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DERGİSİ**

Determinants of Intra-Industry Trade in Final Goods and Intermediate Goods between Turkey and Selected OECD Countries

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Absract:

The increased importance of fragmentation in world trade has created an interest among trade economists to explain the determinants of trade in intermediate goods. A significant portion of trade in intermediates between Turkey and OECD countries takes the form of intra-industry (IIT). Country-specific and industry-specific hypotheses drawn from the IIT literature are put forward to investigate the IIT in final and intermediates between Turkey and other selected OECD countries for the period of 1985-2000. To test these hypotheses, we have utilized three-way fixed effects and random effects models. The results indicate that the determinants of IIT for final goods are not much different from those for intermediate goods. Finally, the results suggest that country-specific rather than industry-specific variables are the central determinants of IIT in final and intermediate goods between Turkey and OECD.

Keywords : Fragmentation, Outsourcing, Final Goods, Intermediate Goods, Intra-Industry Trade, Panel Econometrics, OECD, Turkey

Özet:

Üretimin farklı ülkelerde gerçekleştirilmesi nedeniyle uluslar arası ara malları ticareti ekonomistler arasında bu ticaretin belirleyicilerini açıklama konusunda bir ilgi uyandırmıştır. Türkiye ile OECD ülkeleri arasında yapılan ticaretin önemli bir kısmı ara mallarında gerçekleşen endüstri-içi ticaret oluşturmaktadır. Bu çalışmada endüstri-içi ticaret literatüründeki ülkeye özgü ve endüstriye özgü hipotezler kullanılarak 1985-2000 döneminde Türkiye ve seçilmiş OECD ülkeleri arasındaki ara ve nihai mal ticareti açıklanmaya çalışılmıştır. Bu hipotezleri test etmek için Fixed Effects ve Random Effects modelleri kullanılmıştır. Ampirik sonuçlar ara mal ve nihai mal ticaretinin belirleyicileri arasında bir fark bulunmadığını göstermektedir. Ayrıca, sonuçlar Türkiye ve OECD ülkeleri arasında ara ve nihai mallarda gerçekleşen endüstri-içi ticareti açıklamasında ülkeye özgü hipotezlerin endüstriye özgü hipotezlerin açıklanmasında daha başarılı olduğunu önermektedir.

Anahtar Kelimeler: Parçalama, Dış Kaynak Kullanımı, Nihai Mallar, Ara Mallar, Endüstri-içi Ticaret, Panel Ekonometrisi, OECD, Türkiye

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1. Introduction

A distinctive feature of present economic globalization is fragmentation of production, or outsourcing. Fragmentation occurs when the production of a final good requires multiple stages. As the world markets have become increasingly integrated in the last few decades due to developments in transportation and communication technologies, fragmentation of production occurs not only across regions within a country but also across countries. Empirical evidence indicates that fragmentation of production ultimately led to a surge in intermediate goods trade (for example Feenstra and Hanson (1998), Hummels et al. (1998), and Yeats (2001)). Despite the fact that these studies used different data sources and methods to measure the degree of fragmentation, three important facts emerge. First, the level of production sharing across countries has increased. Second, the degree of fragmentation varies significantly across countries and industries. Finally, a considerable amount of trade in intermediate goods between advanced nations is intra-industry trade.

Intra-industry trade (IIT) is defined as the simultaneous export and import of products in the same statistical product category. Since the early 1980s, numerous studies have attempted to identify the determinants of IIT. These studies can be divided into two groups: country-specific studies and industry-specific studies. The country-specific studies explain IIT through the macroeconomic variables in each country, such as per capita income, country size, distance, and trade orientation (for example Stone and Lee (1995) and Hummels and Levinsohn (1993)). Industry-specific studies explain an industry's IIT as a function of industry-specific variables, such as scale variables, advertising/sales ratio, product differentiation, and firm concentration ratio (for example Greenaway et al. (1995)). Other studies have attempted to combine both country and industry variables to identify determinants of IIT (for example Clark and Stanley (1999), Greenaway et al. (1999).

A typical final good consists of many intermediate goods. The traditional and new trade models, however, ignore the possibility of trade in intermediate goods. Evidence suggests that a considerable amount of trade in intermediate goods is two-way trade. However, few theoretical and empirical studies have been carried out to analyze the determinants of IIT in intermediate goods.

There are two possibilities that lead to the two-way exchange in intermediate goods: vertical specialization and an exchange of horizontally differentiated intermediate goods. Vertical specialization involves the exchange of technologically linked intermediates. Vertical IIT in intermediate goods is consistent with the traditional trade theories. Firms engage in trade in intermediate goods since each component production requires different factor intensities and thereby firms are expected to exploit the factor cost differences across countries. A number of studies, such as Sanyal (1983), Hummels et al. (1998), and Deardoff (1998), have employed the Ricardian model to explain the pattern of vertical specialization in intermediates. On the other hand, Feenstra and Hanson (1997), Arndt (1997), Deardoff (1998), and Jones and Kierzkowski (2001), use the Heckscher-Ohlin model to explain the effects of fragmentation on the pattern of specialization and especially on factor returns.

There is also horizontal IIT in intermediate goods. Countries may export and import technologically unrelated differentiated intermediate goods because of product differentiation and increasing returns to scale, and love of input varieties. Ethier(1982) and later by Luthje (2000) have developed a model of intra-industry trade in horizontally differentiated intermediate goods. Like consumers, Ethier (1982) argues that firms also benefit from an increasing number of varieties of intermediates.

To the best of our knowledge, with the exception of Kol and Rayment (1989) and Schüler (1995), intermediate goods trade is often neglected in empirical studies of IIT in intermediate goods. In addition to the increasing importance of IIT in intermediate goods, there are very few studies focusing on Turkey's IIT pattern. Schüler (1995), Gönel (2001), Kösekahyaoğlu (2002), and Erlat and Erlat (2003) provide the measurements of Turkey's IIT levels. Of these studies, only Schüler (1995) considers Turkey's IIT in intermediate goods, but he only measures IIT levels in terms of end use of the traded goods (intermediate goods, final goods, and capital goods). None of these studies, however, explicitly identify the determinants of Turkey's IIT in intermediate goods.

