.032	0.093	0.061	199
	% > 0	35	68	10	94	71	

Notes: This table presents the differences between OP and LP estimates for each coefficient across 30 bootstrapped samples plus the original sample. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which β_{OP}-β_{LP} >0.

Table A.III.4: The difference between the OP estimates with and without exit probability

		k	NOBS			k	NOBS
321	Mean Diff.	-0.0156	4719	**341**	Mean Diff.	0.0218	626
	% > 0	32			% > 0	55	
311	Mean Diff.	-0.0109	3090	**355**	Mean Diff.	0.0207	612
	% > 0	39			% > 0	66	
322	Mean Diff.	-0.0054	3069	**331**	Mean Diff.	-0.0385	505
	% > 0	47			% > 0	40	
381	Mean Diff.	0.0053	2426	**372**	Mean Diff.	-0.0018	499
	% > 0	61			% > 0	47	
369	Mean Diff.	-0.0018	2235	**351**	Mean Diff.	-0.0629	496
	% > 0	40			% > 0	30	
382	Mean Diff.	0.0398	2121	**323**	Mean Diff.	-0.0104	441
	% > 0	66			% > 0	38	
383	Mean Diff.	-0.0043	1747	**313**	Mean Diff.	0.0077	372
	% > 0	57			% > 0	49	
384	Mean Diff.	0.0318	1655	**332**	Mean Diff.	-0.0145	337
	% > 0	70			% > 0	33	
352	Mean Diff.	-0.0184	1382	**362**	Mean Diff.	-0.0335	312
	% > 0	42			% > 0	36	
371	Mean Diff.	0.0093	1337	**385**	Mean Diff.	0.0271	252
	% > 0	37			% > 0	59	
356	Mean Diff.	-0.0058	1177	**324**	Mean Diff.	0.0218	251
	% > 0	44			% > 0	41	
312	Mean Diff.	-0.0064	750	**361**	Mean Diff.	-0.0335	199
	% > 0	40			% > 0	33	

Notes**:** This table presents the differences between OP estimates for each coefficient across 30 bootstrapped samples plus the original sample. The top entry in each cell is the average difference across the samples. The bottom entry is the percentage of samples that yield estimates for which $\beta_{OPwx}-\beta_{OPwox} > 0$**.**