THE EFFECTS OF TRADE AND PRODUCTIVITY ON EMPLOYMENT IN THE MANUFACTURING INDUSTRY OF TURKEY

ABSTRACT

This study empirically analyzes the effects of international trade and productivity on employment in the Turkish manufacturing industry for the period of 2003-2010 by applying panel data method. For this purpose, the direct effects and productivity related indirect effects of international trade on employment are estimated. The findings suggest that the direct effects of export demand and import competition on employment are sound and significant; however, the productivity related indirect effects come solely from import competition. The total effects of international trade on employment is mainly the result of the direct effects of export demand and import penetration. On the other hand, the positive contribution to productivity in the Turkish manufacturing industry comes mainly from investment and research & development expenditures.

Keywords: International Trade, Export Demand, Import Competition, Productivity, Employment, Labour Market, Panel Data Techniques.

JEL Codes: F14, F16.

I. INTRODUCTION

The Turkish economy underwent a serious transformation in the decade of the 1980’s by opening up and directing the output of its existing manufacturing base to foreign markets. A second phase of transformation took place in the 2000’s when, in the face of severe competition from other emerging economies, Turkey integrated further with the world markets by realizing productivity increases and structural change. Turkish export flows consist mainly of manufactures, and foreign demand is a crucial determinant of the demand for manufacturing output. The dynamics of the interactions between export demand, import competition and technological change (productivity increase) in the Turkish manufacturing industry is the topic of the present study.

We investigate the employment effects of trade within the framework of the Heckscher-Ohlin-Samuelson (HOS) theory. There is a positive relationship between an expansion in export demand and the demand for skilled labor. On the other hand, imports have adverse
effects on sectoral employment resulting from increased competition from countries with a relative abundance of cheap and unskilled labour. In addition to the direct employment effects of trade, trade variables influence productivity and therefore indirectly affect employment.

This study uses the framework developed in Abraham and Brock (2003). Abraham and Brock (2003) estimated the direct and productivity related indirect effects of international trade on sectoral employment in 10 industrialized European countries for the period of 1978-1994. They have found significant effects from both international trade directly and productivity indirectly towards sectoral employment in Europe. They conclude that “…evidence is found for the hypothesis that international trade induces adjustments in technology”. (Abraham and Brock, 2003, p.223).

Using data for the 20 sectors of the Turkish manufacturing industry for the period covering 2003 to 2010 and employing panel data techniques, the current study analyzes the direct and indirect effects of international trade on sectoral employment. In the first section of the study, data and econometric methodology used in this study are explained. The second part empirically investigates the relationship between trade and sectoral employment, trade and productivity, and, finally, productivity and sectoral employment in the Turkish manufacturing industry. The final section presents a summary of the empirical analysis and concluding remarks.

II. EMPIRICAL ANALYSIS

EMPIRICAL MODEL AND DATA DESCRIPTION

The effects of international trade and productivity (technology) on the sectoral employment in the manufacturing industry of Turkey is measured for the time period of 2003-2010. For this purpose, two regression equations are estimated:

(1) \[ \ln(EMP_{it}) = \alpha_{i1} + \beta_1 \ln(\text{EXP}_{it}) + \chi_1 \ln(\text{IMP}_{it}) + \eta_1 \ln(\text{WAGE}_{it}) + \lambda_1 \ln(\text{PROD}_{it}) + u_{1it} \]

(2) \[ \ln(\text{PROD}_{it}) = \alpha_{i2} + \beta_2 \ln(\text{EXP}_{it}) + \chi_2 \ln(\text{IMP}_{it}) + \varphi_2 \ln(\text{INV}_{it}) + \delta_2 \ln(\text{RD}_{it}) + \phi_2 \text{PAT}_{it} + u_{2it} \]

While in the first equation, the effects of international trade (export and import) and productivity on sectoral employment are investigated, the second equation estimates the effects of international trade on productivity. This equation also includes investment and research-development expenditures with the relative number of patents given to the sectors in
the manufacturing industry, which show the impact of technological innovations on productivity.