The goal of this study is then two fold. The first one is to measure the empirical significance of bilateral IIT in final and intermediate goods between Turkey and other selected OECD countries. The second one is to analyze the determinants of IIT in final and intermediate goods. Hypothesis drawn from IIT literature will be tested using panel data techniques for Turkey's intermediate goods trade with 9 OECD countries over the period of 1985-2000. Following discussion made by Greenaway et al. (1999), this study will consider both country and industry-specific variables to test whether the determinants of IIT in final goods and intermediate goods differ.

The rest of the paper is organized as follows. Section 2 presents the hypotheses and the data used to explain intra-industry trade in intermediates. Section 3 describes the empirical framework whereas Section 4 presents the econometric results. The final section summarizes the results and concludes the discussion.

2. Determinants of Intra-Industry Trade

Following Clark and Stanley (1999) and Greenaway et al. (1999), the analysis in this section considers both country-specific and industry-specific variables to investigate the determinants of IIT in final goods and intermediate goods for Turkey's trade with OECD (9).

3.1 Country-Specific Variables

The share of IIT in final and intermediate goods is expected to be positively related the average market size of the two countries (in terms of total income). Helpman and Krugman (1985) argue that the share of IIT in manufactured goods trade tends to increase as the average market size of the two countries increases due to the presence of economies of scale. Similarly, Ethier (1982) show that, component producers with free trade will be able to utilize increasing returns to scale, and thereby increase the number and production of intermediate goods. A country with a small domestic market has limited opportunities to take advantage of economies of scale in the production of differentiated intermediate goods. Thus, the larger the international market the larger the opportunities for production of differentiated intermediate goods and the larger the opportunities for trade in intermediate goods. Thus, it is expected that average market size of home country h and its partner country f, denoted as $AGDP_{hft}$, will have a positive effect on IIT in final and intermediate goods between two economies.

The share of IIT in final goods is expected to vary negatively with the bilateral inequality in per capita GDP ($DPCGDP_{hft}$) between two countries, while the sign for IIT in intermediate goods is ambiguous. Linder (1961) and other studies use per capita income differences as proxies for consumer tastes and preferences. It has been argued that as per capita incomes of two countries become equal, their tastes and preferences also become similar. Hence, the share of IIT rises as the difference in per capita declines. Alternatively, Helpman and Krugman (1985) consider differences in per capita as differences in the capital-labor ratio. Thus, there is an expected negative relationship between bilateral inequality in per capita GDP and the share of IIT in final goods. Turning now to the intermediate goods, Ethier (1982) predicts that as differences in factor endowments escalate, the IIT in intermediate goods declines. On the other hand, Feenstra and Hanson (1997) predict that IIT in intermediate goods is more likely to take place between countries with dissimilar factor endowments. Thus, IIT in intermediate goods will tend to increase with greater dissimilarities in per capita GDPs between home and foreign country. As a result, there is no clear consensus among economists on the sign of bilateral inequality in per capita GDPs on the IIT in intermediate goods.

We also include human capital into our analysis to determine the relationship between intra-industry trade patterns and factor endowments. As discussed in Helpman and Krugman (1985), IIT will be negatively related to differences in factor endowments. Similarly, in Ethier (1982), differences in factor endowments reduce the extent of IIT in intermediate goods. Highly skilled laborers, mainly R&D personnel, are necessary ingredients to increase the number of intermediate varieties. If the difference in human capital endowments between countries is large, then it is expected a negative sign on IIT in intermediates. Conversely, Feenstra and Hanson's (1997) model of outsourcing shows that an increase in the ratio of the relative supply of skilled labor in the home country to the foreign country will increase vertical specialization from the home country to the foreign country. Thus, the level of IIT is expected to be larger when the differences in human capital endowments between two countries are large. It is difficult to construct a useful measure of skilled labor endowment. Yet it is well recorded that a higher education attainment increases the skill levels of workers. Following Greenaway and Torstensson (1997), we have used education data as a proxy for human capital endowment, obtained from OECD Education at Glance. This data set provides the share of population or labor force aged between 25 and 64 for whom the highest level of education falls into four main categories: below secondary education, upper-secondary education, non-university tertiary education, and university-level education. The sum of the shares of non-university tertiary education and university-level education gives the skilled labor force while the sum of the shares of below secondary education and upper-secondary education provides the share of unskilled labor force for each country. We thus use the absolute differences in the relative ratio of skilled labor/unskilled labor between the home country and the foreign country as a proxy in the estimations, denoted as $DHCAP_{hft}$. Thus, the expected sign of the bilateral inequality in human capital endowments between two economies on IIT in intermediates are somewhat ambiguous while on IIT in final goods is negative.

Balassa (1986) argues that IIT will tend to be greater when trading partners are geographically close. Distance will increase the transaction costs including insurance and transportation costs. Considering trade in intermediate goods, we may interpret distance as direct measure of the costs involved in spreading a production process across countries. For instance, small changes in transportation costs have a major effect on fragmentation decisions since these costs are a significant fraction of total costs if the intermediate goods cross multiple borders. Thus, the decision to fragment production depends on a tradeoff between its extra transportation costs and the cost saving that can be achieved by outsourcing some of the production stages into countries where factor prices are cheaper. We should then find a higher propensity to outsourcing to neighbouring countries. Thus, IIT in final and intermediate goods also should be negatively correlated with the distance between Turkey and its trading partner. Following Balassa (1986), the geographical distance variable is defined as the weighted distance between Turkey and its partner country f. The weight is the ratio of the GDP of its trading partner f to the sum of the GDPs of Turkey's all trading partners. The distance, denoted as $DIST_{hf}$, is the direct distance in kilometers between Turkey's capital and its trading partners' capital.

