Determinants of International Fragmentation of Production in Turkey

Ferda Karagöz Özenç & Yasin Barış Altaylıgil

The latest phase of globalization is marked by the fragmentation of the stages of production and the dispersion of these stages to different regions around the world. Consequently, countries specialize in specific types of intermediate production stages instead of producing a final product from scratch. This phenomenon caused a dramatic increase in parts and components trade flows in recent years.

This study investigates the changing structure of Turkey's manufacturing industry and trade in manufactures in the face of growing predominance of international fragmentation of production processes. In particular, it focuses on the determinants of parts and components trade which is a widely accepted indicator of international fragmentation of production.

The study is organized as follows: First part surveys main determinants of parts and components trade from the perspective of fragmentation theory. Using parts and components trade flows aggregated from SITC 5-digit product categories, the second part tries to investigate the reasons behind parts and components trade between Turkey and its 46 trade partners. Besides technological differences and factor endowments, other country specific factors such as market size, regional trade agreements, product diversity and the real exchange rate are included into the model and their explanatory power on parts and components trade flows are investigated. Empirical analysis is conducted in a gravity model setting and a panel data technique is used during the period covering 1992-2009. The final section is devoted to conclusions.

Jel Code: F14, C23, L23

1. Introduction

Over the past 30 years, world economy has witnessed a new globalization wave. The distinctive feature of this wave among other international integration processes is fragmentation of production. Since 1980s, the leading manufacturing industries such as automotive, aircraft, electronics, machinery and textile has begun to spread each production process of a final product to the different locations around the world. Intermediate goods pass beyond the international borders more than once on global commodity chains in order to generate a final product. Therefore, parts and components (P&Cs) trade has increased sharply in those industries. In 2010, fragmentation trade has reached to 8 trillion dollars. This amount consists of both the export value of formal subsidiaries and other firms tied to an international firm by contracting or outsourcing (UNCTAD, 2011: s. 133). Hence fragmentation trade accounts for 42 % of total world trade. Nonetheless, it is projected that P&Cs trade will continue to increase over next two decades (Athukorala, 2011: s. 16-18).

As a result of this fragmentation process, developed and developing countries are connected together by global production sharing. As North American and European countries are specialized in services industry and/or research and development, standardized production processes of manufacturing industry shift to developing countries. Hence developed countries become headquarter bases and developing countries has transformed to factories (Baldwin,

2011, p. 4). Since 1990s, South Korea, India, Poland, Indonesia, Thailand, Turkey and notably China increased their total share in global manufacturing value added (Baldwin & Lopez-Gonzales, 2013, p. 4). Although this is true, developing countries share in total world value added hasn't changed so much from 2000 to 2008, as their share in services industry has increased less than developed countries. (Memedovic & Iapadre, 2010, p. 9).

All these developments in the world economy smoothed the path for new studies in the international trade literature. Fragmentation is discussed in detail under the various theoretical approaches. A number of researchers have used the tools of new trade theory as well as the tools of the traditional trade models such as Ricardian and Heckscher-Ohlin type models in order to analyse this process.[*] In doing so, they try to analyse the specialization patterns of countries, put forward how the welfare of countries and factor revenues are affected. In spite of this, other developments such as reduction of the transportation and communication costs, economic integration activities resulted in the abolishment of tariffs are also discussed in a number of studies.

2. The Reasons behind the International Fragmentation of Production

It is argued that developments in the transportation and communication technologies are two main exogenous factors behind the fragmentation of production. Vertical models of multinational corporations underline the trade-off between opportunities of factor price differences and fragmentation costs (Helpman, 1984; Antras & Helpman, 2004: s. 557-575). On that point, decreases in the transportation and communication costs reduce the costs of fragmentation and therefore it becomes feasible to shift low skilled production tasks to low-waged developing countries. Although these developments are declared in several studies, theoretical framework is stated by Jones and Kierzkowski (1990). According to their analysis, such developments smooth the path for fragmentation by decreasing the cost of service links facilitating the organization of different production blocks.

Another determinant of fragmentation process is reduction of tariffs and quotas on foreign trade. This case is modelled as the magnification effect by Yi (2003) and economic integration policies of countries are the main drivers of this reduction. Because tariff exemptions differ for each country, multinational corporations include preferential trade agreements into their decisions about where to fragment production. Therefore developing countries began to both decrease their trade barriers and signed bilateral investment treaties (BITs) with the MNEs originated in the developed countries. Hence Turkey's inclusion to Customs Union with EU countries will be tested as a country specific determinant of Turkey's integration process to global production chains.

On the other hand, factor endowment and technology differences come out as a country specific determinant of global production sharing. New theories enhanced the scope of Ricardian and Heckscher-Ohlin type models by putting fragmentation into trade models. From that point of view, it is suggested that developed countries experience a labour-saving technical progress, as the standardized labour intensive stages of production shift from developed countries to the developing ones (Jones & Kierzkowski, 2001; Arndt, 1997;

[*] In the international trade literature, fragmentation trade is analyzed under different titles, such as global production sharing, vertical specialization, slicing up the value chain, intermediate goods trade and outsourcing. Those theoretical and empirical studies analyze the reasons behind the decisions of firms shifting their production stages to different countries and hence the product specialization of countries in the new international division of labour.