In the equations above,

\[ EMP = \text{the number of persons employed in the sectors of the manufacturing industry (i and t refer respectively to industry and time).} \]

The data for employment include annual average number of employees at work as well as self employed and partners, unpaid family workers and apprentices.

\[ EXP = \text{sectoral real exports which shows the export demand effect.} \]

\[ IMP = \text{import penetration ratio which is defined as real imports divided by the difference between sectoral real production and sectoral real net exports. Import competition is measured by the import penetration.} \]

\[ WAGE = \text{Real wages and salaries paid per person employed in the manufacturing industry.} \]

The data for wage covers total provisions, as cash or in kind, paid all people working during the account period in exchange for the business (including the persons working at home).

\[ PROD = \text{Labour productivity which is measured by the value added at factor cost per person employed in the manufacturing industry.} \]

The data for value added at factor cost show gross income obtained from business activities after the corrections in business subsidies and indirect taxes.

\[ INV^2 = \text{Gross investment expenditures in tangible goods per person employed in the manufacturing industry.} \]

\[ RD = \text{Research and Development Expenditures per person employed in the manufacturing industry.} \]

\[ PAT = \text{The number of relative granted patents given to the sectors in the manufacturing industry.} \]

\[ \text{Abraham and Brock use capital stock per employee in order to measure the effect of labour-saving technologies on employment. Because of the lack of capital stock data for Turkey, the gross investment expenditures in tangible goods per worker in the manufacturing industry are used instead in this study.} \]
Relative granted patents = The number of granted patents in one industry for a certain year relative to the total granted patents in that year.

The data for employment, export, import, labour cost, production, value added and investment are obtained from the Turkish Statistical Institute (TUIK) Databases for Annual Industry And Service Statistics and Foreign Trade Statistics. The data for research and development are from the OECD Stan Database for R&D expenditures in Industry and the data for patent variable come from the Turkish Patent Institute Statistics.

Except for relative granted patents, all variables are expressed in constant prices and in logarithms. The deflators used for all variables, except for foreign trade variables, are sectoral producer price indexes (PPI); export and import variables are deflated by using export and import unit value indexes.

This data set covers 20 sectors in Turkish manufacturing industry which are classified according to the “Statistical Classification of Economic Activities in the European Community” (NACE), Revision 2. The differences between data series on the classification are solved by the aid of correspondence tables of Eurostat and Turkish Statistical Institute.

Because of the difficulties in obtaining data, the study covers the years from 2003 to 2010.

**ECONOMETRIC METHODOLOGY**

The employment and productivity equations (Equation 1 and 2) are estimated by using panel data econometrics. The empirical analysis of the 20 sectors of Turkish manufacturing industry during 2003 to 2010 constitutes 160 observations. Since the number of observations are not

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3The sectors according to the NACE Rev.2 classification are: Manufacture of food products and beverages (10+11), Manufacture of tobacco products (12), Manufacture of textiles (13), Manufacture of wearing apparel (14), Manufacture of leather and related products (15), Manufacture of wood and of products of wood and cork, except furniture (16), Manufacture of paper and paper products (17), Printing and reproduction of recorded media (18), Manufacture of coke and refined petroleum products (19), Manufacture of chemicals, chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations (20+21), Manufacture of rubber and plastic products (22), Manufacture of other non-metallic mineral products (23), Manufacture of basic metals (24), Manufacture of fabricated metal products, except machinery and equipment (25), Manufacture of computer, electronic and optical products (26), Manufacture of electrical equipment (27), Manufacture of machinery and equipment n.e.c (28), Manufacture of motor vehicles, trailers and semi-trailers (29), Manufacture of other transport equipment (30), Manufacture of furniture and Other manufacturing (31+32).
sufficient for applying stationarity tests, unit root tests are not performed\(^4\). Although we do not perform unit root tests for only 8 annual observations, regression are run in levels as well as in first differences in order to check the robustness of the findings.