The data on GDP and per capita GDP for Turkey and 9 OECD countries in 1995 constant $US is obtained from the OECD Statistical Compendium CD-ROM. Education data is obtained from OECD Education at Glance. Distance is in kilometers and the geographical distance data between Turkey and its trading partners is taken from John Haveman's web page.[1]

3.2 Industry-Specific Variables

A variety of industry-specific variables are also expected to influence the degree of IIT in Turkey's trade with OECD (9). According to Helpman and Krugman (1985), the share of IIT in manufactured goods is expected to be positively related to product differentiation. Similarly, Ethier's (1982) model predicts that an increase in the number of firms will result in an increase in the number of components since each firm produces only one variety in equilibrium. Therefore, the share of IIT in intermediates will tend to grow as the average number of firms in the economy increases. In the IIT literature, there are several variables used as proxies for the product differentiation such as minimum efficient scale (m.e.s.), seller concentration ratio, unit price variation, and the number of establishments. In this study, average number of establishments ($AEST_{jhft}$) is used as a proxy for the product differentiation. Industries with many establishments will produce a larger number of differentiated products. Hence, the shares of IIT in final and

[1] The web address is http://www.haveman.org.

intermediate goods are expected to be positively correlated with the average number of establishments.

According to Greenaway et al. (1995), small-scale economies at the plant level imply greater scope for firm entry and product differentiation. Some researchers, however, expect the plant size to be positively related to the share of IIT. Ethier's (1982) model of division of labor predicts that output in the final manufactured sector is an increasing function of the number of both home and foreign component varieties. These economies of scale are the result of greater division of labor rather than increasing plant sizes. Large-scale economies at the plant level imply a smaller number of firms and consequently a smaller number of component varieties. As a result, Ethier (1982) expects the economies of scale to be negatively related to the share of IIT in intermediate goods. In Feenstra and Hanson (1997), vertical specialization involves producing intermediate goods and final goods in different plants. Thus, plant size is cut rather than increased as each production stage is conducted in different plants. As a result, vertical specialization leads to IIT in intermediate goods. Overall, ambiguity also remains in explaining the share of IIT in intermediates. In this study, differences in real value added per establishment ($DVAEST_{jhft}$) at the industry level will be used as a proxy for economies of scale.

Finally, we include differences in the capital-to-labor ratio at the industry level ($DPCAP_{jhft}$) in order to incorporate differences in factor endowments into the analysis. As mentioned above, Helpman and Krugman (1985) and Ethier (1982) predict that IIT will be negatively correlated with the differences in the capital-to-labor ratio. In Ethier's model, the differentiated intermediate good is assumed to be a capital-intensive good. If capital-endowments increase for the home country, the model predicts that the number of intermediate varieties produced in the home country rises. The home final goods producers begin to rely on locally produced intermediate goods. This will eventually lead to a reduction in IIT in intermediate goods. On the other hand, in Feenstra and Hanson (1997), dissimilarities in the capital-to-labor ratio between home and foreign country are necessary condition for vertical specialization. Therefore, the impact of bilateral inequality in the capital-to-labor ratio between two countries on the share of IIT in final goods is expected to be negative while on the share of IIT in intermediate goods is ambiguous.

Industry-specific variables are constructed using The World Bank's "The Trade and Production Database" CD-ROM, which provides data on value added in thousands of \$US, number of establishments in units, and gross fixed capital formation (GFCF) in thousands of \$US, and the number of employees in thousands at the 3-digit ISIC (Rev.2). Monetary data are not deflated, and are expressed in thousands of \$US. Therefore, a conversion procedure is necessary to convert value added and GFCF data into real internationally comparable units. We employ the price level of GDP and the price level of investment series taken from the Penn World Tables version 6.0 to obtain real data in a common currency (\$US) across countries. Finally, we employ the perpetual inventory method to calculate the capital-labor ratios at the industry level from real GFCF series.

Table 1: Variable Definition and Expected Signs

Variable Definition	Expected Signs		
	TIIT	FIIT	IIIT
$DIST_{hf}$ = The weighted distance between Turkey and its trading partner	-	-	-
$AGDP_{hft}$ = Average GDP between Turkey and its trading partner	+	+	+
$DPCGDP_{hft}$ = Absolute difference of GDP per capita	+/-	-	+/-
$DHCAP_{hft}$ = Absolute difference of the % of the population with higher education between Turkey and its trading partner	+/-	-	+/-
$AEST_{jhft}$ = Average number of establishments at industry level between Turkey and its trading partner	+	+	+
$DVAEST_{jhft}$ = Absolute differences of value added per establishment at industry level between Turkey and its trading partner.	+/-	+/-	+/-
$DPCAP_{jhft}$ = Absolute difference of physical capital endowment per worker at industry level between the Turkey and its trading partner.	+/-	-	+/-

Note: Variables with four subscripts indicates that this variable has three dimensions: industry, country, and time. Variables with three subscripts indicate that this variable has two dimensions: country and time.

4. Empirical Methods

4.1 Dependent Variables

The dependent variables are bilateral intra-industry indices of total manufactured goods, final goods, and intermediate goods trade between Turkey and OECD countries. The first step to calculate IIT in final and intermediate goods is to select the intermediate goods and final goods in the bilateral trade data. Following Hummels, et al. (1999), we employ the United Nations Broad Economic Categories (BEC) classification scheme to distinguish intermediate goods from final goods. The BEC includes 19 basic categories, which are classified as capital goods, consumption goods (final goods), and intermediate goods. The trade data used in this dissertation is based on SITC (Rev. 2). In order to select the intermediate goods from this trade data, I concord from the BEC to SITC (Rev.3) and then match the SITC (Rev.3) codes to the SITC (Rev.2) codes using a correspondence table developed by the UN.[2] As a consequence, about 149 items are considered as final goods and 372 items are considered as intermediate goods out of 637 items from the 4-digit level of SITC.[3]

[2] The concordances table from BEC to SITC Rev.3 and from SITC Rev.3 to SITC Rev. 2 is acquired from the United Nations publication: "Standard International Trade Classification Revision 3" Series M, No.34/Rev.3. The BEC table is obtained from the United Nations publication: "Classification by Broad Economic Categories: defined in terms of SITC Rev.3". Series M, No.53, Rev.3.

[3] Since this study deals with only manufacturing ISIC Rev.2 industries, non-manufactured industries are dropped from calculations. 637 items are left out of 981 items of SITC Rev.2.