Venables, 1999). Nonetheless, labour cost saving behaviour comes out as one of the main reasons of firms in the vertical MNE theories. According to this, benefits gained by low labour costs must be greater than the fragmentation costs such as packaging, tariffs, transportation and communication costs (Helpman, 1984; Hanson et.al., 2005).

Although taking the advantage of labour cost differences is an important factor on fragmentation, it is not enough solely. From the perspective of a leader firm, the search for the most suitable subsidiary for its production requirements among several potential suppliers comes along with extra costs. These costs will probably be smaller in large markets in which experienced input suppliers with several diversified products and many customers operates. Hence it is expected that finding a subsidiary producing the proper product for the preferences of a leader firm will be much feasible in the countries with market thickness (Grossman & Helpman, 2005). Nonetheless, some of the studies analyzing the international fragmentation by the help of the new trade theory emphasize the importance of the product diversification together with the increase in the varieties of P&Cs as a cost saving factor (Ethier, 1984; Lüthje, 2001).

On the other hand, the effect of exchange rate policy on trade flows is a drastically disputed issue in the case of fragmentation trade. It is expected that trade competitiveness of a country will be negatively affected by the relative appreciation of its domestic currency. In line with this traditional result, Obstfeld (2002) argues that global production sharing has increased the sensitivity of trade flows to relative price changes, thereby enhancing the efficacy of exchange rate policy. The increasing importance of global production sharing induces firms to respond swiftly to changes in relative prices by switching between domestic and imported inputs, shifting tasks across borders, or changing procurement sources of final products.

In contrast to this view, a number of researchers reckon that global production sharing could in fact weaken the link between international price changes and trade flows for several reasons (Arndt 2008, Jones and Kierzkowski 2001). First, in the process of global production sharing, international prices and cost differentials are only one consideration for firms in deciding on production location and procurement. Setting up overseas production bases and establishing service links entail high fixed costs. Once incurred, relative price and cost changes become less important in business decision making. Especially, those firms, which benefit from the wage differences in developing countries by their subsidiaries, cannot easily move from one production block to another. Second, activities within production networks are generally characterized by fixed coefficient production techniques and, therefore, the substitutability of components obtained from various sources is rather limited. Within global production networks, production units located in different economies normally specialize on specific tasks that are not easily substituted elsewhere (Jones 2000).

In the light of these theoretical approaches, it is aimed to conduct an econometric study about the reasons behind the articulation of Turkey's manufacturing industry into global production chains.

2. Turkish Manufacturing Industry in the Process of International Fragmentation

The year of 1980 is a turning point for the Turkish economy. Since then, Turkish manufacturing industry became the locomotive of the process of integration into global economy as a consequence of the transition from import substitution trade regime to export oriented growth policies.

Average weighted protection rate on manufacturing products declined from 75,8 % in 1983 to 20,7 % in 1994 in consequence of liberalization regulations such as the incremental elimination of quantitative restrictions and customs duties. After the customs union (CU) agreement in 1996, it declined further to 10 % (Taymaz, et.al., 2011, s.35). Dismantling of trade barriers increased the trade volume of Turkey with European Union countries, not just in the final products but also in P&Cs.

In Table 1, vertical specialization measure of trade is shown for Turkey with respect to EU average (Hummels, et. al., 1998). This measure is computed for a number of combinations of imported inputs and industrial exports. Turkey's manufacturing import content of manufacturing exports is expected to be the closest measure of international fragmentation of production and it is 23,4% in 2002. In other words, in every 100 units of manufacturing exports, Turkey needs to import 23,4 units of manufacturing inputs, on average.

Table 1. Vertical Specialization in Turkey and EU (for the mid of 2000s)

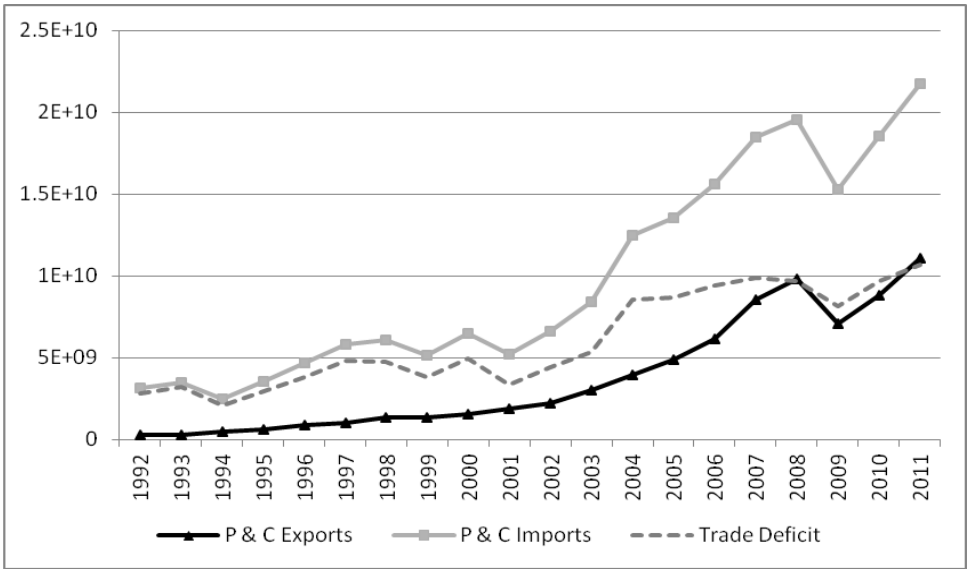
	Turkey				European Union			
	Primary Products Industry Exports	Manufacturing Industry Exports	Services Industry Exports	Total Exports	Primary Products Industry Exports	Manufacturing Industry Exports	Services Industry Exports	Total Exports
Primary Products Imports	2,7%	4,7%	2,2%	3,9%	3,2%	4,2%	1,2%	3,3%
Manufacturing Imports	5,7%	23,4%	5,1%	17,0%	3,0%	10,5%	2,2%	7,70%
Services Imports	0,7%	1,0%	2,3%	1,4%	1,1%	2,0%	2,4%	2,1%
Total Imports	9,1%	29,2%	9,6%	22,3%	7,3%	16,7%	5,9%	13,10%