In this model, employment (or labour demand) is explained by export demand, import penetration, wage per person employed and productivity that is measured by value added per person employed (Equation 1). Employment equation estimates the direct impact of export demand ($\beta_1$) and import competition ($\chi_1$) on the sectoral employment in Turkish Manufacturing industry. This regression equation also estimates the effect of productivity ($\lambda_1$) on employment which is one aspect of the productivity effect of international trade on employment.

On the other hand, productivity is explained by export demand, import penetration, investment expenditures per person employed, research&development expenditures per person employed and relative granted patents (Equation 2). The important point here is the impact of trade integration on productivity which is the other aspect of the productivity effect of international trade on employment. The coefficients for the export ($\beta_2$) and import ($\chi_2$) that shows the impact of trade integration on productivity can be positive or negative. If the companies faced with international competition improve productivity successfully, this impact becomes positive whereas it can be negative if they prefer to struggle with internal structuring instead (Abraham and Brock, 2003, p.226).

The other variables in the productivity equation are for measuring the effect of the changes in investment expenditures that affects capital stock finally, of new technologies and innovations on productivity. Whether companies adopt labour-saving or labour-augmenting technologies as a result of international trade is important for the sign of productivity parameter in the employment equation. If $\lambda_1$ parameter is positive, increases in productivity are labour-augmenting; when $\lambda_1$ is negative, increases in productivity are labour-saving.

\(^{4}\)According to the theory on the unit root tests in panel data (Baltagi, 2005; Breitung, 2000; Hadri, 2000; Im, Pesaran and Shin, 2003 ; Levin, Lin and Chu, 2002), the minimum observation number should be 20 to get robust results from these tests.
The equations above show that the productivity equation does not contain any endogenous variables from the labour demand equation, while this latter equation contains endogenous variables coming from the former equation. More specifically, the productivity that is an exogenous explanatory variable in the employment equation, is explained by a set of exogenous explanatory variables in the second equation. Following Abraham and Brock, a two stage least squares approach is used in order to capture in the employment equation only the productivity changes that are explained by export demand, import penetration and technology variables (Abraham and Brock, 2003, p.227).

For this purpose, the fitted values of the productivity variable obtained by the estimation of Equation 2 are substituted into Equation 1. But before estimating these equations, various econometric tests are applied to determine first - whether individual and time effects exist and second - fixed or random effect approach is appropriate for these two equations (Baltagi, 2005; Hill, Griffiths and Guay, 2011; Greene, 2003; Tatoğlu, 2012). After F, Likelihood-ratio, Breusch-Pagan Lagrange Multiplier and Adjusted Lagrange Multiplier Tests are applied, both individual and time effects are identified for the productivity equation. As a result of Hausman test, fixed effects approach is found to be more appropriate than random effects approach.

Then, productivity equation is estimated by Least Squares and the fitted values of productivity variable (dependent variable of this equation) are determined. These fitted values are substituted into the employment equation. Before estimating this equation, the same tests determining individual-time effects and fixed-random effects are applied. Fixed individual effects approach is decided for employment equation.5

After productivity equation and employment equation with the fitted values of the productivity variable are estimated separately, the necessary tests are run to detect heteroscedasticity, otoocorrelation and crosssection correlation for each equation and remedial measures are taken.

For both tests and estimations, STATA and E-Views Programmes are used and the estimation results are checked mutually.

5However, the estimation of the regression equations in first differences show that pooled model and random model with individual effects are more suitable for productivity and employment equations respectively (See Tables 2 and 4).
III. ESTIMATION RESULTS

TRADE AND EMPLOYMENT

\begin{equation}
(1) \ln(\text{EMP}_it) = a_{i1} + \beta_1\ln(\text{EXP}_it) + \chi_1\ln(\text{IMP}_it) + \eta_1\ln(\text{WAGE}_it) + \lambda_1\ln(\text{PROD}_it) + u_{1i}
\end{equation}

The first topic of this paper is the relationship between international trade and sectoral employment in the manufacturing industry of Turkey. Tables 1-2 show the estimated results of this relationship, which is expressed by Equation 1. The employment equation is estimated in both levels and first differences of variables.

