The Relationship between Exports and Productivity at the Plant-level in the Turkish Apparel and Motor Vehicle Parts Industries

Mahmut Yaşar Carl H. Nelson

Second Draft, August, 2003

Abstract
We investigate the relationship between exports and productivity in the Turkish apparel and motor vehicle and parts industries from 1990-1996, using two different models for plant-level panel data. In the first model, we examine the effect of past export status on current productivity both with and without controlling for the export history of plants. Our results show that the plants' prior market experience is a factor in their current productivity. The learning effects are evident among continuing exporters and entrants. This model, however, neither controls for the endogeneity of the explanatory variables nor for the unobserved plant-specific effects that persist over time. Moreover, it does not distinguish between the long- and short-run relationships between exports and productivity. Thus, a second model, an Error-Correction specification for panel data, is estimated to address these three issues. Our findings suggest that there is a bidirectional relationship between exports and productivity both in the short- and long-run. The effect of productivity on exporting is much stronger than the effect of exporting on productivity, suggesting that more productive firms enter the export market, then they experience a productivity enhancement due to their participation in the export market.

Keywords: Productivity, Multilateral Index, Exports, Causality, Error-Correction Model, Dynamic Panel Data Estimator, System GMM.

J.E.L Classification: C33, D24, F14, O47.

Acknowledgements: The authors would like to thank Omer Gebizlioglu, Emine Kocberber, and Ilhami Mintemur at State Institute of Statistics in Turkey for providing the data for this study. The authors would also like to thank Prof. Catherine Morrison-Paul for help with data construction and productivity measurement. The authors would also like to thank Sofronis Clerides for his useful comments on an earlier draft of the paper.

1. Introduction

There has been an ongoing debate, since the 1970's, about whether policies of export promotion or import substitution offer the best economic results for a country.[1] This debate produced some new evidence demonstrating that there is a link between exporting and economic performance (Havrylyshyn (1990), Feenstra, (1995) and Edwards (1998)), and inspired some developing countries to switch from import substitution to outward- and market-oriented policies in the 1970's and 1980's. For instance, the Asian newly industrializing countries (NIC's) used export-oriented policies starting in the 1970's, and over the last thirty years they have increased their standards of living tremendously. Trade liberalization, along with other structural changes, enhanced the countries' income by allocating resources from less productive uses to more productive uses.

The central claims of the debate on productivity and trade are that productivity impacts exports through comparative advantage effects central to Hecksher-Ohlin (H-O) and Ricardian theories, and exports impact productivity through the mechanisms emphasized by endogenous growth theory. Following the suggestions made by these theories that trade and productivity are related, many researchers have used national-, industry-, and plant-level data to investigate the relationship between exports and productivity. Although studies using macro data have linked productivity and exporting, the link at the microeconomic level needs further verification, especially concerning the effect of exporting on productivity.

Several studies using micro data conclude that there exists a one directional causation between productivity and exports, such that productivity increases exports.[2] However, there is little evidence of significant impacts of exports on productivity.

The papers most closely related to this work are those by Bernard and Jensen (1995, 1999a, 1999b) on the United States; Aw, Chung, and Roberts (1998) on Taiwan and Korea; Clerides, Leach, and Tybout (1998) on Colombia, Mexico, and Morocco; and Kraay (1997) on China. All but Kraay find that the self-selection of relatively efficient plants into the export market is the dominant source of the productivity differences between exporters and non-exporters. The results from the studies on the causal link between exports and productivity at the plant level suggest a need for further investigation.

This study investigates the plant-level causal relationship between exports and productivity for Turkey's apparel, and motor vehicle and parts industries. Turkey offers a pertinent example for studying the causal relationship between exports and productivity. In 1980, Turkey initiated a comprehensive trade liberalization program and implemented a wide range of economic reforms, which had a significant impact on the performance of Turkish exports. As a result of these policies, Turkish exports boomed from 1981-1988. However, the growth rate of exports has been progressively declining since the late 1980s. Is this because external and policy factors can only stimulate export growth to a degree? Or, is it the case that once an economy becomes integrated into global economic change, productivity becomes the main determinant of competitiveness? The answers to these questions are important for the design of policies to improve future export performance.

The remainder of the paper has the following organization. Section 2 examines whether or not exporters tend to have higher performance indicators than non-exporters. In section 3, we examine the relationship between the past export status of the plant and the productivity of the plant today using an OLS estimator. Section 4 introduces the error correction model, which is followed by an overview of the estimation methods and a presentation of the results. Finally, section 5 concludes with a summary and discussion of the results.

2. Plant Performance of Exporters and Non-exporters: Export Premia

This study uses unbalanced panel data on plants with more than 25 employees for the apparel (manufacture of wearing apparel except fur and leather, ISIC 3222), and motor vehicle and parts (ISIC 3843) industries from 1990-1996. The apparel and motor vehicle and parts industries are the first and fourth largest exporters in Turkey, respectively. Of total Turkish exports, apparel products represent an average of 25.9 percent and motor vehicle and parts represent 5.6 percent. Thus the data that is used in the study accounts for 31.5 percent of the total Turkish merchandise exports.

The data was collected by the State Institute of Statistics in Turkey from the Annual Surveys of Manufacturing Industries, and classified based on the International Standard Industrial Classification (ISIC Rev.2). These plant-level data consist of output; capital, labor, energy, and material inputs; investments; depreciation funds; import; export; and several plant characteristics.[3] To protect confidentiality, the State Institute of Statistics uniformly altered all the original data by a constant, which is why we do not report any summary statistics of levels. Of the 2233 total apparel industry (ISIC 3222) plants in the sample, 1412 are non-exporters and 821 plants exported at some point from 1990-1996. The motor vehicle and parts industry (ISIC 3843) consists of 512 sampled plants. There are 376 non-exporters and 146 plants that exported at some point from 1990-1996.

This section reports estimates of the proportional differences between the characteristics of exporting and non-exporting plants in the Turkish apparel and motor vehicle and parts industries by forming the following regression (See Bernard and Wagner, 1997):

$$X_{it} = \alpha_0 + \alpha_1 Exporter_{it} + \alpha_2 Size_{it} + \alpha_3 Region_{it} + \alpha_4 Year_t + e_{it}, \quad \textbf{(1)}$$

where X stands for either the log or the share of plant characteristics that reflect plant capabilities in productivity, technology, and employment.[4] Exporter is a dummy for the export status, taking a value of 1 if the plant exports in the current year. Year dummies are included to capture macroeconomic shocks and the changes in the institutional environment. The agglomeration effect might be important in explaining the differences in plant characteristics (see Krugman, 1991 and Porter, 1998). There are large development disparities across Turkey's regions because of different regional capabilities such as infrastructure, rule of law, quality of public services, localized spillovers, the export and import density, foreign investment intensity (to take advantage of international spillovers, (See Coe and Helpman,1995). Therefore, we included regional dummies to correct for the exogenous disparities in the productivity differences across the regions. Finally, the plant size is included to capture differences in the production technology across plants of different sizes. One would expect the larger plants to be more productive for two reasons. They benefit from scale economies and have access to more productive technology to a greater extent. However, they tend to be less flexible in their operation which affects productivity negatively. In order to capture the size effects, we divide the plants into three size groups: small plants, with less than 50 employees; medium plants, with between 50 and 100 employees; and large plants, with 100 employees or more. We select the small group as the base group. The omitted variable is non-exporters. The coefficient on the exporting dummy variable, α_1, shows the average percentage difference between exporters and non-exporters, conditional on size, region, and year.

The estimated parameters are presented in Table 2. All of the estimated premia are statistically significant and positive. Our results show that the difference in total factor productivity between exporters and non-exporters is large and statistically significant for both industries. The exporting plants have significantly higher productivity for both industries. After controlling for region, year, and size, the difference in total factor productivity between exporting and non-exporting plants was highest in the apparel industry at 13.8 percent, followed by the motor vehicle and parts industry at 8.2 percent. The difference in labor productivity between exporting and non-exporting plants was even more dramatic. The difference was positive and significant for each of the two industries, with the apparel industry at 81.9 percent and the motor vehicle industry at 37.3 percent.

Our results also show that exporting plants have significantly higher output. The exporters produce significantly more output per employee; the apparel industry is 81.1 percent higher and the motor vehicle parts industry is 34.1 percent higher. Exporting plants are more capital-intensive, and they invest more heavily in machinery and equipment. The apparel and motor vehicle and parts industries have 43.3 and 28.2 percent higher investments per employee for the exporters, respectively. The average number of employees is 66.2 percent higher for exporters in the motor vehicle industry and 61.3 percent higher for exporters in the apparel industry. Exporters also pay their workers, on average, significantly higher wages than non-exporters. Exporters in the apparel and motor vehicle and parts industries pay 32 and 26 percent higher wages, respectively. Also, exporting plants employ more administrative workers, while only exporters in the motor vehicle and parts industry employ significantly more technical workers. Moreover, exporting plants spend more on communication and advertisement. The share of subcontracted input was also significantly higher in exporting plants. However, the exporting plants had a smaller subcontracted output share. These results imply that subcontracting in exporting plants is established between the large exporters and the small subcontracting plants. In short, our results show that exporting plants perform much better than their domestically oriented counterparts.