Source: OECD STAN Database, http://stats.oecd.org/Index.aspx?QueryId=4414#

On the other hand, observations arising from trade data is computed and shown in Figure 2.[*] As it is shown, P&Cs trade began in the early years of 1990s and its yearly trend increased sharply after 2001. But exports haven't increased as much as imports. Therefore trade deficit has been increasing as well. Although this process increases the diversity of exports, it, nevertheless, intensifies the import dependency and current account deficit. Share of P&Cs exports in total exports of SITC 7 and 8 product categories has been increasing gradually and average share accounts for 12 % between 1992 and 2011, whereas share of imports has been undulating around 25-35% and is approximately 30 % in the same period.

[*] Trade data have advantages in terms of being easy to reach and disaggregated. Therefore SITC Rev. 3 5-digit product classification is used in the econometric estimation part of this study. Based on the list of Yamashita (2011), 264 units of SITC Rev. 3 5-digit products are identified as parts and components. These products are classified under SITC 7 *transport and machinery equipments* and SITC 8 *miscellaneous manufacturing* product groups. Although international product fragmentation has been expanding beyond SITC 7 and 8, outsourcing activities in those categories other than SITC 7 and 8 are presumably not yet widespread. P&C trade flows of Turkey computed for each of the 46 trade partners and for the years between 1992 and 2009.

Figure 1. Parts And Components Exports and Imports of Turkey



Source: Computed by data collected from the database of TUIK.
http://tuikapp.tuik.gov.tr/disticaretapp/disticaret.zul?param1=3&param2=0&sitcrev=3&isicrev=0&sayac=5806

On the other hand, empirical studies conducted to analyze the structural transformation of Turkey's manufacturing trade are mostly interested in vertical intra-industry trade. Although fragmentation trade is related with intra industry trade (IIT) in some parts, it differs from IIT in terms of both theoretical background and measurement methods.[*] Even so, vertical IIT, with its 85% share in total IIT, may be accepted as an indicator of supply chain activity in Turkey (Emirhan, 2005).

Turkey's PCX flows are mainly concentrated on EU countries. As it is shown in Table 2, five of the top ten trade partners of Turkey are from EU in 2011. It may be a result of both Turkey's integration into the Customs Union (CU) and market size of these countries. Nonetheless, major automotive companies from EU countries have begun to shift their production stages to Turkey, since 1990s. As a result of this division of labour between EU MNEs and Turkish subsidiaries, supply of automotive parts and components to leading automotive MNEs such as Opel, Volkswagen, Ford, GM and Renault has reached to approximately % 45 of total PCX for Turkey in 2011.

[*] The reasons behind vertical IIT can be classified into two groups of approaches. According to the quality ladder approach suggested vastly in the literature, high income countries specialize in and export high quality and high price products and low income countries specialize in and export low quality and low price products. Hence vertical IIT arises, as an industry's final products which are differentiated according to their quality are traded between high and low income countries (Falvey, 1981; Shaked & Sutton, 1984; Falvey & Kierzkowski, 1987; Flam & Helpman, 1987). In contrast to this, vertical IIT can also occur as a result of fragmentation, when the inputs on a global production chain are in the same industrial category (Lloyd & Grubel, 2003; Ando, 2006).