The estimated results in these tables for the export demand, import penetration and labour cost are significant and have the theoretically expected signs. The regression coefficients for export demand ($\beta_1$), import penetration ($\chi_1$) and labour cost ($\eta_1$) are 0.23, -0.33 and -0.17 respectively, when they are estimated in levels; the same coefficients are 0.24, -0.41 and -0.14 respectively, when the estimation is made in first differences (Table 1 and 2). While export demand affects sectoral employment in the manufacturing industry of Turkey positively, import competition makes a negative affect on it. The negative sign before labour cost variable, which is measured by the wage paid per person employed in this study, shows the negative relationship between labour demand and wages.

According to these findings, as 1% increase in export demand causes sectoral employment to increase by 0.23 %, the same amount of increase in import competition causes a 0.33 % decrease in sectoral employment (Table 1).

The productivity variable in the employment equation is obtained from the second equation; after this equation is estimated, employment equation (Equation 1) is estimated where the productivity variable is instrumented by using the fitted values in levels or in first differences from the productivity regression. This variable shows the response of employment to productivity changes. The impact of productivity on employment is one aspect of the productivity effect of international trade on employment.

However, the estimation results show that productivity variable does not make a significant effect on employment in Turkish manufacturing industry. Whether it is estimated in levels or in first differences, the coefficient before productivity is very small and also insignificant. This result suggests that productivity variable, which is measured by value added per person
employed in this study, does not make a statistically significant effect on sectoral employment.

Table 1. The Regression Results of the Employment Equation, Estimated in levels

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>7.011737***</td>
<td>1.914809</td>
<td>3.66</td>
<td>0.0004</td>
</tr>
<tr>
<td>ln (EXP)</td>
<td>0.229402**</td>
<td>0.093363</td>
<td>2.46</td>
<td>0.0153</td>
</tr>
<tr>
<td>ln (IMP)</td>
<td>-0.331372***</td>
<td>0.098328</td>
<td>-3.37</td>
<td>0.0010</td>
</tr>
<tr>
<td>ln (WAGE)</td>
<td>-0.166797*</td>
<td>0.088822</td>
<td>-1.88</td>
<td>0.0625</td>
</tr>
<tr>
<td>ln (PROD)</td>
<td>0.046589</td>
<td>0.124134</td>
<td>0.38</td>
<td>0.7080</td>
</tr>
</tbody>
</table>

\[
(1) \ln(EMP_{it}) = \alpha_{it} + \beta_1 \ln(EXP_{it}) + \chi_1 \ln(IMP_{it}) + \eta_1 \ln(WAGE_{it}) + \nu_1 \ln(PROD_{it}) + u_{1t}
\]

Cross-section fixed (dummy variables)
Sample: 2003 2010
Periods included: 8
Cross-sections included: 20
Total panel (balanced) observations: 160
White cross-section standard errors & covariance (d.f. corrected)

\[
R^2: 0.98 \\
\text{Adj. } R^2: 0.97
\]

Note: *** Significance at the 1 % level; ** Significance at the 5 % level;
* Significance at the 10 % level.
Table 2. The Regression Results of the Employment Equation, Estimated in First Differences

\[ \ln (\text{EMP}_{it}) = \alpha_i + \beta_1 \ln (\text{EXP}_{it}) + \chi_1 \ln (\text{IMP}_{it}) + \eta_1 \ln (\text{WAGE}_{it}) + \lambda_1 \ln (\text{PROD}_{it}) + u_{1it} \]

Method: Panel EGLS (Cross-section random effects)
Sample (adjusted): 2004 2010
Periods included: 7
Cross-sections included: 18
Total panel (unbalanced) observations: 122
White cross-section standard errors & covariance (d.f. corrected)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.027141</td>
<td>0.033217</td>
<td>0.82</td>
<td>0.4155</td>
</tr>
<tr>
<td>\ln (\text{EXP})</td>
<td>0.236297*</td>
<td>0.141504</td>
<td>1.67</td>
<td>0.0976</td>
</tr>
<tr>
<td>\ln (\text{IMP})</td>
<td>-0.414081**</td>
<td>0.155099</td>
<td>-2.67</td>
<td>0.0087</td>
</tr>
<tr>
<td>\ln (\text{WAGE})</td>
<td>-0.140862**</td>
<td>0.053668</td>
<td>-2.62</td>
<td>0.0098</td>
</tr>
<tr>
<td>\ln (\text{PROD})</td>
<td>0.002871</td>
<td>0.005420</td>
<td>0.53</td>
<td>0.5973</td>
</tr>
</tbody>
</table>

\[ R^2 : 0.17 \]
\[ \text{Adj. } R^2 : 0.14 \]