After selecting the final goods and intermediate goods, we need to measure IIT at industry level. The IIT index for each industry consists of many final and intermediate goods. The most widely used method for computing the IIT is developed by Grubel and Lloyd (1971). A number of different modifications of the Grubel-Lloyd measure are often employed in the empirical literature: unweighted IIT method and weighted IIT method. The preferred measure of IIT and the measure adopted in this study is the adjusted Grubel and Lloyd (1975) index using the relative size of exports and imports of a particular good within an industry as weights:

$$IIT_{jhft} = \frac{\sum_{i=1}^{n}\left(X_{jhft} + M_{jhft}\right) - \sum_{i=1}^{n}\left|X_{jhft} - M_{jhft}\right|}{\sum_{i=1}^{n}\left(X_{jhft} + M_{jhft}\right)} \tag{1}$$

where $i = 1.......n$ (about 637 HS items) are products that are included in the j th ISIC industry group, $j = 1.......J$ (ISIC 25 industry groups), $f = 1........F$ (Turkey's trading partners: 9 OECD Countries), and IIT_{jhft} stands for either IIT in all manufactured goods, $TIIT_{jhft}$, IIT in final goods, $FIIT_{jhft}$ or IIT in intermediate goods, $HIIT_{jhft}$. Hence, IIT_{jhft} computes the export and import flows with country f in industry j , adjusted or weighted according to the relative share of the trade flows in the i products included in j . The value of this index is zero if all trade is inter-industry trade, it is equal to one if it is completely IIT.

To calculate the IIT index for each case, the final goods and intermediate goods are selected according to the BEC scheme. Once, the final goods are selected, we separately obtained $(X_{ihf} + M_{ihf})$ and $\left|X_{ihf} - M_{ihf}\right|$ at the 4-digit product level of SITC products, and thereafter summed over all 4-digit SITC products comprising a particular industry using a concordance table from SITC to ISIC.[4] Using equation (1), we calculated the index for total IIT in final goods for each industry, $FIIT_{jhft}$. The process was repeated for the intermediate goods.[5]

4.2 Econometric Specifications

Following Greenaway and Milner (1986), we test the hypotheses presented in Section 3 with the following regression model:

$$y_{nti} = \alpha_n + \mu_t + \gamma_i + \beta_c x_{nt} + \delta_I x^*{}_{nti} + e_{nti} \tag{2}$$

[4] The concordances table from SITC (Rev.2) to ISIC (Rev. 2) is obtained from World Bank "Trade and Production database" CD-ROM.

[5] Notice that sum of shares of IIT in final goods and intermediate goods could not add up to IIT in all manufactured goods due to the presence of the categories (41,521, 321, and 51).

where: y_{nti} is total IIT, final IIT, or intermediates IIT indices, x_{nt} is the vector of country-specific explanatory variables with variation in dimensions n, t, x^*_{nti} is the vector of industry-specific explanatory variables with variation in all three dimensions n, t, and i, α_n is the country effect, $n = 1.....,N$, μ_t is the time effect, $t = 1.....,T$, γ_i is the industry effect, $i = 1.....,I$; and e_{nti} is the usual white noise disturbance terms which is distributed randomly and independently.

From an econometric point of view, the specific effects, α_n, μ_t, and γ_i, can be treated as random variables (random effects model) or fixed parameters (fixed effects model). If α_n, μ_t, and γ_i are assumed to be fixed parameters to be estimated with $e_{nti} \sim IID(0,\sigma^2_\varepsilon)$, then (2) represents a three-way fixed effects error component model. x_{nti} is assumed independent of the e_{nti} for all n, t, and i. Following Greene (1999), we can obtain the fixed effects estimates of β_c and δ_I by performing the least squares dummy variable (LSDV) approach, also known as fixed effects least squares. In order to explain the procedure that this study employs in the estimation, we combine both country (x_{nt}) and industry-specific variables (x^*_{nti}) into one vector of explanatory variables (x_{nti}). Equation (2) can be rewritten as

$$y_{nti} = \alpha_n + \mu_t + \gamma_i + \beta x_{nti} + \varepsilon_{nti} \qquad (3)$$

As suggested in the LSVD approach, this study includes all necessary dummy variables to account for the three effects in an OLS. Equation (3) involves three sets of dummy variables in our case. That is, there are N sets of partner countries dummies, T sets of time dummies, and I sets of industry dummies. For example, the country dummy for $n = 1$ equals 1 whenever country 1 is Turkey's trading partner and 0 otherwise, the time dummy for $t = 1990$ is 1 only in the first time period and 0 otherwise, and finally the industry dummy for $i = 311$ is 1 whenever the ISIC industry code is 311 and 0 otherwise.

Once all these dummies have been specified, OLS estimates of β can be obtained. However, there has been one problem left in the estimation. At every observation, the country, time and industry-specific dummy variables sum to 1, so there are some redundant coefficients. In order to remove perfect collinearity between all three sets of dummies and a constant term, we could estimate (3) directly by OLS, including the constant term, but removing one column from each of the three sets of dummies. Then, the resulting regression model is,

$$\tilde{y}_{nti} = \delta + (\alpha_n - \alpha_1) + (\mu_t - \mu_1) + (\gamma_i - \gamma_1) + \beta x_{nti} + e_{nti} \qquad (4)$$

If α_n, μ_t, and γ_i are assumed to be independent of each other, then (3) represents a three-way random effects model with four independent error components. x_{nti} is assumed independent of α_n, μ_t, γ_i and e_{nti} for all n, t, and i. In this study, we follow the method described in Baltagi (1987) to obtain the FGLS estimator of (3). Following Baltagi (1987), this study utilizes a three-way error component model for the disturbances,

$$e_{nti} = \xi_t + \zeta_n + \eta_i + \varepsilon_{nti} \qquad (5)$$

where $t = 1.......T$, $N = 1.......N$, and $I = 1.......I$. ξ_t, ζ_n, η_i, and ε_{nti} are random components of the random error e_{nti}. The components are independent of each other, with zero means and variances: $\sigma_\xi^2, \sigma_\zeta^2, \sigma_\eta^2$, and σ_ε^2, respectively. The variance-covariance matrix Ω can be expressed as:

$$\Omega = \sigma_\varepsilon^2 (I_T \otimes I_N \otimes I_I) + \sigma_\xi^2 (I_T \otimes J_N \otimes J_I) + \sigma_\zeta^2 (J_T \otimes I_N \otimes J_I) + \sigma_\eta^2 (J_T \otimes J_N \otimes I_I) \qquad (6)$$

where $\otimes$ is the kronecker product operator, I is an identity matrix and J is a matrix with unit elements only. In order to find the spectral decomposition, Baltagi (1987) introduces some notation. Let $\bar{J}_N = \frac{1}{N} J_N$, $\bar{J}_T = \frac{1}{T} J_T$, $\bar{J}_I = \frac{1}{I} J_I$, $E_N = I_N - \bar{J}_N$, $E_T = I_T - \bar{J}_T$, and $E_I = I_I - \bar{J}_T$. In the next step, the I's are replaced by $E_N + \bar{J}_N$, $E_T + \bar{J}_T$, and $E_I + \bar{J}_T$ and J's replaced by $N\bar{J}_N$, $T\bar{J}_T$, and $I\bar{J}_I$ and collect terms with same matrices. Note that E's and $\bar{J}$'s are idempotent, and that multiplication of both equals zero. With the help of these specifications, the following spectral decomposition is obtained:

$$\Omega = \sum_{i=1}^{5} \lambda_i V_i \qquad (7)$$

where λ's are eigenvalues (i.e. distinct characteristics roots) of the variance covariance matrix Ω and V's are the corresponding matrices of eigenprojectors.[6] The eigenvalues and eigenprojectors are provided in Table 8. Each V_i is symmetric and idempotent with its rank equal to its trace. In addition, V_i's are pairwise orthogonal and sum to the identity matrix. The advantages of this spectral decomposition is that

$$\Omega^r = \sum_{i=1}^{5} \lambda_i^r V_i \qquad (8)$$

where r is an arbitrary scalar so that

$$\sigma_\varepsilon \Omega^{-1/2} = \sum_{i=1}^{5} \left(\sigma_\varepsilon / \sqrt{\lambda_i}\right) V_i \qquad (9)$$

and the typical element of $\hat{y}_{nti} = \sigma_\varepsilon \Omega^{-1/2} y_{nti}$ is given by

$$\hat{y}_{nti} - \theta_1 \bar{y}_{.t.} - \theta_2 \bar{y}_{n..} - \theta_3 \bar{y}_{..i} + \theta_4 \bar{y}_{...} \qquad (10)$$

where $\theta_i = 1 - \left(\sigma_\varepsilon / \sqrt{\lambda_{i+1}}\right)$ for $i = 1,2,3$ and $\theta_4 = \theta_1 + \theta_2 + \theta_3 - 1 + \left(\sigma_\varepsilon / \sqrt{\lambda_5}\right)$ for $i = 4$. A dot indicates that observations on y have been averaged over that classification. As a result, FGLS or random effects model coefficients can be obtained as OLS of $\hat{y}_{nti}$ on $\hat{x}_{nti}$, where $\hat{x}_{nti} = \sigma_\varepsilon \Omega^{-1/2} x_{nti}$. The best quadratic unbiased (BGQ) estimators of the variance components arise naturally from the fact that $V_i e \sim (0, \lambda_i V_i)$. Thus,

$$\lambda_i = \frac{e' V_i e}{tr(V_i)} \qquad (11)$$

[6] See Wansbeek and Kapteyn (1982) for detail derivation of Ω.

is the BQU estimator of λ_i for $i = 1,2,3,4,$ and λ_5 has no unbiased estimator. Using one-to-one correspondence provided in Table 2, we may obtain feasible estimates of σ 's by replacing the true disturbances by OLS residuals. To summarize the method used in this study, we first regressed of y_{nti} on x_{nti} to obtain OLS residuals. Then using these residuals, we transformed the dependent variables and explanatory variables according to equation (10). Finally, FGLS is computed by the regression of $\hat{y}_{nti}$ on $\hat{x}_{nti}$, where $\hat{x}_{nti}$ includes the constant term. This provides efficient estimates of the coefficients of the model. Considering the computational warning made by Baltagi (1995), whenever the results indicate negative estimates of σ 's, then we have set corresponding $\theta's$ equal to zero during the transformation process.[7]

Table 2: Eigenvalues and Eigenprojectors of Ω

i	λ_i	V_i	rank V_i
1	σ_ε^2	$\dot{Q}$	$INT - T - N - I + 2$
2	$NI\sigma_\xi^2 + \sigma_\varepsilon^2$	$E_T \otimes \bar{J}_N \otimes \bar{J}_I$	$(T-1)$
3	$TI\sigma_\zeta^2 + \sigma_\varepsilon^2$	$\bar{J}_T \otimes E_N \otimes \bar{J}_I$	$(N-1)$
4	$NT\sigma_\eta^2 + \sigma_\varepsilon^2$	$\bar{J}_T \otimes \bar{J}_N \otimes E_I$	$(I-1)$
5	$NI\sigma_\xi^2 + TI\sigma_\zeta^2 + NT\sigma_\eta^2 + \sigma_\varepsilon^2$	$\bar{J}_T \otimes \bar{J}_N \otimes \bar{J}_I$	1

Note: $\dot{Q} = I_T \otimes I_N \otimes I_I - I_T \otimes \bar{J}_N \otimes \bar{J}_I - \bar{J}_T \otimes I_N \otimes \bar{J}_I - \bar{J}_T \otimes \bar{J}_N \otimes I_I + 2\bar{J}_T \otimes \bar{J}_N \otimes \bar{J}_I$

Source: Baltagi (1987)

5. The Results

5.1 Evidence of Intermediate Goods Trade in Turkey

The trade data used in this study indicate that a significant portion of Turkey's manufactured goods trade occurred with OECD (9) countries, about 55 percent in 2000. In addition, the share of Turkey's final goods trade with OECD (9) countries is relatively larger than intermediate goods, 68 per cent and 48 per cent in 2000. Also, a significant portion of Turkey's manufactured goods trade occurred with Germany, about 19 percent, while Italy accounted for about 9 per cent of Turkey's trade. These figures are consistent with our expectation that Turkey is signed a Customs Union Agreement with these countries and these countries are geographically close to Turkey.