Table 2. Top Ten Trade Partners of Turkey for PCM and PCX in 2011

TOP TEN TRADE PARTNERS FOR PCX	Share of PCX in Turkey's TOTAL PCX	TOP TEN TRADE PARTNERS FOR PCM	Share of PCM in Turkey's TOTAL PCM
Germany	0,20	Germany	0,20
France	0,07	China	0,12
UK	0,06	France	0,10
USA	0,06	Italy	0,09
Italy	0,06	UK	0,06
Romania	0,06	USA	0,06
Iran	0,05	Japan	0,04
Russia	0,03	Poland	0,04
BLX	0,02	Spain	0,04
Spain	0,02	Korea	0,03
TOP TEN TOTAL	**0,62**	**TOP TEN TOTAL**	**0,78**

Source: Computed by data collected from the database of TUIK.
http://tuikapp.tuik.gov.tr/disticaretapp/disticaret.zul?param1=3&param2=0&sitcrev=3&isicrev=0&sayac=5806

On the other hand, total share of these top ten trade partners of Turkey in total PCX and PCM is 62% and 78%, respectively. It can be argued that Turkey's parts and components trade heavily concentrated. More strictly speaking, first two countries for PCX and PCM account for one-third of total PCX and PCM.

3. Data and Empirical Analysis

An econometric panel data approach will be applied to determine the influence of different explanatory factors on parts and components exports and imports of Turkey to its 46 trade partners. These trade partners are those which have the highest share in Turkey's total trade volume. It is limited to 46 countries due to the lack of the data for a number of countries.[*] Nevertheless, P&Cs exports to these 46 countries in 2009 account for 81% of Turkey's total P&Cs trade. Therefore this country coverage will be sufficient to make a judgment about the determinants of Turkey's total P&Cs trade.

On the basis of theoretical considerations about fragmentation trade, the following import and export panel data models can be derived respectively:

$$\ln PCM_{tr,i,t} = \mu + \beta_1 \ln GDP_{tr,t} + \beta_2 \ln GDP_{i,t} + \beta_3 \ln Dist_i + \beta_4 NU_i + \beta_5 \ln WR_i + \beta_6 \ln RER_{tr} + \beta_7 CU_i + \varepsilon_{i,t}$$

[*] For example, no data is available for manufacturing wages of Iraq, Switzerland, Saudi Arabia, United Arab Emirates, Kazakhstan, and Turkmenistan between 1992 and 2009.

$$\ln PCX_{tr,i,t} = \alpha + \beta_1 \ln GDP_{tr,t} + \beta_2 \ln GDP_{i,t} + \beta_3 \ln Dist_i + \beta_4 NU_i + \beta_5 \ln WR_i + \beta_6 \ln RER_{tr} + \beta_7 CU_i + \varepsilon_{i,t}$$

In the models, tr, i and t symbolise Turkey, other trade partners and time respectively. A symbol ln before a variable denotes the natural logarithm. The variables are listed below with the expected sign of the regression coefficient of each explanatory variable in brackets.

Table 3. Variable Definition and Expected Signs

Dependent Variables	PCM (P&Cs import)	PCX (P&Cs exports)
Independent Variables		
GDP_{tr} (Gross Domestic Product of Turkey)	(+/?)	(+)
GDP_i (Gross Domestic Product of trade partners)	(+)	(+/?)
$Dist_i$ (Distance btw Turkey and trade partners' capitals)	(-)	(-)
CU (Dummy for Customs Union)	(+)	(+)
WR (Manufacturing wage of a country relative to Turkey	(-)	(+)
RER (Reel Exchange Rate)	(-)	(+)
NU (Internet user per 100 people)	(+)	(+)

Turkey's GDP is an indicator of the market size. 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, it is expected that average market size of Turkey will have a positive effect on PCX. Similarly, PCM, which also shows P&C export flows of each trade partner to Turkey, will be positively related with trade partner's GDP.

On the other hand, GDP of a trade partner, which is expected to be positively related with partner's final goods imports, lose its explanatory power in the case of parts and components. For example, if one tries to analyze the determinants of automotive PCX from B to A, import demand behind these exports is not A's consumer expenditures. Because in a global production chain, automobiles produced in A will probably be exported to a third country for final consumption. Thus it can be argued that the determinant of P&Cs import of A (P&Cs export of B) will be the automobile demand of a third country, say C. Therefore A's GDP is a weak measure of import demand of automobile P&Cs (Baldwin & Taglioni, 2011, p. 1-7). Therefore, we would expect that PCX will be weakly affected by GDP_i and PCM will be weakly affected by GDP_{tr}.

Distance is included as a proxy for transport (shipping) costs and other costs associated with time lags. Although technological developments alleviate its negative effect on trade, multiple border-crossing structures of global production chains still places a value on distance.

Internet usage, which is an indicator of the developments in telecommunication technologies, is expected to be positively related with PCX and PCM, as it decreases the costs of service links. Besides, Customs Union membership decreases the trade barriers on trade and will probably increase both PCX and PCM.

Labour cost differences between countries are similarly like productivity differences, expected to increase bilateral trade in P&Cs. Therefore wages of foreign countries relative to Turkey is expected to be positively related with PCX and negatively related with PCM, as Turkey's cost advantage increases.

Lastly, real exchange rate, RER, is included into the model in order to see whether a change in Turkish Lira relative to foreign currencies has an effect on PCX.

$$\text{RER} = e_{TL/i} \cdot \frac{P_i}{P_{TL}}$$

It is computed by using UNCTAD's data of Turkey's nominal cross exchange rate with each trade partner. By using the above formula, this nominal exchange rate is converted to real values. The expected sign is positive for PCX, as an increase in RER (a depreciation of Turkish Lira) will cause an increase in PCX and vice versa in PCM.