Note: ** Significance at the 5% level; *Significance at the 10% level.
TRADE AND PRODUCTIVITY

(2) $\ln(\text{PROD}_i) = \alpha_i + \beta_2 \ln(\text{EXP}_i) + \chi_2 \ln(\text{IMP}_i) + \delta_2 \ln(\text{RD}_i) + \phi_2 \text{PAT}_i + \varphi_2 \ln(\text{INV}_i) + u_{2it}$

While the impact of productivity on employment is one aspect of the productivity effect of international trade on employment, the other aspect of this effect concerns the impact of trade integration on productivity. Therefore, a second equation is introduced where productivity is regressed on trade and other variables.

In the analysis of these effects, one important point is related to the impact of exports and imports on productivity. This impact can be positive or negative depending on the behaviour of companies facing with international competition about improving productivity successfully instead of struggling with internal restructuring (Abraham and Brock, 2003, s.226).

The regression results of the productivity equation (Equation 2) are given in Tables 3-4. One unexpected result is about the relationship between exports and productivity: This result displays that export demand is not a statistically significant source of productivity in the manufacturing industry of Turkey. When using the estimation results in either levels or in first differences, the regression coefficients for export demand variable ($\beta_2$) are always statistically insignificant. This result implies that the increases in export demand do not make a positive contribution to labour productivity (value added per person employed) in Turkish manufacturing industry.

On the other hand, the productivity effect of import penetration is very strong and statistically significant. When the regression is estimated in levels and in first differences, the coefficients for import penetration ($\chi_2$) are -1.19 and -1.74, respectively (Table 3 and 4). The large and negative coefficients before import competition variable suggests that increased import competition causes a loss in productivity in Turkey’s manufacturing industry. This supports the view that restructuring is a difficult process in Turkey as well as in Europe: Companies going through rising foreign competition that reduces their sales are unable to scale down their factor use at the same rate (Abraham and Brock, 2003, s.229).
As Lawrence (2000)\textsuperscript{6} and Bernard and Jensen (1999 and 2001)\textsuperscript{7} point out, the relationship between international trade and productivity can work in both directions. On the one hand, import and export competition can lead to higher productivity, sectors confronted with growing productivity may tend to have high levels of exports on the other. In order to solve this problem, Granger causality tests are run between trade and productivity variables. These tests say that there is a mutual relationship between import penetration and productivity in Turkish manufacturing industry. However, it is not found a statistically significant relationship between export demand and productivity. These findings support the estimations of the productivity equation.

As to the other independent variables in the productivity equation, research-development and investment expenditures per worker have always positive impact on the productivity of Turkish manufacturing industry. Whether it is estimated in levels or in first differences, the coefficients for these variables are statistically significant. The last independent variable in this equation, which shows the relative numbers of patents given to the sectors, has an unexpected sign although it is significant at 10\% level if first differences are used. Actually, patent variable does not seem to make a sound effect on Turkish manufacturing industry.

In order to check the robustness of the results of Equation 2, the lagged values of trade and other variables are used. This clearly leads to lower significance of the trade and research development variables in the productivity equation with high standard errors.

\textsuperscript{6}Lawrence (2000) works on the impact of international competition on technological change as reflected in changes in total factor productivity and the skill ratio in U.S. manufacturing during the period 1978-89. Lawrence finds out that import competition has a positive impact on US total factor productivity. This effect is mainly present in skill-intensive sectors and industries competing with developing countries. Additionally, Lawrence explicitly computes the employment effects of trade-related productivity changes. For Lawrence, international competition and technological change are not independent sources of change; actually, causation runs in both directions. Changes in technology and international competition can mutually affect each other. Ignoring these interactions could be seriously misleading.