3. Learning-by-Exporting: Export Status and Productivity Level

The association between exports and productivity could be explained by self selection of more productive firms into the export market or by productivity improvements that result from knowledge and expertise gained through interactions with the export market. In this section, we examine the relationship between the past export status of the plants and the current productivity of the plants in two steps. In the first step, we pool all the observations and do not control for the export history of plants. In the second step we control for export history by grouping the plants into five categories: continuous exporters, non-exporters, entrants, switchers, and exiters. We allow the coefficient on the lagged exports to differ with the export history of plants.

Exporters are plants that export continuously from 1990-1996. Non-exporters do not export at any point in the time period. Entrants begin as non-exporters and become exporters at some point in the time period and continue exporting until 1996. Switchers enter and exit the export market multiple times from 1990-1996. Finally, exiters are plants that start as exporters and exit at some point in the time period and remain outside of the export market until 1996. Of the 2233 plants in the apparel industry sample, 1412 are non-exporters and 821 plants exported at some point from 1990-1996. Of those 821, 84 are continuous exporters, 251 are entrants, 166 are switchers, and 320 are exiters. The motor vehicles and parts industry consists of 512 sampled plants. There are 376 non-exporters and 146 plants that exported at some point from 1990-1996. Of the 146 plants, 38 are exporters, 40 are entrants, 25 are switchers, and 43 are exiters.

In order to examine whether or not a plant's productivity depends on past export experience, we examine the relationship between the past export status of the plant and the productivity of the plant today by specifying the following model:

$$\ln Y_{i,t} = \alpha_0 + \alpha_1 \ln Y_{i,t-1} + \alpha_2 Exporter_{i,t-1} + \alpha_3 Size_{it} + \alpha_4 Region_{it} + \alpha_5 Year_t + e_{it}, \qquad \textbf{(2)}$$

where $\ln Y_{i,t}$ is the productivity (either total factor productivity or labor productivity) level; Exporter is a dummy for the export status, taking a value of 1 if the plant exports in year t-1; Size is determined by the total employment. It is included to capture differences in the production technology across plants of different sizes. Region is a dummy for six regions. Year is a vector of year dummies.

The results are presented in Table 3. The coefficients on lagged productivity are positive and significant for both industries, indicating that plant performance is persistent over time. For the apparel industry, the past export status of the plant is positively correlated with the current labor productivity and current total factor productivity as evidenced by positive and significant coefficients. An additional year of export experience increases total factor productivity by 5.5 percent and labor productivity by 13.2 percent. Similarly, for the motor vehicles and parts industry there is statistically significant evidence of learning-by-exporting in labor productivity and total factor productivity. The coefficient on the past export status of the plant indicates that an additional year of exporting increases labor productivity by 8.8 percent and total factor productivity by 4.3 percent.

The results from the basic model provide evidence that exporting in year t-1 increases productivity in year t. However, this model does not control for the export history of plants. Export history is an important factor in understanding the relationship between lagged exports and recent plant productivity for several reasons

(Kraay, 1997). First, if a plant must incur high costs to enter the export market, then its early productivity will be adversely affected (Roberts and Tybout, 1997). However, once it recovers its initial costs, its productivity will improve over subsequent years. Second, a plant's entry into the export market may create a one-time improvement in productivity because of the sudden effects of learning-by-exporting. Third, exporting may offer a long-term and slowly progressing improvement in productivity because of gradual and continuous learning-by-doing effects.

Results in table 4 show evidence of learning-by-exporting after controlling for the export histories of the plants. For the apparel industry, the coefficient on lagged exports is positive and statistically significant in both total factor productivity and labor productivity for continuous exporters. The continuous exporters have 7.3 and 24.1 percent higher total factor productivity and labor productivity, relative to continuous non-exporters. Also in this industry, the coefficient for entrants is positive and significant for both labor productivity and total factor productivity. The entrants have 5.1 and 18.8 percent higher total factor productivity and labor productivity, than the continuous non-exporters. For the motor vehicle and parts industry, the coefficient for the continuous exporters is also statistically significant in both equations. An additional year of exporting increases the total factor productivity of continuous exports by 7.7 percent and labor productivity by 14.3 percent. The coefficient for entrants is positive and significant for labor productivity, but not for total factor productivity. The coefficient in the labor equation for both industries is significant for switchers, providing further evidence in support of learning-by-exporting.

The positive and significant coefficients on past exporting for continuous exporters support the idea that exporting has a long-term effect on productivity because there is a gradual learning-by-exporting effect that persists over years. Since the data is only from 1990-1996, we must acknowledge that these plants may have been exporting before 1990. If their export history is more extensive than the seven years we analyze, then the results may indicate an effect on productivity that lasts over a more lengthy time period. On the other hand, these plants that are continuous exporters from 1990-1996 may have entered the market shortly before or during our initial year of 1990. Thus the productivity effects may have also been influenced by their recent entry into the market.

In short, the plants' prior market experience is correlated with their current productivity, as evidenced by the lagged exports for continuous exporters and the lagged exports for entrants. It is interesting that there is more evidence of learning-by-exporting for the apparel industry than the motor vehicle and parts industry. One interpretation is that more labor-intensive industries are more strongly influenced by the learning effects of exporting. In other words, plants with low technological and employment capabilities may learn more from exporting.

4. Short-and Long-run Relationship between Exports and Productivity

In this section we test two different hypotheses about the causal relationship between exports and productivity. The first one is that the most productive firms are able to enter and survive in the highly competitive export market. The second states that productivity improves from expertise gained through interactions with the export market. In order to test these hypotheses thoroughly, we take into consideration the following three issues.

First, one would assume that both exports and productivity are correlated with the current realization of unobserved plant-specific effects (Marschak and Andrews, 1944). Thus, there may be unobserved factors that could affect the relationship between exporting and productivity. The unobserved plant characteristics that persist over time could have a significant impact on the relationship between exports and productivity across the plants. For instance, better management practices, foreign ownership, contracting, and investment in research and development are four attributes that could have a significant impact on productivity and/or exporting. These attributes could foster learning and thus productivity growth or vice versa. Thus, it is important to examine the relationship between exporting and productivity in a model that incorporates the dynamics of unobserved plant characteristics.

Second, as we will explain more fully in the next section, productivity and exports are highly persistent over time and assumed to be jointly determined. In such a case, adjustments to unobserved shocks may not be immediate but may occur with some delay. The explanatory variables are not strictly exogenous conditional on unobserved plant characteristics. Thus, if one assumes that plant productivity is persistent over time, and that the more productive plants are selected into export markets, then the current productivity will be associated with the lagged exports even in the absence of learning effects (Kraay, 1997).

These two issues are addressed by Kraay (1997) employing different empirical methods than here. He used a first-differenced GMM estimator to handle both issues. However, when the lagged values of series are weakly correlated with the first-differences, the first-differenced GMM estimator yields parameter estimates that suffer from a large finite sample bias because of the weak instruments (Arellano and Bover, 1995 and Blundell and Bond, 1998). Furthermore, when the individual series for the dependent and independent variables are highly persistent, and T is small, the problem becomes even more serious. Kraay's (1997) findings may suffer from weak instruments since he assumes that the series are persistent and the time dimension in his sample is only 5 years.

To address the two issues discussed above we employ a system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimator allows us to examine the cross-sectional relationship between exports and productivity since the plant-specific effect is not eliminated, but rather controlled, by the lagged differences of the dependent and independent variables as instruments. Moreover with the highly persistent nature of our data, lagged levels of independent and explanatory variables will provide weak instruments for differenced equations. Thus the system estimator is more appropriate than the first-differenced estimator.

Third, both trade and endogenous growth theories produce the expectation that the relationship between exporting and productivity exists in the long run. Thus, it is desirable to distinguish between the long-run relationship and the short-run dynamics of the two. To our knowledge, previous studies on the causality between exporting and productivity have not attempted to discern the distinctions between the short-run and long run co-movements. We use an error correction specification to distinguish between the variations associated with adjustments toward the long-run relationship and the short-run dynamics.

4.1 An Error-Correction Model

We examine the relationship between productivity and exporting by employing a generalized one-step error correction model[5] along the lines of work by Bond et al. (1997); Bond, Harhoff, and Reenen (1999); and Mairesse, Hall, and Mulkay (1999). We begin with the following autoregressive-distributed lag model:

$$\ln y_{i,t} = \alpha_1 \ln y_{i,t-1} + \alpha_1 \ln y_{i,t-2} + \beta_0 \ln x_{i,t} + \beta_1 \ln x_{i,t-1} + \beta_2 \ln x_{i,t-2} + \psi_t + v_{it} \qquad \textbf{(3)}$$

where $v_{i,t} = \varepsilon_i + u_{i,t}$ and $i = 1,.....N, t = 1,.......,T$. Furthermore, i represents the cross-sectional units; t represents the time periods; $y_{i,t}$ is the dependent variable; $x_{i,t}$ is a vector of explanatory variable; ψ_t is the time-specific effect; and assuming fixed effects, the cross section error term, $v_{i,t}$, contains the following two effects: 1) the unobserved time-invariant, plant-specific effect, ε_i, and 2) a stochastic error term, $u_{i,t}$, varying across time and cross section. The time-specific effect is included to capture aggregate shocks, which may appear in any year. The plant-specific effect, ε_i, is included to capture plant-specific differences such as managerial ability, geographical location, and other unobserved factors. The unobserved plant-specific effect, ε_i, is correlated with the explanatory variables, but not with the changes in the explanatory variables (See Arellano and Bover, 1995 and Blundell and Bond, 1998).