Table 3 shows IIT indices for total manufactured goods trade, final goods, and intermediate goods. At the more aggregated level, we observe that the shares of IIT in three product groupings for Turkey's trade with OECD (9) have increased significantly over the period between 1985 and 2000. These findings are in line with the results of

[7] At the time of writing this study, there is virtually no specialized statistical package for the estimation of three-way REM. In principle, this can be done using matrix programming languages such as GAUSS, MATLAB, or SAS/IML. In this study, we have successfully used SAS/IML.

Gönel (2001) and Kösekahyaoğlu (2002), where they both found that the level of IIT between Turkey and EU countries has increased significantly following the 1980 trade liberalization. Table 3 indicates that Turkey's IIT trade with OECD (9) in all manufactured goods rose from 7 per cent to 18 per cent over the period of 1985-2000. On the other hand, the shares of Turkey's IIT with the world is relatively stable during the period analyzed. In addition, the share of IIT in all three product groupings of Turkey is much lower with OECD (9) than with the world, consistent with the findings of Gönel (2001) and Kösekahyaoğlu (2002). Furthermore, the results suggest that significant portion of Turkey's trade with OECD (9) is still inter-industry, also consistent with results of Gönel (2001) and Kösekahyaoğlu (2002). Among three product groupings, Germany has the highest level of IIT indices. The low level of IIT with Japan can be explained by distance and the protectionist trade policies of Japan. Finally, IIT in intermediates for the world and OECD (9) countries is consistently higher than IIT in final goods during the period of 1985-2000. This result is in accordance with the recent findings by Schüler (1995), where he found that the enormous increase in Turkey's IIT with the world was mainly due to an increasing exchange of intermediates against intermediates.

5.2. Empirical Results

The data set used in the estimation is a panel data set in three dimensions: the trading partner dimension, the industry dimension, and the time dimension. Thus, the standard panel data analysis technique will be used to analyze the determinants of IIT. The data set in this study has 9 countries, 25 industries, and covers the period of 1985-1999.[8] In addition, there are some zero observations on IIT indices. To avoid selection bias, we have chosen to set zero observations to 0.01 in these regressions.

[8] These are Austria, Germany, Spain, the United Kingdom, Italy, Japan, Netherlands, Sweden, and USA. Deleted ISIC industries are 311, 313, and 324.

Table 3: Grubel-Lloyd Indices of Trade between Turkey and OECD (9) Countries

	1985	1990	1995	2000
Total Manufactured Goods				
World	0.32	0.30	0.35	0.34
OECD (9)	0.07	0.14	0.16	0.18
Austria	0.07	0.15	0.18	0.17
Germany	0.16	0.20	0.25	0.27
Spain	0.00	0.11	0.12	0.21
United Kingdom	0.08	0.15	0.16	0.16
Italy	0.08	0.16	0.18	0.20
Japan	0.02	0.06	0.07	0.08
Netherlands	0.05	0.18	0.17	0.19
Sweden	0.09	0.10	0.08	0.14
USA	0.08	0.13	0.19	0.19
Final Goods				
	1985	1990	1995	2000
World	0.19	0.14	0.22	0.20
OECD (9)	0.04	0.06	0.08	0.11
Austria	0.03	0.07	0.10	0.10
Germany	0.09	0.08	0.12	0.15
Spain	0.00	0.06	0.05	0.13
United Kingdom	0.03	0.09	0.09	0.12
Italy	0.05	0.04	0.08	0.13
Japan	0.00	0.02	0.03	0.04
Netherlands	0.02	0.09	0.11	0.08
Sweden	0.03	0.03	0.03	0.09
USA	0.05	0.06	0.13	0.12
Intermediate Goods				
	1985	1990	1995	2000
World	0.35	0.31	0.34	0.35
OECD (9)	0.08	0.16	0.16	0.19
Austria	0.04	0.16	0.19	0.22
Germany	0.20	0.25	0.26	0.28
Spain	0.01	0.12	0.13	0.19
United Kingdom	0.13	0.17	0.14	0.19
Italy	0.08	0.18	0.17	0.18
Japan	0.01	0.06	0.07	0.11
Netherlands	0.09	0.24	0.19	0.24
Sweden	0.09	0.09	0.09	0.13
USA	0.05	0.13	0.17	0.19

Source: Author own calculations from the World Trade Analyzer (WTA), SITC, Revision 2, 1985-2000.

Before determining the model specification we assess the problems of multicollinearity and heteroskedasticity. Using well-known R^2 criteria, we found out that $AEST_{jhft}$, a proxy for product differentiation, shows perfect multicollinearity. As a consequence, $AEST_{jhft}$ is dropped from the estimations. In addition, the White test failed to reject the hypothesis of homoskedasticity in the data set. As a result, the White's robust variance-covariance matrix is used to generate the corrected standard errors and t-statistics.

Table 4 presents results for pooled OLS of equation (3) with IIT indices as dependent variables.[9] No country, industry, or time effects are included. As evident in Table 11, the determinants of FIIT and IIIT are fairly the same, because signs and significance of variables are quite similar.[10] Table 5 presents results of the estimation of (4) using fixed effects panel data regressions techniques. All variables in the estimation equations can vary across partner countries, across industries, and across years. The question is then whether we should pool the data across partner countries, or across industries, or across years. One can test the joint significance of these dummy variables by employing the Chow's test to determine whether we should pool the data or not. Under the null hypothesis, the efficient estimator is pooled OLS. Based on the OLS residuals, the calculated test-statistics in all three cases, reported in Table 5, strongly reject the null hypotheses that there are no specific effects, and hence the specifications including all three effects should be preferred, i.e three-way FEM, over the simple pooled OLS. There are, however, doubts about the three-way FEM in that most of the country and industry dummies and all the time dummies are insignificant in all estimations.[11] The doubts regarding the three-way FEM further increased because most of the explanatory variables became insignificant in this specification, except $DPGDP_{hft}$ for IIIT.