\textsuperscript{7}Bernard and Jensen (1999, 2001) examines the relationship between export and productivity growth in U.S. manufacturing and can not find any evidence for a positive impact of exports on productivity. According to their findings, the causality between these two variables work in the other direction: more productive firms become better exporters but there is no evidence that exporting increases the productivity growth rates of firms.
In the light of these estimations, it is possible to conclude that the main contributors of productivity in the manufacturing industry of Turkey are new investments and new technologies realized in the related sectors.

Table 3. The Regression Results of the Productivity Equation, Estimated in Levels

(2) \( \ln(\text{PROD}_i) = \alpha_{i2} + \beta_2 \ln(\text{EXP}_i) + \gamma_2 \ln(\text{IMP}_i) + \delta_2 \ln(\text{INV})_i + \phi_2 \ln(\text{RD})_i + \varphi_2 \text{PAT}_i + u_{2i} \)

Cross-section fixed (dummy variables)  
Period fixed (dummy variables)

Sample: 2003 2010  
Periods included: 8  
Cross-sections included: 20  
Total panel (balanced) observations: 160  
White period standard errors & covariance (d.f. corrected)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3.695001</td>
<td>4.595005</td>
<td>0.80</td>
<td>0.4228</td>
</tr>
<tr>
<td>\ln(\text{EXP})</td>
<td>0.072647</td>
<td>0.206347</td>
<td>0.35</td>
<td>0.7254</td>
</tr>
<tr>
<td>\ln(\text{IMP})</td>
<td>-1.188928***</td>
<td>0.346695</td>
<td>-3.43</td>
<td>0.0008</td>
</tr>
<tr>
<td>\ln(\text{INV})</td>
<td>0.323002***</td>
<td>0.118633</td>
<td>2.72</td>
<td>0.0074</td>
</tr>
<tr>
<td>\ln(\text{RD})</td>
<td>0.115033***</td>
<td>0.038448</td>
<td>2.99</td>
<td>0.0033</td>
</tr>
<tr>
<td>PAT</td>
<td>-3.393358</td>
<td>3.325149</td>
<td>-1.02</td>
<td>0.3094</td>
</tr>
</tbody>
</table>

\( R^2 : 0.94 \)  
Adj. \( R^2 : 0.93 \)

Note: *** Significance at the 1 % level.
Table 4. The Regression Results of the Productivity Equation, Estimated in First Differences

\[ \ln(\text{PROD}_n) = \alpha_n + \beta_2 \ln (\text{EXP}_n) + \chi_2 \ln (\text{IMP}_n) + \phi_2 \ln (\text{INV})_n + \delta_2 \ln (\text{RD}_n) + \phi_2 \text{PAT}_n + u_{2n} \]

Pooled regression
Sample (adjusted): 2004-2010
Periods included: 7
Cross-sections included: 20
Total panel (balanced) observations: 140
White diagonal standard errors & covariance (d.f. corrected)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Robust Std. Error</th>
<th>t-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.008210</td>
<td>0.029494</td>
<td>-0.28</td>
<td>0.7812</td>
</tr>
<tr>
<td>ln (EXP)</td>
<td>-0.018372</td>
<td>0.165988</td>
<td>-0.11</td>
<td>0.9120</td>
</tr>
<tr>
<td>ln (IMP)</td>
<td>-1.738927***</td>
<td>0.234812</td>
<td>-7.41</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln (INV)</td>
<td>0.203923***</td>
<td>0.061326</td>
<td>3.33</td>
<td>0.0011</td>
</tr>
<tr>
<td>ln (RRD)</td>
<td>0.138416***</td>
<td>0.031715</td>
<td>4.36</td>
<td>0.0000</td>
</tr>
<tr>
<td>PAT</td>
<td>-7.064506*</td>
<td>3.961544</td>
<td>-1.78</td>
<td>0.0768</td>
</tr>
</tbody>
</table>

\[ R^2 : 0.91 \]
\[ \text{Adj. } R^2 : 0.91 \]