This autoregressive-distributed lag model specification is appropriate if the short-run relationship between exporting and productivity is the only object of interest. However, it does not allow for a distinction between the long and short run effects. We incorporate this distinction into our model by using an error correction specification of the dynamic panel model. This error correction specification is a linear transformation of the variables in equation (3), which provides an explicit link between the short run effects and long run effects.[6]

$$\begin{aligned}\Delta \ln y_{i,t} &= (\alpha_1 - 1)\Delta \ln y_{i,t-1} + \beta_0 \Delta \ln x_{i,t} + (\beta_0 + \beta_1)\Delta \ln x_{i,t-1} + \eta(lny_{i,t-2} - lnx_{i,t-2}) \\ &\quad + \theta \ln x_{i,t-2} + \psi_t + v_{it}\end{aligned} \qquad \textbf{(4)}$$

where $\theta = \beta_0 + \beta_1 + \beta_2 + \alpha_2 + \alpha_1 - 1$ and $\eta = \alpha_2 + \alpha_1 - 1$

For nonzero values of η this is an error correction model (ECM). The coefficient on the error correction term gives the adjustment rate at which the gap between exporting and productivity is closed. If η is negative and significant, then we conclude that the relationship between exporting and productivity exists in the long-run, which implies that error correction mechanism induces the dependent variable adjustments to close the gap with respect to the long run relationship between dependent and independent variables. The dependent variable could deviate from the equilibrium relationship due to certain shocks in the short run, but it eventually converges to the equilibrium in the absence of the shocks in subsequent periods. In such a framework, the changes in the dependent variable over time are driven by both the changes in the independent variable and by the stable nature of the long-run equilibrium.

In this specification, if the coefficient on the error correction term is significantly less than zero, one can conclude that the change in the dependent variable in period t is equal to the change in the independent variable in period t and the correction for the change between the dependent variable and its equilibrium value in period t-1. If the dependent variable is greater than its equilibrium level, it must decrease for the model to approach equilibrium, and vice versa. If the model is in equilibrium in period t-1, the error correction term does not influence the change in the dependent variable in period t. In this case, the change in the dependent variable in period t is equal to the change in the independent variable in period t. The error-correcting model allows us to describe the adjustment of the deviation from the long-run relationship between exporting and productivity. In this specification, the first three terms (lagged growth rate of dependent variable, the contemporaneous and lagged once growth of the dependent variables) capture the short run dynamics and the last two terms (error correction and the lagged level of independent variable) provide a framework to test the long run relationship between productivity and exports.

In general, a long-run multiplier (ϕ) is estimated separately and used to form the error correction term of $(\ln y_{i,t-2} - \phi \ln x_{i,t-2})$ because with the use of $(\ln y_{i,t-2} - \ln x_{i,t-2})$, the long-run relationship is restricted to be homogeneous.[7] That is because the implied coefficient of ϕ=1 on $\ln x_{i,t-2}$ in $(\ln y_{i,t-2} - \ln x_{i,t-2})$ indicates a proportional long-run relationship between y and x. Following Banerjee et al. (1990) and Banerjee et al. (1993), we add the term $(\ln x_{i,t-2})$ to the model to break the homogeneity assumption of long-run relationships between y and x. Thus, in our formulation of the error correction model we can interpret the coefficient η directly as adjustments to disequilibrium although the true equilibrium is given by $(\ln y_{i,t-2} - \phi \ln x_{i,t-2})$ instead of $(\ln y_{i,t-2} - \ln x_{i,t-2})$.

Thus, our generalized error correction model does not imply homogeneity (ϕ=1) although the error correction term is illustrated as $(\ln y_{i,t-2} - \ln x_{i,t-2})$. By adding the term $(\ln x_{i,t-2})$ to the model we break the homogeneity assumption so that the equilibrium relationship between y and x can deviate from one-to-one. This term is also used to calculate the true long-run relationship, which can be written as, $1-(\hat{\theta}/\hat{\eta})$. This error correction specification of the autogressive distributed lag model permits the direct calculation of short and long run effects in panel data. Considering the fact that the formal panel data unit root and cointegration tests require large T, one can conclude that the ECM model is a better alternative for a distinction between the short and long run effects under the situation of the small T.

4.2 Estimation Method: Generalized Method of Moment (GMM)

For consistent and efficient parameter estimates of our dynamic equation model, we apply the system GMM approach proposed by Arellano and Bover (1995) and Blundel and Bond (1998). Alternative estimators do not appear to be as effective. The within-groups estimator will result in biased upward parameter estimates in a panel of short length since the new lagged dependent variable after the subtraction of the variable means and the new independent variables after the subtraction of the variable means are correlated with the new error term. Thus, the OLS estimator will continue to be biased, even with the elimination of firm-specific effects through first differencing.[8] When the time dimension of panel data is short, the problem with this estimator is even more pronounced.[9]

Therefore, our focus is on estimation methods that provide consistent and efficient parameter estimates when: i) N is large, but T is small; ii) the explanatory variables are endogenous; and iii) the plant-specific effects are correlated with other regressors. Under the assumptions that u_{it} are serially uncorrelated and that the explanatory variables are endogenous, Arellano and Bond (1991) showed that the following moment conditions hold for the equations in first differences:[10] E ($\Delta u_{i,t}\ y_{i,t-r}$)=0; E ($\Delta u_{i,t}\ x_{i,t-r}$)=0; where r=2,...,t-1 and t =3,...,T. (7)

Therefore, the lagged values of endogenous variables dated t-2 and earlier are valid instrumental variables for the equations in first-differences.

As a result, Arellano and Bond (1991) showed that the first-differenced GMM estimator method results in a significant efficiency gain compared to the Anderson and Hsiao (1981) estimator. However, in the context of the above model specification, there are two possible problems with the use of the first differenced GMM estimator. First, the plant-specific effect is eliminated, so that one cannot examine the cross-plant relationship between the variables of interest, in our case exports and productivity. Second, when the lagged values of series are weakly correlated with the first-differences, it can yield parameter estimates that suffer from large finite sample bias because of weak instruments. When the individual series for the dependent and independent variable are highly persistent, and when T is small, the problem is more severe.

Arellano and Bover (1995) noted that if the initial condition, X_{i1}, satisfies the stationarity restriction $E(\Delta X_{i2}\varepsilon_i) = 0$, then ΔX_{it} will be correlated with ε_i if and only if ΔX_{i2} is correlated with ε_i. The resulting assumption is that although there is a correlation between the level of right-hand-side variables, X_{it}, and the plant-specific effect, ε_i, no such correlation exists between the differences of right-hand-side variables, ΔX_{it}, and the plant-specific effect, ε_i. This additional assumption gives rise to the level equation estimator, which exploits more moment conditions. Lagged differences of explanatory variables, ΔX_{it-r}, are used as additional instruments for the equations in levels, when X_{it} is mean stationary.

Blundell and Bond (1998) showed that the lagged differences of the dependent variable, in addition to the lagged differences of the explanatory variables, are proper instruments for the regression in the level equation as long as the initial conditions, y_{i1}, satisfy the stationary restriction, $E(\Delta Y_{i2}\varepsilon_i) = 0$. Thus, when both ΔX_{it} and ΔY_{it} are uncorrelated with ε_i, both lagged differences of explanatory variables, ΔX_{it-r} and lagged differences of dependent variable, ΔY_{it-r}, are valid instruments for the equations in levels. Furthermore, Blundell and Bond (1998) show that the moment conditions defined for the first-differenced equation can be combined with the moment conditions defined for the level equation to estimate a system GMM. When the explanatory variable is treated as endogenous, the GMM system estimator utilizes the following moment conditions:

$E(\Delta u_{i,t}\, y_{i,t-r})=0$; $E(\Delta u_{i,t}\, x_{i,t-r})=0$; where r=2,...,t-1 and t =3,...,T.

$E(v_{i,t}\, \Delta y_{i,t-r})=0$; $E(v_{i,t}\, \Delta x_{i,t-r})=0$; where r=1; and t =3,...,T.

This estimator combines the T-2 equations in differences with the T-2 equations in levels into a single system. It uses the lagged levels of dependent and independent variables as instruments for the difference equation and the lagged differences of dependent and independent variables as instruments for the level equation. Blundell and Bond (1998) showed that this new system GMM estimator results in consistent and efficient parameter estimates, and has better asymptotic and finite sample properties.