Figure 3. Heterogeneity across countries for PCM

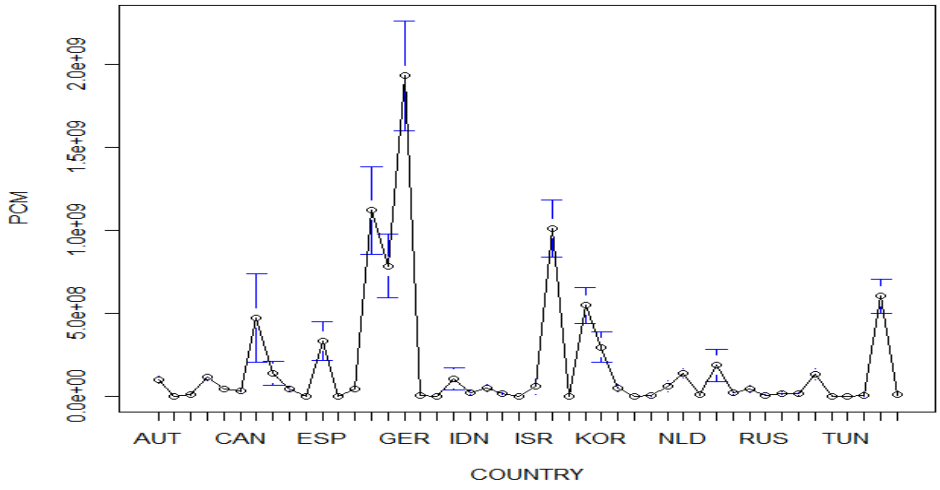


Figure 4. Heterogeneity across years for PCM

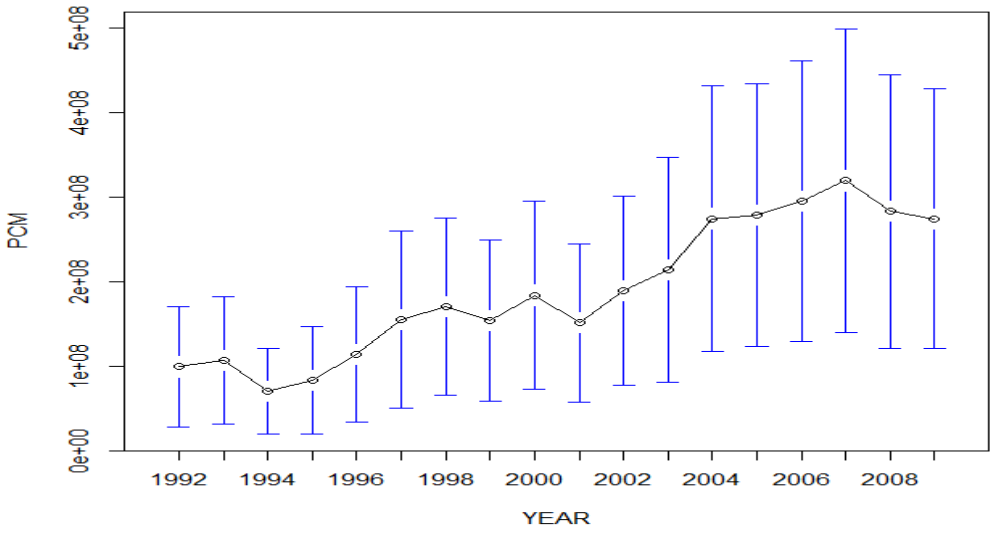


Figure 5. Heterogeneity across countries for PCX

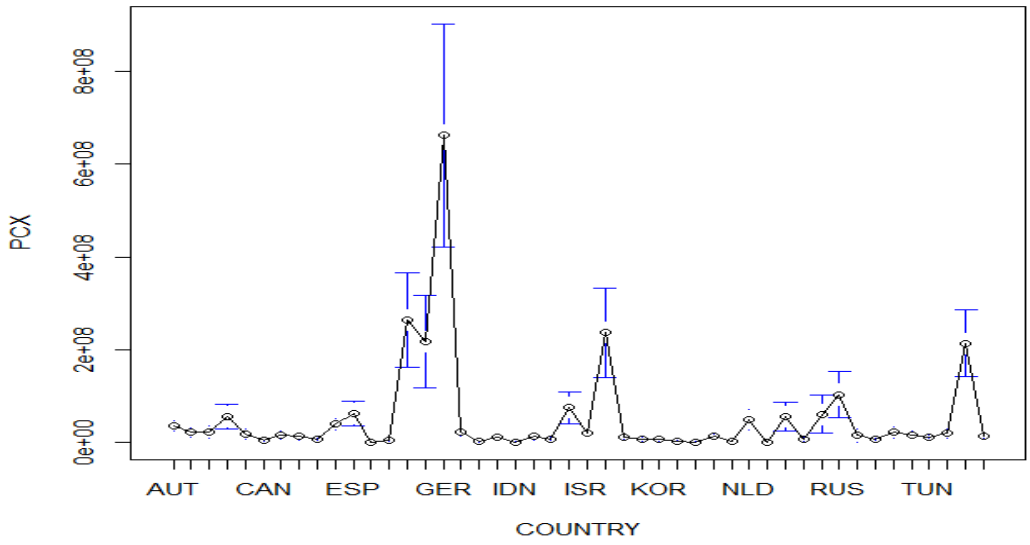
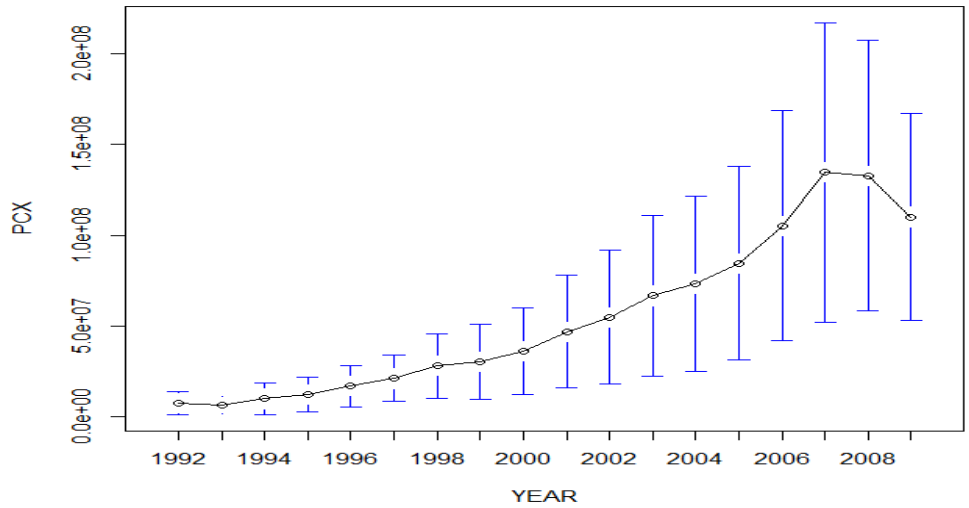


Figure 6. Heterogeneity across years for PCX



The estimation process started with the pooled ordinary least squares (OLS). But the simple OLS estimation disregards unobserved heterogeneity effects, shown in Figure 3 through Figure 6. Therefore it will probably lead to biased estimates. To overcome this problem, fixed or random effects models must be used. It is well known that these models take into consideration of the unobserved heterogeneity. For this purpose, LM-tests are used in order to decide whether there are individual and/or time effects.

Table 4. Lagrange Multiplier (LM) test of individual and/or time effects

	PCM			PCX		
	individual	time	two-way	individual	time	two-way
BP	4679.7090	14.8892	4694.5990	4524.9780	352.5168	4877.495
	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Honda	68.4084	3.8586	51.1005	67.268	18.7754	60.8419
	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
King-Wu	-	-	39.1084	-	-	51.2194
	-	-	[0.0000]	-	-	[0.0000]
GHM	-	-	4694.5990	-	-	4877.4950
	-	-	[0.0000]	-	-	[0.0000]

Notes: p-values are given the brackets.

The results can be summarized as follows: The null hypothesis of zero individual variances, as well as the null hypothesis of zero individual variances and/or zero time variances (two-way effects), are rejected by all tests considered. Also, the null hypotheses of zero time variances are rejected. Among these tests Honda (1985) test statistic is robust to non-normality. These results indicate the existence of unobservable individual and time heterogeneity. In order to identify whether the unobservable individual heterogeneity is randomly distributed or fixed, Hausman test is used.

Table 5. Hausman Specification Test for fixed and random effects models.

	PCM	PCX
Hausman	33.9895	32.9611
	[0.0000]	[0.0000]