Table 4: Simple OLS Results for Total, Final, and Intermediates IIT

Independent Variables	Dependent Variables		
	TIIT	FIIT	IIIT
Constant	-4.718*** (-16.26)	-2.320*** (-9.27)	-4.712*** (-14.93)
$DIST_{hf}$	-0.137*** (-15.99)	-0.069*** (-9.32)	-0.133*** (-14.27)
$AGDP_{hft}$	0.214*** (16.27)	0.111*** (9.80)	0.209*** (14.57)
$DPCGDP_{hft}$	-0.041*** (-2.92)	-0.017 (-1.44)	-0.023 (-1.48)
$DHCAP_{hft}$	0.024*** (4.04)	0.016*** (3.17)	0.022** (3.32)
$DVAEST_{jhft}$	0.005** (3.19)	-0.009*** (-5.89)	0.009*** (4.62)
$DPCAP_{jhft}$	0.005** (1.99)	-0.0007 (-0.31)	-0.006** (-2.20)
R^2	0.43	0.2197	0.42
F	364.28***	135.51***	349.43***
No. of observations[a]	2643	1271	2335

Note: t-values (given within parentheses) are based on White's method. Asterisks indicate statistical significance at different levels: ***(1%), **(5 %), *(10%).
[a] Panel data have 3375 observation points (9 countries, 25 industries, and 15 years).

[9] In the empirical analysis, the explanatory variables are expressed in natural logarithms. All estimations are performed in SAS 8.2. The predicted signs of the explanatory variables are provided in Table 1.
[10] The focus of this study is to determine whether the determinants of IIT in final goods and intermediate goods differ. As a result, the results of the regression of TIIT will not be discussed.
[11] Results of the coefficients for dummies are not reported in this study to save space, but available upon request.

The alternative to the FEM is a random effects model (REM). Consequently, the question of model selection naturally arises. To decide whether the FEM or REM is appropriate, the Hausman specification test can be applied. Under the null hypothesis, the Hausman test statistic is asymptotically distributed as Chi-squared with K degrees of freedom. In the calculations of the Hausman statistic, the constant term was excluded from both the three-way FEM and the three-way REM estimations since the test is based on the slope coefficients only. Large values of the test statistic argue in favor of the FEM specification. The resulting Hausman test statistics is 9.23 for FIIT and 9.15 for horizontal IIT. Hence, the result of the Hausman test indicates that the REM should be preferred over the FEM.

Table 5: Fixed Effects Results for Total, Final, and Intermediates IIT with Country, Industry, and Time Dummies

Independent Variables	Dependent Variables		
	TIIT	FIIT	IIIT
Constant	-8.926* (-1.68)	-0.020 (-0.00)	-7.286 (-1.26)
$DIST_{hf}$	-0.329 (-1.64)	0.047 (0.28)	-0.280 (-1.27)
$AGDP_{hft}$	0.300 (1.35)	-0.042 (-0.23)	0.257 (1.06)
$DPCGDP_{hft}$	0.307*** (3.38)	0.113 (1.50)	0.226** (2.28)
$DHCAP_{hft}$	0.011 (0.63)	0.011 (0.76)	-0.001 (-0.740)
$DVAEST_{jhft}$	0.001 (0.34)	-0.001 (-0.46)	0.014 (0.45)
$DPCAP_{jhft}$	0.003 (1.10)	0.002 (1.25)	-0.003 (-1.07)
R^2	0.58	0.46	0.57
F	87.54***	55.37***	83.77***
Chow test	24.94***	32.47***	24.10***
No. of observations[a]	2643	1271	2335

Note: t-values (given within parentheses) are based on White's method. Asterisks indicate statistical significance at different levels: ***(1%), **(5 %), *(10%). Omitted country is USA and omitted year is 1999.

[a] Panel data have 3375 observation points (9 countries, 25 industries, and 15 years).

Table 6 presents the results from the random effects model of equation (10). The overall fit drops drastically compare to the FEM, a phenomenon often encountered in the case of the REM. Comparing the three-way FEM estimates and three-way REM estimates, utilizing the REM does appear to significantly improve the significance of parameter estimates. The efficiency of the REM estimates further confirms the fact that the REM is the right specification to analyze the determinants of IIT in final goods and intermediates. In addition, Table 6 shows that the estimated coefficients are almost the same for the FIIT and IIIT with the exception of $DPCGDP_{hft}$.

In the case of FIIT, country effects are found to have significant explanatory power. Average market size between two countries ($AGDP_{hft}$) does assert a significant effect on FIIT, while distance ($DIST_{hf}$) exerts a negative effect. These findings are consistent with those of Balassa (1986) and Clark and Stanley (1999). Furthermore, bilateral inequality in human capital endowment ($DHCAP_{hft}$) exerts a statistically positive effect on the share of FIIT, which is inconsistent with the prediction of Helpman and Krugman's (1985) model. Theoretical models of North-South IIT, such as Flam and Helpman (1987) and Falvey and Kierzkowkski (1987), suggest that IIT is positively related to differences in factor endowments.[12] As seen in Table 6, the coefficient of $DHCAP_{hft}$ does appear to support a factor proportions explanations of North-South models.

Table 13: Random Effects Results for Total, Final, and Intermediates IIT

Independent Variables	Dependent Variables		
	TIIT	FIIT	IIIT
Constant	-1.184***	-0.303***	2.238***
	(-6.18)	(-9.28)	(12.82)
$DIST_{hf}$	-0.123***	-0.066***	-0.138***
	(-5.94)	(-8.88)	(-12.82)
$AGDP_{hft}$	0.188***	0.107***	0.215***
	(5.76)	(9.39)	(13.28)
$DPCGDP_{hft}$	0.0001	-0.012	-0.029**
	(0.00)	(-1.11)	(-2.09)
$DHCAP_{hft}$	0.021*	0.015***	0.024***
	(1.65)	(2.95)	(3.63)
$DVAEST_{jhft}$	0.005**	-0.0008	0.003
	(2.52)	(-0.30)	(0.90)
$DPCAP_{jhft}$	0.006**	0.003	-0.003
	(2.08)	(1.36)	(1.16)
R^2	0.06	0.03	0.20
F	32.63***	17.11***	120.50***
Hausman Test[h]	4.68	9.23	9.15
No. of observations[a]	2643	1271	2335

Note: t-values are given within parentheses. Asterisks indicate statistical significance at different levels: ***(1%), **(5 %), *(10%).
[a] Panel data have 3375 observation points (9 countries, 25 industries, and 15 years).
[h] Based on the results from three-way FEM and three-way REM.