This estimator not only controls for the endogeneity of the explanatory variables but also for the unobserved plant-specific effects that persist over time such as managerial ability and R&D. It allows us to examine the cross-sectional relationship between exporting and productivity since the firm-specific effect is not eliminated but rather controlled by the lagged differences of the dependent and independent variables as instruments, assuming that the differences are not correlated with a plant-specific effect, while levels are. Moreover, as explained above, with the highly persistent nature of our data, lagged levels of independent and explanatory variables will provide weak instruments for differenced equations. Thus in this case, the system estimator is more appropriate than the first-differenced estimator. We examined the nature of the series to see whether the series for exporting and productivity are persistent. Our estimates of the AR (1) coefficients on exporting and productivity show that the series of exporting and productivity are highly persistent, thus the lagged levels of exports and productivity provide weak instruments for the differences in the first-differenced GMM model. As a result, the system GMM estimator is more appropriate than the other estimators.

We use specification tests proposed by Arellano and Bond (1991) and Arellano and Bover (1995) to check the validity of the instruments. First, we apply the Sargan test, a test of overidentifying restrictions, to determine any correlation between instruments and errors. For valid instruments, there should not be a correlation between the instruments used and the error terms. The null hypothesis is that the instruments and the error terms are independent. Thus, failure to reject the null hypothesis could provide evidence that valid instruments are used. Second, the GMM estimator is consistent if there is no second order serial correlation in the error term of the first-differenced equation. We test whether there is a second order serial correlation with the first differenced errors. The null hypothesis in this case is that the errors are serially uncorrelated. Thus, failure to reject the null hypothesis could supply evidence that valid orthogonality conditions are used. One would expect the differenced error term to be first order serially correlated, although the original error term is not.

Finally, we use the Differenced Sargan test to determine whether the extra instruments implemented in the level equations are valid. We compare the Sargan test statistic for the first differenced estimator and the Sargan test statistic for the system estimator.[11] After obtaining an appropriate specification, we use the Wald test to determine whether exporting causes productivity or vice versa, both in the short-run and in the long run. In our specification, the short-run relationship between the two variables is captured by the terms in differences, while the long-run relationship is captured by the terms in levels. For the short-run, we use the t test on β_0 and on $\beta_0 + \beta_1$. If the differenced explanatory variables are significant in the equation, we can conclude that the independent variable causes the dependent variable. In order to examine the long-run relationship, we use the Wald test on the variables in levels $(x_{i,t-2})$ and $(y_{i,t-2} - x_{i,t-2})$.

4.3 Results

The results for the causal relationship between productivity growth and export growth are presented in Tables 5 and 6. Table 5 presents the results for the causal relationship between total factor productivity (TFP) growth and export (EXP) growth while Table 6 presents the same for labor productivity (LP) growth and export growth. The first column for each industry in each table shows the effect of productivity on exporting, while the second column for each industry shows the effect of exporting on productivity. As it can be seen from the tables, the specification tests to check the validity of the instruments are satisfactory. The test results show no evidence of second order serial correlation in the first differenced residuals. Moreover, the validity of lagged levels dated t-2 and earlier as instruments in the first-differenced equations, combined with lagged first differences dated t-2 as instruments in the levels equations are not rejected by the Sargan test of overidentifying restrictions. The system GMM parameter estimates of our error correction model are satisfactory. We interpret the results for the short- and long-run causal relationship between exports and productivity for the apparel and motor vehicle and parts industries in detail below.

The contemporaneous relationship between total factor productivity and exporting is noteworthy for the two industries. The coefficient on the current productivity is high, 0.874 for the apparel industry and 0.633 for the motor vehicle and parts industry, both statistically significant with positive signs. The lagged coefficients on productivity are negative in both industries, but they are not statistically significant. The sum of the coefficients on the current and lagged productivity is positive for both industries, 0.542 for the apparel industry and 0.477 for the motor vehicle and parts industry.

The same holds for the relationship between labor productivity and exporting. The contemporaneous relationship between exports and productivity seems to be strong, while the lagged one is not. The coefficients on current labor productivity in the exporting equation are significant with high positive values in both industries, while the coefficients on lagged labor productivity have a statistically insignificant negative sign.

Thus, we can conclude that both labor productivity and total factor productivity causes export growth based on the significant contemporaneous responses of exporting to the short run shocks in productivity. These findings are consistent with earlier studies (Bernard and Jensen (1995, 1999a, 1999b) on the United States of America; Aw, Chung and Roberts (1998) on Taiwan and Korea; and Clerides, Lach, and Tybout (1998) on Colombia, Mexico, and Morocco), which conclude that there exists a unidirectional causation between productivity and exports, such that productivity increases exports.

In contrast to the earlier studies cited, we also find a significant productivity response to increases in exports. The short run responses of productivity to exporting are smaller than the short run responses of exporting to productivity shocks. The current export growth coefficient in the total factor productivity equation is 0.232 for the apparel industry and 0.155 for the motor vehicle and parts industry, both of which are significant. The coefficients on current export growth in the labor productivity equation for both the apparel and motor vehicle and parts industries, 0.099 and 0.145, respectively, are also significant but smaller than the coefficients in the total factor productivity equation.

The contemporaneous relationship between exporting and productivity seems to be strong in both industries since the coefficients on current export growth in both the total factor productivity growth equation and the labor productivity equation are statistically significant and positive. The sum of the current and lagged export growth coefficients in the total factor productivity equation is 0.072 for the apparel industry and 0.083 for the motor vehicle and parts industry, both being positive. The sum of the current and lagged coefficients in the labor productivity equation is 0.069 for the apparel industry and 0.097 for the motor vehicle and parts industry, which are also both positive. However, the short run responses of both labor and productivity growth to exporting shocks are only statistically significant contemporaneously.

Thus, based on the current coefficients of the growth rate of explanatory variable in each equation, we conclude plants that enter the export market experience small improvements in productivity. Combined with the previous results, the evidence indicates that more productive firms enter and compete in the export market, and these plants receive further productivity enhancements as a result of participation in export markets.

The coefficient on the error correction term indicates whether a long-run relationship between exporting and productivity exists. If the coefficient on the error correction term is statistically significant with a negative sign, we conclude that exporting and productivity move together in the long run. The deviations from the equilibrium are partially corrected in each period to re-establish the long-run equilibrium. If the coefficient on the error correction term is significantly less than zero, one can conclude that the change in the dependent variable in period t is equal to the change in the independent variable in period t and the correction for the change between the dependent variable and its equilibrium value in period t-1. If the dependent variable is above the equilibrium value in the previous period, then there will be a change in the dependent variable equaling the negative of the error correction term, $(\alpha_1 + \alpha_2 - 1)(\ln y_{i,t-2} - \ln x_{i,t-2})$, resulting in the dependent variable moving toward the equilibrium value. When the dependent variable is below the equilibrium value, it will be adjusted upward. Thus, again the dependent variable will move toward the equilibrium value.

The error correction terms are significant and negative as expected. Thus, the results show that the relationship between exporting and productivity exists in the long run. Since the coefficient on the error correction term is statistically significant with a negative sign, we can use this coefficient to comment on the speed of adjustment to the deviation from the long-run relationship between exporting and productivity. Our test result shows that this adjustment process has a significant affect on the dependent variable, thus the changes in the dependent variable will be adjusted by the error correction term to reestablish the equilibrium.

The error correction term in the exporting equation is statistically significant with a negative sign in both the apparel and motor vehicle and parts industries, with coefficients of -0.403 and -0.078, respectively. The speed of the adjustment is different for the two industries. For the apparel industry, the model converges quickly to equilibrium with over 40 percent of discrepancy corrected in each period. The speed of the adjustment to the deviation from the long-run relationship between exporting and productivity is slower in the motor vehicle and part industry. The speed of the adjustment of the exporting shocks to the labor productivity shocks was similar in the motor vehicle industry but not in the apparel industry. It is -0.125 for the motor vehicle industry, and -0.126 for the apparel industry.

The significance of the long run relationship between exporting and productivity is also evident from the total factor productivity and labor productivity equations. From the total factor productivity growth equation, our result shows that the speed of the adjustment of the total factor productivity to the exporting shocks is slightly faster in the motor vehicle industry than in the apparel industry. However, the speed of the adjustment of labor productivity to the exporting shocks in the long run was greater in the apparel industry than the motor vehicle industry.

The long-run elasticities of the dependent variable to the independent variable are also shown in Tables 5 and 6. These elasticities are calculated by subtracting the ratio of the coefficient of the scale effect (lag value of independent variable) to the coefficient of the error correction term from one. The significance of these elasticities is tested with a Wald test. The P-values for the test are also shown in Tables 5 and 6. The test results indicate that they are statistically significant in each equation for both industries.

The long run productivity coefficient in the exporting equation, when the independent variable is total factor productivity, is 0.958 for the apparel industry and 0.923 for the motor vehicle and parts industry. This indicates that exporting responds to the permanent shock in productivity very quickly in both the apparel and motor vehicle and parts industries. Similar to the results explained for total factor productivity, the results for labor productivity also show that exporting responds to the permanent shocks very quickly in both the apparel and motor vehicle and parts industries. The response of exporting to labor productivity in the apparel industry is much slower than that of the motor vehicle and parts industry. The long-run productivity accelerator coefficient in the exporting equation, when the independent variable is labor productivity, is 0.834 for the apparel industry and 1.504 for the motor vehicle and parts industry.