Note: *** Significance at the 1 % level; * Significance at the 10 % level.
PRODUCTIVITY RELATED AND TOTAL EFFECTS OF INTERNATIONAL TRADE ON EMPLOYMENT

Combining two aspects of this model produces the productivity effects of international trade on employment. When we substitute productivity equation into employment equation:

\[
(3) \ln(EMP_{it}) = \alpha_i + \beta \ln(EXP_{it}) + \chi \ln(IMP_{it}) + \eta \ln(WAGE_{it}) + \delta \ln(RD_{it}) + \phi \ln(PAT_{it}) + \varphi \ln(INV_{it}) + u_{it} \\
\]

\[
\alpha_i = \alpha_{i1} + \lambda_1 \alpha_{i2}, \quad \beta = \beta_1 + \lambda_1 \beta_2, \quad \chi = \chi_1 + \lambda_1 \chi_2, \quad \eta = \eta_1, \quad \delta = \lambda_1 \delta_2, \quad \phi = \lambda_1 \phi_2, \\
\varphi = \lambda_1 \varphi_2 \quad \text{and} \quad u_{it} = u_{i1t} + u_{i2t}. \\
\]

This equation produces the productivity effect of international trade on employment by combining the effect of productivity (\(\lambda_{i1}\)) on employment with the effect of trade integration on productivity.

In this equation, the total impact of export demand on employment is measured by the \(\beta\) coefficient which is the sum of the direct effect of export demand on employment (\(\beta_1\)) and the effect of an increase in export demand on employment that occurs via an increase in productivity (\(\lambda_1 \beta_2\)). Similarly, \(\chi\) refers to the total impact of import competition on employment and consists of the direct (\(\chi_1\)) and the productivity induced effects (\(\lambda_1 \chi_2\)) of import competition on sectoral employment.

The estimation results of Equation 3 are summarized in Table 5. Actually, the estimations here are the combination of the results exhibited in Table 1 and Table 3 since the Equation 3 is the substitution of Equation 2 into Equation 1. Both trade variables and technology variables are similar in terms of their sign, size and statistic significance.
Table 5. The Regression Results of the Employment Equation (Equation 3), Estimated in Levels

\[(3) \ln(EMP_{it}) = \alpha_i + \beta \ln( EXP_{it}) + \gamma \ln( IMP_{it}) + \eta \ln( WAGE_{it}) + \phi \ln( INV_{it}) + \delta \ln( RD_{it}) + \psi \ln( PAT_{it}) + u_{it} \]

Sample: 2003 2010  
Periods included: 8  
Cross-sections included: 20  
Total panel (balanced) observations: 160  
White cross-section standard errors & covariance (d.f. corrected)

<table>
<thead>
<tr>
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<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>8.299487***</td>
<td>1.779796</td>
<td>4.66</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln (EXP)</td>
<td>0.196992***</td>
<td>0.070397</td>
<td>2.80</td>
<td>0.0059</td>
</tr>
<tr>
<td>ln (IMP)</td>
<td>-0.447188***</td>
<td>0.100033</td>
<td>-4.47</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln (WAGE)</td>
<td>-0.295650***</td>
<td>0.068559</td>
<td>-4.31</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln (CAP)</td>
<td>0.066153***</td>
<td>0.013113</td>
<td>5.04</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln (RRD)</td>
<td>0.055108***</td>
<td>0.022251</td>
<td>2.48</td>
<td>0.0145</td>
</tr>
<tr>
<td>ln (PAT)</td>
<td>1.171610</td>
<td>1.212098</td>
<td>0.97</td>
<td>0.3355</td>
</tr>
</tbody>
</table>

\[R^2: 0.98\]  
\[Adj. R^2: 0.98\]

Note: *** Significance at the 1 % level.
In the Tables 6 and 7 below, direct and productivity-related employment effects of export demand and import competition are calculated for the level and first difference estimations by the aid of the parameter coefficients produced by employment and productivity equations. The first columns in the tables come from Tables 1 and 2, which show the estimated values for export demand ($\beta_1$) and import competition ($\chi_1$) in the employment equation. The second columns show the elasticities that measure the productivity effect of exports and import competition on employment; these values are computed from the parameter values for productivity variable ($\lambda_1$) in the employment equation (Tables 1 and 2) and from the parameter values for export demand ($\beta_2$) and import competition ($\chi_2$) variables in the productivity equation (Tables 3 and 4). Finally, the last columns in the tables show the total elasticities of export demand and import competition on employment, which are calculated by summing up the figures in the previous two columns.