With regard to the industry-specific variables, differences in value added per establishments ($DVAEST_{jhft}$) and differences in the capital-to-labor ratio ($DPCAP_{jhft}$) do not have any significant effect on the FIIT. Thus, the findings of the present study do not support the role of economies of scale in determining the share of IIT, a common result in empirical work but which is contrary to theoretical predictions.

Considering the intermediate goods trade, the country-specific factors also contribute most of the explanatory power behind the IIIT. First of all, we find a positive sign for the average market size, consistent with the prediction of Ethier's (1982) model.

[12] In the context of the Falvey and Kierzkowksi model, Martin and Rios (2002) found that bilateral inequality in factor endowments including human capital exert positive effect on the vertical type IIT.

In addition, the distance has a statistically significant negative effect on the IIIT, confirming our predictions. According to this result, transportation costs unambiguously hamper the fragmentation of production across countries. With regard to other country-specific variables, differences in GDP per capita ($DPCGDP_{hft}$) turn out to have negative and statistically significance influence on the IIIT, consistent with the prediction of Ethier's (1982) model. Furthermore, there is strong evidence that dissimilarities in human capital endowments have statistically positive effect on the IIT. This is in contrast with Ethier (1982), whereas in line with the prediction of Feenstra and Hanson (1997). The positive relationship between the IIIT and dissimilarity in human capital endowments does support the factor proportion explanations of Feenstra and Hanson's (1997) model of outsourcing. However, this conclusion may be weakened by the indirect evidence in the regression, since we find a negative relationship between the IIIT and the differences in per capita GDP between countries (proxy for factor endowment dissimilarity).[13] Finally, likewise in the FIIT, none of the coefficients on the industry-specific variables ($DVAEST_{jhft}$ and $DPCAP_{jhft}$) have statistically significant effect on the IIIT.

Some difficulties arise when we interpret our result as a whole: we obtain both positive and negative signs for the each indicator of differences in factor endowments. At this point, thus, our results make it difficult to claim that Feenstra and Hanson's (1997) model of outsourcing or Ethier's (1982) model of division of labor is right theoretical model to explain the determinants of IIT in intermediate goods between Turkey and selected OECD (9) countries. Overall, the REM results confirm the fact that the determinants of the FIIT and IIIT indeed are similar. In addition, the country-specific factors contribute most of the explanatory power behind the FIIT and IIIT while industry-specific factors do not have any impact on the FIIT and IIIT.

6. Conclusions

In this study, we have investigated the country and industry-specific determinants of IIT in final and intermediate goods between Turkey and selected OECD (9) countries from 1985 to 1999. Our key hypotheses regarding the country and industry-specific variables that determine the extent of IIT in final goods are drawn from Balassa (1986), Helpman and Krugman (1985), Clark and Stanley (1999), Greenaway and et al. (1995), and other studies. Furthermore, the hypotheses drawn from Ethier (1982) and Feenstra and Hanson (1997) put forward to explain the extent of IIT in intermediate goods between Turkey and other selected OECD countries.

The data set used in this study involves three dimensions, which allow us to utilize panel data techniques, which can be performed using both fixed-effects models (FEM) and random-effects models (REM). The result of the Hausman test results support the REM model, which also yields more efficient estimates than the FEM estimates. Based on the results from the REM, we first observe that the determinants of IIT for final goods are not much different from those for intermediate goods. Second, the results indicate that country-specific factors are contributing most of the explanatory power behind IIT in final and intermediate goods between Turkey and OECD (9). Specifically, none of the industry-specific variables (economies of scale and the capital-labor ratio) are

[13] Empirical findings of Harrigan (1995) suggest that the volume of bilateral intermediate goods trade may be explained by factor endowments theorem rather than the monopolistic competition trade model.

the central determinants of IIT in final and intermediate goods. In particular, IIT in final goods found to be positively correlated with the average market size, consistent with the previous studies. In addition, the IIT share is positively related to the differences in human capital endowments. This finding is inconsistent with the Helpman and Krugman's (1985) theoretical model but consistent with the predictions of North-South models. As expected, distance exerts a negative effect on IIT in final goods. Turning now to the results for IIT in intermediate goods, it was found that IIT is positively affected by the average size and the dissimilarity of human capital endowments, while it is negatively affected by the differences in per capita GDP and distance variable. The results for the average market size and differences in per capita GDP are in line with the predictions of Ethier's (1982) model. Finally, the finding of a positive relationship between IIT in intermediate goods and the differences in human capital endowments is clearly in line with the prediction of Feenstra and Hanson' (1997) model. Based on these results, we conclude that the data partially support the hypotheses drawn from Ethier's model of international division of labor and Feenstra and Hanson's model of outsourcing.

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Appendix

Table 7: International Standard Industrial Classification of All Economic Activities (ISIC Rev.2)

Code	Industry
311	Manufacture of food products
312	Manufacture of food products not elsewhere classified
313	Manufacture of beverages
314	Manufacture of tobacco
321	Manufacture of textiles
322	Manufacture of wearing apparel, except footwear
323	Manufacture of leather products
324	Manufacture of footwear, except rubber or plastic
331	Manufacture of wood products, except furniture
332	Manufacture of furniture, except metal
341	Manufacture of paper and products
342	Manufacture of printing and publishing
351	Manufacture of industrial chemicals
352	Manufacture of other chemicals
353	Manufacture of petroleum refineries
354	Manufacture of miscellaneous petroleum and coal products
355	Manufacture of rubber products
356	Manufacture of plastic products
361	Manufacture of pottery, china, earthenware
362	Manufacture of glass and products
369	Manufacture of other non-metallic mineral products
371	Manufacture of iron and steel
372	Manufacture of non-ferrous metals
381	Manufacture of fabricated metal products
382	Manufacture of machinery, except electrical
383	Manufacture of machinery, electric
384	Manufacture of transport equipment
385	Manufacture of professional and scientific equipment
390	Manufacture of other manufactured products