The results show that productivity (both labor and total factor productivity) responses to the permanent shocks in exporting are much smaller than the exporting responses to the permanent shocks in labor productivity and total factor productivity in both the apparel and motor vehicle and parts industries. These results are consistent with those found for the responses of exporting and productivity to short-run shocks, in which we also conclude that the short-run responses of exporting to labor and total factor productivity shocks are faster than the short-run responses of the labor and total factor productivity growth to the shocks in exporting.

5 Summary and Conclusions

Our results from the comparison of plant performance show that exporting plants are more productive than their domestically-oriented counterparts. They invest more heavily, pay substantially higher wages, and employ more. They also take advantage of the subcontracting relationship with the small plants. They spend more on advertisement and communication, which may be interpreted as the exporting plants pursuing better marketing strategies. Thus, exporting plants perform much better than their domestically-oriented counterparts.

Ordinary least squares estimates of plant productivity on the lagged productivity, the lagged export status dummy variable, and three control variables, provide evidence that the exporting in year t-1 increases the productivity in year t. One interesting finding is that there is more evidence of learning-by-exporting for the apparel industry than the motor vehicle and parts industry. One interpretation is that the more labor-intensive industries are more influenced by the learning effects of exporting. In other words, plants with lower technological and employment capabilities may learn more from exporting.

Our results show that contemporaneous productivity has a significant affect on exports. Moreover, the impact of productivity growth on export growth in the long run appears to be stronger than the short run impact. And contemporaneous export growth has a significant positive impact on productivity growth. The long-run effect of export growth on productivity growth is even more significant. The results from previous studies on both developed and developing countries suggest that the direction of the causality is from productivity to exports but not the reverse. The evidence presented here indicates that the more productive firms that enter the export market experience further productivity enhancements. The different development levels of the economies might affect the way plants absorb the benefits from exporting. The fact that our findings differ from previous studies may be due to the different institutional factors in place in Turkey. Since developing countries such as Turkey invest little in research and development and rely on the technology and knowledge produced by trade partners, one would reasonably expect the exporting plants in developing countries to learn through the experience of exporting. Our results provide evidence of this hypothesis.

Further, unlike the other studies that pooled data from different industries, this study analyzes each industry separately. It is important to consider the differences in the structure (market concentration, market size, product differentiation, and entry barriers) and dynamics of the industries when assessing the causal relationship between exports and productivity. For instance, the Turkish motor vehicle and parts industry is more concentrated than the apparel industry. In such a concentrated industry, entry and exit decisions are shaped by endogenous sunk costs (i.e., R&D and advertising expenditures), which are affected by the firms' actions. The firms in such industries heavily invest in research and development in order to improve their technology and skills. The new technology and products are consequences of these investments, and thus technological progress is considered endogenous.[12] The apparel industry is characterized by many medium- and small-sized firms that constantly restore themselves during industry evolution. The sunk costs incurred to enter the market are low, thus many firms enter the market when market size is increasing and more exit the market when the market size is declining, as opposed to the motor vehicle and parts industry. Because of its resource-based and labor-intensive nature, plants in this industry do not invest in research and development but rely on cheap labor and resources available in the home country.[13]

Our results support the existing literature in presenting evidence of a strong causality from productivity to exports. And they identify a less strong, yet clear, causality from exports to productivity. This is a contribution adding to the small amount of evidence in support of this causality reported in the literature thus far.

On the policy front, our findings show that policies must take into consideration that the effect of productivity on exports is much stronger than the reverse. Thus, exports can be expanded by improving the productivity of plants, although plants can also improve their productivity through exporting. Policy makers should take into consideration that productivity growth is a major source of increase in export earnings and subsequent economic growth, once the country is opened to international trade and the underutilized labor and natural resources are efficiently allocated. A secondary consideration is that plants can also experience further improvement in their productivity through exporting.

Bibliography

Anderson, T. W. and C. Hsiao (1981). Estimation of Dynamic Models with Error Components. *Journal of the American Statistical Association* 76, 598-606.

Anderson, T. W. and C. Hsiao (1982). Formulation and Estimation of Dynamic Models Using Panel Data. *Journal of Econometrics* 18, 47-82.

Arellano, M. and S. R. Bond (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies* 58, 277-297.

Arellano, M. and O. Bover (1995). Another Look at the Instrumental Variable Estimation of Error Components Models. *Journal of Econometrics* 68, 29-52.

Arrow, K. (1962). The Economic Implications of Learning-by-doing. *Review of Economic Studies* 29, 155-173.

Aw, B., X. Chen, and M. Roberts (1997). Firm-level Evidence on Productivity Differentials and Turnover in Taiwanese Manufacturing. Cambridge MA, NBER.

Aw, B., S. Chung, and M. Roberts (1998). Productivity and the Decision to Export Market: Micro Evidence from Taiwan and South Korea. Cambridge MA, NBER.

Aw, B. and M. Roberts (1987). *Price and Quality Level Comparisons for U.S. Footwear: An Application of Multilateral Index Numbers, in R. Feenstra, (eds.), Empirical Methods for International Trade*. Cambridge, MA: MIT Press.218

Baltagi, B. (1995). *Econometric Analysis of Panel Data*. Chichester, England: Wiley.

Banerjee, A., J. Galbraith, and J. J. Dolado (1990). Dynamic Specification with the General Error-Correction Form. *Oxford Bulletin of Economics and Statistics* 52, 95-104.

Banerjee, A., J. J. Dolado, J. Galbraith, and D. F. Hendry (1993). *Cointegration, Error Correction, and the Econometric Analysis of Non-stationary Data*. Oxford: Oxford University Press.

Barro, R. J. and X. Sala-I-Martin (1995). *Economic Growth*. New York: McGraw-Hill.

Bean, C. R. (1981). An Econometric Model of Manufacturing Investment in the U.K. *Economic Journal* 91, 106-121.

Bernard, A. B. and J. B. Jensen (1995). Exporters, Jobs and Wages in U.S. Manufacturing, 1976–1987. The Brooking papers on economic activity. *Microeconomics* **1995** (1995), pp. 67–112.

Bernard, A. B. and J. B. Jensen (1998a). Understanding the U.S. Export Boom. Cambridge, MA, NBER.

Bernard, A. B. and J. B. Jensen (1998b). Why Some Firms Export: Experience, Entry Costs, Spillovers, and Subsidies. Yale Mimeo.

Bernard, A. B. and J. B. Jensen (1999a). Exceptional Exporter Performance: Cause, Effect, or Both? *Journal of International Economics* 47(1), 1-26.

Bernard, A. B. and J. B. Jensen (1999b). Exporting and Productivity. Cambridge, MA, NBER.

Bernard, A. B. and J. Wagner (1997). Exports and Success in German Manufacturing. *Weltwirtschaftliches Archive* 133, 134-157.

Blundell, R. and S. R. Bond (1998a). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics* 87(1), 115-143.

Blundell, R. and S. R. Bond (1998b). GMM Estimation with Persistent Panel Data: An Application to Production Functions. Mimeo, Institute for Fiscal Studies, London.

Blundell, R., S. R. Bond, and F. Windmeijer (2000). Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM Estimators. The Institute of Fiscal Studies, London.

Bond, S. R., J. Elston, J. Mairesse, and B. Mulkay (1997). Financial Factors and Investment in Belgium, France, Germany and the UK: A Comparison Using Company Panel Data. NBER Working Paper.

Bond, S. R., D. Harhoff, and J. V. Reenen (1999). Investment, RD, and Financial Constraints in Britain and Germany. Mimeo, Institute for Fiscal Studies, London.

Caves, D. W., L. R. Christensen, and W. E. Diewert (1982a). The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica* 50, 1393-1414.

Caves, D. W., L. R. Christensen, and W. E. Diewert (1982b). Multilateral Comparison of Output, Input, and Productivity Using Superlative Index Numbers. *Economic Journal* 92, 73-86.

Caves, D. W., L. R. Christensen, and M. W. Trethway (1981). *U.S. Trunk Air Carriers, 1972-1977: A Multilateral Comparison of Total Factor Productivity, in Thomas G. Cowing and Rodney E. Stevenson (eds.), Productivity Measurement in Regulated Industries*. New York: Academic Press.

Caves, D.W., L. R. Christensen, and M. W. Trethway (1983). Productivity Performance of U.S. Trunk and Local Service Airlines in the Era of Deregulation. *Economic Inquiry* 21, 312-324.

Clerides, S., S. Lach, and J. Tybout (1998). Is learning-by-exporting important? Micro Dynamic Evidence from Colombia, Mexico, and Morocco. *Quarterly Journal of Economics* **CXIII,** 903–947.

Coe, D. and E. Helpman (1995). International R&D Spillovers. *European Economic Review* 39, 859-887.

Davidson, J.E.H., D.F. Hendry, F. Srba, and S. Yeo (1978). Econometric Modeling of the Aggregate Time-Series Relationship between Consumers' Expenditure and Income in the United Kingdom." *Economic Journal* 88, 661-692.