Notes: The null hypothesis is; the individual effects are randomly distributed. p-values are given the brackets.

The Hausman test statistics with values of 33.9895 and 32.9611 reject the hypothesis that the individual effects are randomly distributed. Therefore fixed effects models are preferred.

It is important to note that fixed effects are estimated as deviations from each individual's mean. Therefore time invariant variables will be omitted. In this study, as a time-invariant variable, distance exhibits the same feature and is dropped out of the model. But percentage of internet users variable is still in the model and an alternative indicator for service link costs, as it represents prevalence of the countries' telecommunication usage. This variable is expected to be positively correlated with fragmentation trade, as its prevalence represents a proxy for the development level of telecommunication infrastructure. Nonetheless, GDP_{tr} is an only time-variant variable. Because time-variant unobserved effects are also included into the model, it may not be possible to identify the real effect of Turkey's GDP on dependent variables. Therefore, GDP_{tr} is excluded from the model.

In addition, it is well known that the literature on testing unit root in panel data econometrics has made progress (see Baltagi, 2005). The driving idea of these studies is to increase the power of tests for unit roots by combining the information coming from the

cross-section and the time dimensions, especially when both dimensions are large enough. Hence the length of dimensions is a crucial point in determining the asymptotic properties of estimators and tests proposed for unit root testing (Phillips and Moon, 1999). In practice, short dimensions limit these properties. As a result of this approach, length of time dimension with 18 years is accepted as an obstacle for unit root testing in our paper. For this, we do not check the stationarity of those variables used in the model for possible modelling of cointegration. The analysis of unit root is left to the future where data for future years would make possible longer time dimensions for this application.