Since there is not a significant relationship between export demand and productivity in the Turkish manufacturing industry according to our estimations, productivity related effects of exports on employment are ignorable. Actually, total effect in the table below is mainly the result of the direct effect of export demand on employment, which is positive and statistically significant (Table 6).

Table 7 below gives the direct and indirect effects of import competition on employment. The productivity related effect of import penetration is statistically significant and negative. As the productivity related effect is not estimated directly, statistical significance can not be calculated and reported. Although the robustness of this estimation is open to discussion, it is possible to conclude that increasing import competition results in decreasing jobs in the manufacturing industry of Turkey when we take into consideration the direct employment and productivity effects of import competition ($\chi_1$ and $\chi_2$ parameters).

The coefficient values displaying the total effects of export and import calculated by using the estimated coefficients of Equation 1 and 2 are in harmony with those estimated by Equation 3.

The calculated coefficient for export in Table 6 is 0.2328 whereas the estimated value for it in Table 5 is 0.1960. The calculated coefficient for import is -0.3868 in Table 7 but the estimated value for it in Table 5 is -0.4472. The results are rather close.
### Table 6. The Productivity And Total Effects of Exports on Employment

<table>
<thead>
<tr>
<th>Levels</th>
<th>$\beta = \beta_1 + \lambda_1 \beta_2$</th>
<th>First Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export Demand Effect $\beta_1$</td>
<td>Productivity-Related Effect $\lambda_1 \beta$</td>
<td>Total Effect $\beta$</td>
</tr>
<tr>
<td>0.2294</td>
<td>0.0034</td>
<td>0.2328</td>
</tr>
</tbody>
</table>

Source: Tables 1, 2, 3, 4.

### Table 7. The Productivity And Total Effects of Import Competition on Employment

<table>
<thead>
<tr>
<th>Levels</th>
<th>$\chi = \chi_1 + \lambda_1 \chi_2$</th>
<th>First Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import Competition Effect $\chi_1$</td>
<td>Productivity-Related Effect $\lambda_1 \chi$</td>
<td>Total Effect $\chi$</td>
</tr>
<tr>
<td>-0.3314</td>
<td>-0.0554</td>
<td>-0.3868</td>
</tr>
</tbody>
</table>

Source: Tables 1, 2, 3, 4.
IV. CONCLUSION

This paper investigates the sectoral employment effects of international trade and productivity in the manufacturing industry of Turkey. There are several important conclusions of this study:

First of all, international trade is effective on sectoral employment in Turkish manufacturing industry. Our empirical results show that both export demand and import penetration have a significant impact on sectoral employment in Turkey. While the increase in export demand leads to an increase in labour demand, the increase in import penetration reduces it.

Secondly, the relationship between productivity and international trade does not make any contribution to sectoral employment. Our findings suggest that export demand is not a determinant of productivity, but import competition and productivity are related. The strong negative relationship between import competition and productivity, measured by value added per worker, suggests that firms, when faced with international competition, cannot adjust the level of employment to decreased demand. This result is similar to the findings of Abraham and Brock who explain it by the rigid labour markets in Europe constrained by strict hiring and firing conditions (Abraham and Brock, s.232).

Third, the main determinants of productivity in the Turkish manufacturing industry are investment and research&development expenditures. The productivity equation shows that these variables are always positive and statistically significant.

Fourth, the findings suggest that there is not a statistically significant relationship between productivity and sectoral employment in the Turkish manufacturing industry. The effect of productivity on employment comes from import demand and this relationship is negative. However, when we combine the direct effects of trade on employment and productivity, total productivity effect on employment does not seem to be significant.
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