Davidson, R. and J. Mackinnon (1993). *Estimation and Inference in Econometrics*. New York: Oxford: Oxford University Press.

Diewert, E. and D. Lawrence (1999). *Progress in Measuring the Price and Quantity of Capital*, University of British Columbia Dept. of Economics Discussion Paper 99/17.

Doornik, J., M. Arellano, and S. Bond (2002). Panel Data Estimation Using DPD for OX. Nuffield College, Oxford.

Dosi, G., O. Marsili, L. Orsenigo, and R. Salvatore (1995). Learning, Market Selection and the Evaluation of Industrial Structures. *Small Business Economics* 7, 411-436.

DTM. Undersecretariat of Foreign Trade. Ankara, Turkey: www.foreigntrade.gov.tr.

Edwards, S. (1993). Openness Trade Liberalization and Growth in Developing Countries. *Journal of Economic Literature* 31(3), 1358-1393.

Edwards, S. (1998). Openness, Productivity and Growth: What Do We Really Know? *Economic Journal* 108, 383-398.

Feenstra, R. (1995). *Estimating the effects of trade policy,* in G. Grossman and K. Rogoff, (eds.), Handbook of International Economics, vol. III, North-Holland, 1553-1595.

Foroutan, F. (1996). *Turkey1976-1985: Foreign Trade, Industrial Productivity and Competition, in M.J. Roberts and J.R. Tybout (eds.), Industrial Evaluation in Developing Countries*. Washington: World Bank.

Good, D. (1985). The Effect of Deregulation on the Productive Efficiency and Cost Structure of the Airline Industry. Ph. D. Dissertation, University of Pennsylvania.

Good, D., I. Nadiri, and R. Sickles (1996). Index Number and Factor Demand Approaches to the Estimation of Productivity. NBER Working Paper, No. 5790.

Grossman, G. and E. Helpman (1991). *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.

Hanson, G. H. and A. Harrison (1999). *Trade, Technology and Wage Inequality in Mexico*. Industrial and Labor Review 52, 271-288.

Harper, M., E. Berndt, and D. Wood (1989). *Rates of Return and Capital Aggregation Using Alternative Rental Prices, in D.W. Jorgenson and R. Landau, (eds.), Technology and Capital Formation*, pp. 331-372. Cambridge, MA: The MIT Press.

Harrison, A. (1994). Productivity, Imperfect Competition and Trade Reform: Theory and Evidence. *Journal of International Economics* 36, 53-73.

Havrylyshyn, O. (1990). Trade Policy and Productivity Gains in Developing Countries: A Survey of the Literature. World Bank Research Observer 5, 1-24.

Hennart, J. F. (1988). A Transaction Cost Theory of Equity Joint Ventures. *Strategic Management Journal* 9, 361-374.

Hsiao, C. (1986). *Analysis of Panel Data*. Cambridge University Press.

Klepper, S. (1996). Entry, Exit, Growth, and Innovation over the Product Life Cycle. *American Economic Review* 86(3), 562-583.

Kraay, A. (1997). Exports and Economic Performance: Evidence from a Panel of Chinese Enterprises. Working Paper, World Bank, Washington, DC.

Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy* 99, 483-499.

Lucas, R. E. (1988). On the Mechanics of Economic Development Planning. *Journal of Monetary Economics* 22(1), 3-42.

Mairesse, J., B. H. Hall, and B. Mulkay (1999). Firm-level Investment in France and the United States: An Exploration of What We Have Learned in Twenty Years. *Annales d'Economie et de Statistiques* 55-56, 27-67.

Marschak, J. and W. Andrews (1944). Random Simultaneous Equations and the Theory of Production. *Econometrica* 12, 143-205.

Nelson, R. and S. Winter (1982). *An Evolutionary Theory of Economics Change*. Cambridge, MA: Harvard University Press.

Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. *Econometrica* 49, 1417-1426.

Parente, S. and E. Prescott (1994). Barriers to Technology Adaptation and Development. *Journal of Political Economy* 102(2), 298-321.

Porter, M. E. (1998). Clusters and New Economies of Competition. *Harvard Business Review* Nov-Dec, 77-90.

Rivera-Batiz, L. A. and P. Romer (1991). Economic Integration and Endogenous growth. *Quarterly Journal of Economics* 106, 531-555.

Roberts, M. and J.Tybout (1997). The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs. *American Economic Review* 87(4), 545-564.

Rodrik, D. (1991). *Closing the Technology Gap: Does Trade Liberalization Really Help, in G. Helleiner, (eds.), Trade Policy, Industrialization and Development: New Perspectives*. Oxford: Calerendon Press.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy* 94, 1002-1037.

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy* 98, 71-102.

Sargan, J. D. (1958). The Estimation of Economic Relationships Using Instrumental Variables. *Econometrica* 26, 393-415.

SIS. State Institute of Statistics. Ankara, Turkey: www.die.gov.tr.

Solow, R. (1957). Technical Change and the Aggregate Production Function. *Review of Economics and Statistics* 39(3), 312-320.

SPO. State Planning Organization. Ankara, Turkey: www.dpt.gov.tr.

Tan, H. W. and G. Batra (1995). Enterprise Training in Developing Countries: Incidence, Productivity Effects, and Policy Implications. Private Sector Development, World Bank, Washington, DC.

Taymaz, E. and G. Saatci (1997). Technical Change and Efficiency in Turkish Manufacturing Industries. *Journal of Productivity Analysis* 8, 461-475.

J.R. Tybout (1997). Heterogeneity and productivity growth: assessing the evidence. In: M.J. Roberts and J.R. Tybout, Editors, *Industrial Evolution in Developing Countries*, Oxford University Press.

Winter, S. (1982). Schumpeterian Competition in Alternative Technological Regimes. *Journal of Economic Behavior and Organization* 5, 287-320.

Young, A. (1991). Learning by Doing and the Dynamic Effects of International Trade. *The Quarterly Journal of Economics* 106, 369-405.

Table 1: Average Annual Growth Rates of Output and Inputs, 1991-1996

Motor Vehicle and Parts Industry

	1991	1992-1993	1994	1995-1996	1991-1996
Output	0.102	0.136	-0.276	0.168	0.091
Material	0.066	0.112	-0.278	0.158	0.071
Capital	-0.062	-0.044	-0.149	0.036	-0.038
Energy	0.000	0.291	-0.165	0.556	0.071
Labor Hours	-0.009	0.048	-0.158	0.110	0.037
Exports	0.101	0.323	0.352	0.455	0.375

Apparel Industry

	1991	1992-1993	1994	1995-1996	1991-1996
Output	-0.156	0.129	-0.020	0.010	0.061
Material	0.014	0.178	0.019	0.130	0.095
Capital	-0.112	-0.046	-0.149	-0.051	-0.065
Energy	-0.050	0.307	-0.452	0.475	0.205
Labor Hours	-0.159	0.013	-0.077	0.083	0.036
Exports	0.105	0.129	0.077	0.173	0.131

Table 2: Plant Performance of Exporters and Non-Exporters: Export Premia

Dependent Variables	Apparel Industry	Motor Vehicle and Parts Industry
Total Factor Productivity	0.138 (0.017)***	0.082 (0.030)***
Labor Productivity	0.819 (0.027)***	0.373 (0.045)***
Wage Per Employee	0.320 (0.011)***	0.260 (0.029)***
Output Per Employee	0.811 (0.025)***	0.341 (0.042)***
Capital Per Employee	0.543 (0.047)***	0.394 (0.086)***
Investment Per Employee	0.433 (0.059)***	0.282 (0.104)***
Investment in Machine Per Employee	0.228 (0.061)***	0.324 (0.112)***
Horse Power	0.234 (0.030)***	0.406 (0.074)***
Engineers and Technicians	-0.069 (0.034)***	0.157 (0.050)***
Managers	0.496 (0.021)***	0.420 (0.048)***
Labor Hours	0.202 (0.014)***	0.169 (0.036)***
Total Employment	0.613 (0.024)***	0.662 (0.096)***
Output	1.234 (0.034)***	0.745 (0.087)***
Advertising Expenditures	0.110 (0.085)	1.079 (0.135)***
Communication Expenditures	0.408 (0.044)***	0.984 (0.089)***
Subcontracted Input	0.681 (0.055)***	0.326 (0.137)**
Subcontracted Output	-0.582 (0.071)***	-0.423 (0.297)

Robust t-statistics are in parentheses. *Significant at the10 percent level. **Significant at the 5 percent level. ***Significant at the1 percent level. Regressions include time, size, region, and industry dummy variables. Dependent variables are in natural logs. The base group is non-exporters.

Table 3: Learning-by-Exporting: Export Status and Productivity Level

	Apparel Industry		Motor Vehicle And Parts Industry	
	TFP	LP	TFP	LP
Productivity(t-1)	0.518	0.806	0.635	0.806
	(0.013)***	(0.008)***	(0.018)***	(0.015)***
Exporters(t-1)	0.055	0.132	0.043	0.088
	(0.016)***	(0.021)***	(0.022)**	(0.031)***
Medium	0.032	0.061	0.015	-0.004
	(0.018)*	(0.022)**	(0.026)	(0.034)
Large	0.062	0.052	0.062	0.126
	(0.017)***	(0.022)**	(0.023)***	(0.033)**
Region Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes

* Significant at the 10% level. ** Significant at the 5% level. ***Significant at the 1% level.