Table 6. Determinants of trade in parts and components of imports (PCM) and exports (PCX) for Turkey 1992–2009

	Two-way fixed effect estimation	
Variables	PCM	PCX
intercept	-	-
$\ln(GDP_i)$	0.2440	0.6758
	[0.3452]	[0.4779]
ln(WR)	0.3442***	0.3907***
	[0.1262]	[0.1028]
ln(RER)	-0.6555***	0.1334
	[0.0943]	[0.0837]
ln(NU)	0.0891	-0.0289
	[0.0705]	[0.0275]
CU	0.3446**	0.2772**
	[0.1414]	[0.1375]
R-Squared	0.0693	0.0939
Observation	705	707
F-statistic	9.4945[p value: 0.000]	13.248 [p value: 0.000]

Notes: Standard errors based on robust Driscoll and Kraay for panel models with heteroscedasticity, cross-sectional and serial correlation by country are given in brackets, with statistical significance levels 0.01(***), 0.05(**), 0.10(*).

Time and country dummies were included in the estimation but their coefficients are not presented here for brevity. It can be seen in the Appendix Table a3.

The estimation results of fixed effects model are presented in Table 6. These results suggest that Turkey's parts and components exports apparently depend on WR and CU. Both of these two variables are statistically significant and their economical signs are in line with those expectations. In the case of PCM, significant and theoretically consistent independent variables are WR, RER and CU.

The results for "GDP_i", is not statistically significant. This might be due to the above mentioned fact that, economic mass variables of trade partners lose their explanatory power as a result of global production chain, causing trade flows to be multilateral. Hence GDP_i (a proxy used for the demand of P&Cs exports and supply of P&Cs imports of Turkey) may not be an exact measure of economic masses in the case of fragmented production stages.

A strongly significant independent variable is wage ratio, WR. Its impact on P&Cs export is greater than CU. Turkey's P&C exports increase 0.39% on average as a result of an increase in wage ratio by 1%. This result is in line with the arguments suggested by Ricardian and Heckscher-Ohlin type models on fragmentation trade. Wage ratio is a proxy for factor

endowment differences. Hence MNEs from developed countries shift their standardized and relatively low skilled production stages to Turkey in order to take advantage of wage differences. A surprising result is about the effect of wage ratio on PCM. Its effect is statistically significant, but its sign is not parallel with theoretical expectations. Theoretically, it is expected that an increase in WR would have a negative effect on PCM as it shows a cost disadvantage of trade partners. But in the case of Turkey, positive relationship between WR and PCM may be the result of the fragmented-chain structure of manufacturing industry. As WR increases, Turkey's PCX increases. Nonetheless, Turkey's PCM increases as well, which may be a result of the import dependency of exports.

Customs Union membership of Turkey is statistically significant for both PCX and PCM. As a result of a 1% increase in CU, PCX and PCM increase 0.27% and 0.34%, respectively.

Internet usage is statistically insignificant for PCX. In the case of PCM, it is statistically significant, but has a small coefficient. This might be a reason of other independent variables which are strongly related with trade flows.

Another interesting result is about Turkey's reel exchange rate, RER. RER is insignificant for PCX, but significant for PCM. As RER decreases, PCX (PCM) is expected to decrease(increase) as a result of an overvaluation of Turkish Lira. But this mechanism might not happen, as parts and components production is due to long term outsourcing agreements or as large amounts of FDI with managerial knowledge and technological know-how are directed to a new production block. Hence once established, it is not easy to shift a production process. The reason for this exchange rate mechanism to hold for PCM, but not for PCX is may be related with the content of parts and components exports and imports. Because the link between exchange rate policy and trade flows differs from one industry to another. Hence it might be expected that Turkey's parts and components exports would generally be characterized by fixed coefficient production techniques (Leontief technology) and, therefore, the substitutability of components obtained from various sources would be rather limited. In contrast, parts and components imports might consist of more price elastic and easy-to-substitute inputs and are easily affected by variations in RER. This is a strongly disputed issue which should be analyzed in more detailed industry-specific studies in the future.

Lastly, the small values of R-square both for PCX and PCM might be a serious problem for prediction. But the models are used only for inference not for prediction. For this reason, statistical reliability of the models is preferred to be more important than high R-square values.

Conclusion

In the present paper, parts and components trade of Turkey with its trade partners, as an indicator for international fragmentation of production, was analyzed in order to identify the main determinants of the establishment of international production networks in Turkey.

According to the theoretical models of fragmentation, variables such as technological level, factor endowments, geographical distance, tariffs and market size come out as main determinants of the position that a developing country would take in a chain. In order to test the explanatory power of these variables on fragmentation trade of Turkey, gravity model of trade is used with a panel data estimation technique.

Overall, the estimation results indicate that integration of Turkey into the international division of labour cannot solely be explained by labour cost advantages, although these advantages have strong effect on both PCX and PCM. Besides, Turkey's inclusion into the

Customs Union is an important country specific variable which has positive effect on both PCX and PCM for Turkey.