Table 4: Learning-by-Exporting: Export Status and Productivity Level

	Apparel Industry		Motor Vehicles And Parts Industry	
	TFP	LP	TFP	LP
Productivity(t-1)	0.517 (0.013)***	0.792 (0.008)***	0.632 (0.018)***	0.802 (0.015)***
Continuous Exporters	0.073 (0.025)***	0.241 (0.033)***	0.077 (0.031)**	0.143 (0.042)***
Entrants	0.051 (0.021)**	0.188 (0.027)***	0.0213 (0.029)	0.094 (0.041)**
Exiters	-0.008 (0.021)	0.139 (0.027)***	0.012 (0.033)	0.081 (0.046)*
Switchers	0.024 (0.021)	0.151 (0.027)***	0.015 (0.035)	0.085 (0.047)*
Medium	0.030 (0.018)*	0.038 (0.022)*	0.018 (0.026)	-0.009 (0.034)
Large	0.058 (0.017)***	0.014 (0.022)	0.050 (0.025)**	0.096 (0.034)***
Region Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes

* Significant at the 10% level. ** Significant at the 5% level. ***Significant at the 1% level.

Table 5: Causal Relationship between Export Growth and Total Factor Productivity Growth at the Plant Level

Explanatory Variables	Dependent Variables: Apparel Industry		Motor Vehicle and Parts Industry	
	$\Delta \ln EXP$	$\Delta \ln TFP$	$\Delta \ln EXP$	$\Delta \ln TFP$
$\Delta \ln TFP$	0.874 (0.532)*		0.633 (0.387)*	
$\Delta \ln TFP_{t-1}$	-0.332 (0.258)	0.373 (0.071)***	-0.156 (0.139)	0.334 (0.051)***
$\ln TFP_{t-2}$	-0.017 (0.252)		-0.006 (0.085)	
$\ln TFP_{t-2} - \ln EXP_{t-2}$		-0.170 (0.069)**		-0.214 (0.040)***
$\Delta \ln EXP$		0.232 (0.112)**		0.155 (0.091)*
$\Delta \ln EXP_{t-1}$	0.364 (0.074)***	-0.160 (0.098)	0.335 (0.043)***	-0.072 (0.046)
$\ln EXP_{t-2}$		-0.144 (0.078)*		-0.186 (0.059)***
$\ln EXP_{t-2} - \ln TFP_{t-2}$	-0.403 (0.117)***		-0.078 (0.028)***	
Long Run Coefficient	0.958	0.153	0.923	0.131
Long Run Coefficient (P-Value)	0.000	0.000	0.013	0.000
Sargan Difference Test (P-Value)	0.146	0.948	0.377	0.291
Sargan Test (P-Value)	0.265	0.438	0.173	0.101
AR1 (P-Value)	0.040	0.065	0.043	0.117
AR2 (P-Value)	0.835	0.377	0.847	0.395

1) Estimation by System-GMM using DPD for OX (Doornik, Arellano, and Bond)
2) Asymptotically robust standard errors are reported in parentheses.
3) *Significant at the 10% level. ** Significant at the 5% level. ***Significant at the 1% level.
4) The Sargan test is a Sargan-Hansen test of overidentifying restrictions. The null hypothesis states that the instruments used are not correlated with the residuals.
5) AR1 and AR2 are tests for first- and second-order serial correlation in the first-differenced residuals. The null hypothesis for the second-order serial correlation test states that the errors in the first-differenced regression do not show second-order serial correlation.
6) Lagged levels of productivity and exports (dated t-2 and earlier) in the first-differenced equations, combined with lagged first differences of productivity and exports (dated t-2) in the level equations are used as instruments.
7) Year dummies are included in each model.

Table 6: Causal Relationship Between Export Growth and Labor Productivity Growth at the Plant Level

Explanatory Variables	Dependent Variables: Apparel Industry		Motor Vehicle and Parts Industry	
	$\Delta \ln EXP$	$\Delta \ln LP$	$\Delta \ln EXP$	$\Delta \ln LP$
$\Delta \ln LP$	0.647 (0.349)*		0.722 (0.359)**	
$\Delta \ln LP_{t-1}$	-0.399 (0.234)	0.367 (0.039)***	-0.192 (0.141)	0.286 (0.067)***
$\ln LP_{t-2}$	-0.021 (0.050)		0.063 (0.084)	
$\ln LP_{t-2} - \ln EXP_{t-2}$		-0.487 (0.044)***		-0.166 (0.093)*
$\Delta \ln EXP$		0.099 (0.046)**		0.145 (0.087)*
$\Delta \ln EXP_{t-1}$	0.603 (0.080)***	-0.030 (0.021)	0.351 (0.052)***	-0.048 (0.036)
$\ln EXP_{t-2}$		-0.422 (0.039)***		-0.113 (0.074)***
$\ln EXP_{t-2} - \ln LP_{t-2}$	-0.126 (0.036)***		-0.125 (0.032)***	
Long Run Coefficient	0.834	0.137	1.504	0.72
Long Run Coefficient (P-Value)	0.000	0.000	0.000	0.000
Sargan Difference Test (P-Value)	0.472	0.416	0.352	0.264
Sargan Test (P-Value)	0.979	0.747	0.125	0.838
AR1 (P-Value)	0.004	0.000	0.053	0.023
AR2 (P-Value)	0.577	0.197	0.906	0.748

1) Estimation by System-GMM using DPD for OX(Doornik, Arellano, and Bond)
2) Asymptotically robust standard errors are reported in parentheses.
3) *Significant at the 10% level. ** Significant at the 5% level. ***Significant at the 1% level.
4) The Sargan test is a Sargan-Hansen test of overidentifying restrictions. The null hypothesis states that the instruments used are not correlated with the residuals.
5) AR1 and AR2 are tests for first- and second-order serial correlation in the first-differenced residuals. The null hypothesis for the second-order serial correlation test states that the errors in the first-differenced regression do not show second-order serial correlation.
6) Lagged levels of productivity and exports (dated t-2 and earlier) in the first-differenced equations, combined with lagged first differences of productivity and exports (dated t-2) in the level equations are used as instruments.
7) Year dummies are included in each model.

Data Appendix

Output (Y) is the value of aggregate output deflated by the corresponding price index. The changes in the stock of output are considered in calculation. As for the calculation of material (M) input value, the expenditures on inputs are used, considering the changes in stocks. The value of fuel is added to that of electricity to obtain energy (E). We divide the nominal values of inputs by the corresponding price deflators to find the constant dollar value quantities of inputs at 1987 prices.

The quantity of labor (L) is based on total hours worked in production, i.e., the product of average hours worked times the number of employees in manufacturing. The labor input consists of administrative personnel, technical personnel, and unskilled workers. The share of labor is calculated for administrative, technical, female, and male, as well as unskilled workers. We use the gross investment data (domestic plus imported capital purchases minus sales, with maintenance investment added in) deflated by a capital price index, and sum them over time using depreciation rates to compute the aggregated capital data. In order to calculate the initial benchmark we use three-year averages of the growth rate of investment (see Harper, Berndt and Wood). We average the investment data for the first three years and then divide by the depreciation rate to compute the t-1 capital benchmark. Then, we cumulate the capital stock from that point using the investment data and a depreciation rate. In other words, the capital stock is estimated by applying the perpetual inventory method (PIM) on the fixed assets, which requires estimated years of lifetime capital equipment: $K_t = K_{t-1}(1-\delta) + I_{t-1}$, where K_t is the capital stock in period t; δ is the depreciation rate of capital; and I_t is the level of the investment during the period. We assume the following service lives for the fixed assets: 40 years for building and construction; 15 years for transportation equipment; and 15 years for machinery and equipment. Then using a formula provided by Diewert and Lawrence we compute the depreciation rates. The depreciation rates corresponding to the assumed services lives of fixed assets are then obtained. They are 12.5 percent for transportation equipment; 12.5 percent for machinery and equipment; and 4.9 percent for building and construction. The annual output and input average growth rates for the apparel and motor vehicle and parts industries from 1991-1996, as well as for the following sub-periods: 1991, 1992-1993, 1994 and 1995-1996 are illustrated in Table 1. This classification of intervals is used because the period from 1990-1996 was a time of significant structural change in Turkey's economic performance, causing significant fluctuations in the growth rates from year to year. The two major factors causing the turbulence were the Gulf War in 1991 and the economic crisis of 1994.

The output of the motor vehicle and parts industry grew at an annual rate of 9.1 percent from 1991-1996. The annual growth rate of output in this industry was impressive for the sub-period 1995-1996. The crisis in 1994 affected this industry negatively. Excluding the year of economic crisis, output grew dramatically. As illustrated in Table 1, the average growth rates of all inputs were lower than those of output.

The average annual growth rate of output was lower for the apparel industry than for the motor vehicle and parts industry from 1991-1996. The highest output growth rates for the apparel industry were attained from 1992-1993. As can be seen from Table 1, all of the inputs, except capital, grew faster than output from 1991-1996. In comparison to the motor vehicle and parts industry, the growth rate of output was slower and the growth rate of inputs was faster.The decline in the market due to the economic crisis in 1994 affected the two industries to different degrees. The decline rate in inputs was much higher than the decline rate in output for the apparel industry while the reverse is true for the motor vehicle and parts industry.

The growth rates of export in the two industries are also given in Table 1. The average annual export growth rate from 1991-1996 in the motor vehicle and parts industry was a remarkable 37.5 percent. The annual export growth rate for the apparel industry was 13.1 percent from 1991-1996. The highest export growth rates in both industries were achieved from 1995-1996.

Total Factor Productivity Growth

Productivity levels and productivity growth are measured with a multilateral index that provides estimates of the relative levels of productivity. The widely used index number approach to the measurement of productivity, without prior estimation of a production function, is the discrete Divisia index known as the Tornqvist-Theil Index. It uses information from the previous time period as a reference. Values of the index are then linked to the first observation allowing for comparisons between the first observation and any subsequent observations (Good, Nadiri, and Sickles, 1996). The use of this index, however, is limited to time series applications. Caves, Christensen, and Diewert (1982b) proposed a multilateral index that is appropriate for cross-sectional data. This index, like the Tornqvist Index, does not impose any prior restrictions on the structure of technology, and does not require any econometric specification. It uses a hypothetical plant with cost shares equal to the arithmetic mean of the revenue shares over all observations, and output and input values that equal the log of the geometric mean of the output and input values over all observations. The productivity for each plant is measured in each time period relative to this hypothetical plant.

This index has been applied by Caves, Christensen, and Trethway (1981) and

Caves, Christensen, and Trethway (1983) to measure productivity in U.S. airlines, and by Aw and Roberts to compare import prices across countries. Although this approach is useful in cross-sectional applications, one needs to recalculate the index if more time periods or more observations are added to the sample.[14] Good (1985) showed that the chaining approach of the Divisia Index can be combined with the hypothetical plant method of Caves, Christensen, and Diewert (1982b). Good, Nadiri, and Sickles (1996) presented this new approach in a framework that constructs different hypothetical plant reference points for each cross-section, and then links the hypothetical plants together over time. We adopted this measure of total factor productivity growth since it combines the features of cross-section and time-series data, making it easier for cross-section comparisons over time.[15]

A total factor productivity measure index for plant f, which produces a single output Y_{ft} using inputs X_{jft} with cost shares S_{jft} , can be calculated as,

$$\begin{aligned} LnTFP_{ft} = {} & (lnY_{ft} - \overline{lnY}_t) + \sum_{k=2}^{t} (\overline{lnY}_k - \overline{lnY}_{k-1}) - [\sum_{j=1}^{n} 1/2(S_{jft} + \overline{S}_{jt})(lnX_{jft} - \overline{lnX}_{jt}) \\ & + \sum_{k=2}^{t} \sum_{j=1}^{n} 1/2(\overline{S}_{jk} + \overline{S}_{jk-1})(\overline{lnX}_{jk} - \overline{lnX}_{jk-1})] \end{aligned} \quad \text{(A.1)}$$

where $\overline{lnY}_t$ and $\overline{lnX}_{jt}$ are the natural log of the geometric mean of output and the natural log of the geometric mean of the inputs (Capital, Energy, Labor Hours, and Material) across all plants in time t, respectively. The first term describes the deviation between the output of plant f and the representative plant's output, $\overline{lnY}_t$ in year t. This term allows comparisons between cross-sections.

The second term sums the change in the hypothetical plant's output across all years, chaining them back to base year. This allows a measure of the change in output of a typical plant over years. The sums in the third and fourth terms provide similar information, however for inputs using revenue shares and arithmetic average revenue shares in each year as weights. The resulting measure is the total factor productivity of plant f in year t relative to the hypothetical plant in the base year. Rearranging equation 1, we obtain the change in TFP from time t to t' for plant f.

$$\begin{aligned}\Delta lnTFP_{ft} = &(lnY_{ft'} - \overline{lnY}_{t'}) - (lnY_{ft} - \overline{lnY}_{t}) - [\sum_{j=1}^{n} 1/2(S_{jft'} + \overline{S}_{jt'})(lnX_{jft'} - \overline{lnX}_{jt'}) \\ &- (S_{jft} + \overline{S}_{jt})(lnX_{jft} - \overline{lnX}_{jt})] + [\sum_{k=t}^{t'} (\overline{lnY}_{k} - \overline{lnY}_{k-1}) \\ &- \sum_{k=t}^{t'} \sum_{j=1}^{n} 1/2(\overline{S}_{jk} + \overline{S}_{jk-1})(\overline{lnX}_{jk} - \overline{lnX}_{jk-1})]\end{aligned} \quad \textbf{(A.2)}$$

We measure productivity for the apparel and motor vehicle and parts industries from 1990-1996 using this index. The base year is 1987.

Productivity growth for the motor vehicle and parts industry fell off after the first Gulf war, then increased indicating an improvement in the plants' productivity. For this industry there were significant productivity changes between the time period of 1992-1993 and the time period of 1995-1996. For the apparel industry, however, the productivity of plants fell from 1995-1996, showing a decline in productivity in this time period. The distribution of productivity growth for both industries illustrates widening differences across plants after 1993. However, the productivity growth differences across plants in the motor vehicle and parts industry is narrower than that of the apparel industry in each time period.

Productivity for the apparel industry improved in 1992-1993 and 1994. This seems to be a result of the fact that the decline in inputs used was much greater than the decline output. For instance, in 1994 the cost of labor decreased by almost 40 percent compared to 1993, while the output did not change nearly as drastically. This is clearly a change that deters the bankruptcy of less efficient plants in the labor-intensive industries. The Gulf War in 1991 affected the apparel industry more than it affected the motor vehicle and parts industry. One interpretation for this is that the importing countries that the Gulf War adversely affected had a higher share in the apparel industry than the motor vehicle industry. After the Gulf War, the apparel industry changed its markets by focusing more on the European Union. The market for the motor vehicle and parts industry has mostly been the European Union in addition to the large domestic market.

Another interesting result that emerges from the data is that the total factor productivity for half of the plants in each industry declined over the years. This is seen in each time period under consideration. The implication of this result is that although some plants in the industry, mostly large-sized, foreign-owned, and export-oriented plants, upgraded their technology, most of the medium- and small-sized plants in these industries suffered from low productivity levels. Weak financial institutions and the resulting high interest rates contributed to this difference. Foreign-owned and large firms had access to sources of finance, but medium and small firms could not obtain the necessary capital to upgrade their technology and skills. Thus, macroeconomic policies that can remove the obstacles for the medium- and small-sized firms have to be put in place to improve the productivity of plants.

Endnotes

---

[1] See Edwards (1993) and Havrylyshyn (1990) for the survey of the literature.

[2] See Tybout(1997) for a review of studies.

[3] See Data Appendix for details of variable construction

[4] We also included the export intensity (the ratio of exports to output of the plant) as an explanatory variable in the regression; however, the results did not change. The export premia was greater for the plants that export a higher proportion of their output.

[5] See Davidson et al. (1978), Banerjee, Galbraith, and Dolado(1990), and Banerjee et al.(1993).

[6] See Banerjee et al. (1993) for more information.

[7] For more information see Banerjee, Galbraith, and Dolado(1990), and Banerjee et al.(1993).

[8] This would be done by the Fixed Effect Model (Within Groups, or Least Squares Dummy Variable, and Between Groups) or by the Random Effect Model, which both assume that explanatory variables are strictly exogenous, an unrealistic assumption in our autogressive model.

[9] Nickel (1981) showed that the bias goes to zero as T goes to infinity and that LSDV results in better parameter estimates when T is large, which is not appropriate in our case since we deal with a short time period.

[10] We assume that the explanatory variable is endogenous, i.e.

$E(x_{ir}\, u_{it}) = 0 \text{ for } r = 1,...,t-1;\ t = 2,......,T$;

and $E(x_{ir}\, u_{it}) \neq 0 \text{ for } r = s,......,T; s = 2,......,T$. The resulting moment conditions, and thus instruments, would be different if one assumes the explanatory variables to be strictly exogenous or weakly exogenous (See Blundell, Bond, and Windmeijer, 2000).

[11] See Arellano and Bond (1991) and Arellano and Bover (1995)

[12] See Schumpeter (1912), Schumpeter (1942), Nelson and Winter (1982), Winter (1982), Dosi et al. (1995), and Klepper (1996).

[13] However, recently the plants in the apparel industry have begun to invest in research and development since the intensive competition amongst the firms in the export market is endogenously motivated by the process of technological change in this industry as well.

[14] See Good, Nadiri, and Sickles (1996) for a presentation of index numbers.

[15] This index has been used to measure productivity by Aw, Chen, and Roberts (1997) and Aw, Chung, and Roberts (1998).