An interesting result is about the relationship of labour costs with PCM. In contrast to theoretical expectations, Turkey's cost advantage in the form of decreasing wages has a positive relationship with PCM. This might be a result of a fragmented-chain structure of manufacturing industry. As Turkey's parts and components exports increase with a cost advantage, its parts and components imports increase as a consequence of import-dependency of exports.

Lastly, the effect of real exchange rate on parts and components exports is not significant. In the case of imports, RER has a significant and negative relationship with parts and components. This maybe a result of parts and components production structure of export industries where substitution of inputs is not easy and different from imports. Nonetheless, future work with a more focus on industry characteristics would probably be more fruitful in analyzing the relationship between RER and fragmentation trade.

Appendix

Table a1 46 Countries and their abbreviations

AUT	Austria	FIN	Finland	ITA	Italy	ROM	Romania
AZE	Azerbaijan	FRA	France	JOR	Jordan	RUS	Russia
BUL	Bulgaria	GBR	Great Britain	JPN	Japan	SVK	Slovakia
BLX	Belgium-Luxembourg	GER	Germany	KOR	Korea	SVN	Slovenia
BRA	Brazil	GRC	Greece	LTU	Lithuania	SWE	Sweden
CAN	Canada	HRV	Croatia	LVA	Latvia	SYR	Syria
CHN	China	HUN	Hungary	MAR	Morocco	TUN	Tunisia
CZE	Czech Rep.	INA	Indonesia	MYS	Malaysia	UKR	Ukraine
DNK	Denmark	IND	India	NLD	Netherlands	USA	United States
EGY	Egypt	IRL	Ireland	NOR	Norway	ZAF	South Africa
ESP	Spain	IRN	Iran	POL	Poland		
EST	Estonia	ISR	Israel	PRT	Portugal		

Table a2 Data Sources

Label	Definition	Data Source
PCX	Trade flows of parts and components of SITC 7 & 8 product categories	TUIK, http://tuikapp.tuik.gov.tr/disticaretapp/menu.zul
Export and Import Unit Value Indices	Deflators for exports & imports	International Monetary Fund (2012): International Financial Statistics (Edition: December 2012). ESDS International, University of Manchester. DOI: http://dx.doi.org/10.5257/imf/ifs/2012-12
GDP	GDP in constant US $ (base year=2005)	World Bank, World Development Indicators, Ed. April 2012, ESDS International, University of Manchester. DOI: http://dx.doi.org/10.5257/wb/wdi/2012-04
RER	Real Exchange Rate (Real values are computed by using Turkey's and each trade partners CPI. base year=2005)	Nominal Cross Exchange Rate: UNCTAD, http://unctadstat.unctad.org/TableViewer/tableView.aspx CPI: World Bank, World Development Indicators, Washington DC, April 2012, ESDS International, University of Manchester, http://dx.doi.org/10.5257/wb/wdi/2012-04, 10/01/2013.
CU	Customs Union Agreement between Turkey and EU countries	World Trade Organization http://www.wto.org/english/tratop_e/region_e/summary_e.xls
Distance	Geographical distance between capitals of Turkey and its trade partner	World Bank Trade and Production Database, http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:21085384~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html
Wage Ratio	Relative wage ratio (Wi/Wtr) where W represents manufacturing wages & salaries of a country divided by the number of employees.	United Nations Industrial Development Organization, INDSTAT2, Industrial Statistics Database, Ed. 2012 ESDS International, University of Manchester. DOI: http://dx.doi.org/10.5257/unido/indstat2/2012
PD	Product Differentiation	Authors' own computation by using TUIK data

Table a3. Time and Individual Effects for PCM and PCX

Fixed effects for individuals						Fixed effects for time		
Country	PCM	PCX	Country	PCM	PCX	Year	PCM	PCX
AUT	11.3250	-1.4377	ISR	10.5961	-1.3627	1992	10.6150	-3.8623
AZE	7.8590	2.0170	ITA	13.3784	-1.0149	1993	10.1642	-3.4796
BGR	10.3303	0.7181	JOR	6.2063	0.8662	1994	9.0000	-3.1582
BLX	11.4070	-1.5685	JPN	9.5402	-4.8480	1995	8.7668	-2.7563
BRA	10.3473	-3.1156	KOR	7.8687	-3.0079	1996	8.8708	-2.3445
CAN	10.0367	-4.1552	LTU	10.7238	-0.8116	1997	9.3879	-1.9840
CHN	12.7471	-1.2808	LVA	5.6293	-2.0593	1998	9.3109	-1.6089
CZE	9.5692	-1.0281	MAR	7.5547	0.0854	1999	9.2505	-1.6302
DNK	9.1070	-2.7600	MYS	10.5097	-1.9851	2000	9.3432	-1.3347
EGY	6.1311	0.6630	NLD	11.4186	-2.0105	2001	9.1662	-1.2972
ESP	12.1779	-1.9344	NOR	7.5721	-4.4991	2002	9.2025	-1.1138
EST	6.2746	-3.6306	POL	11.5861	-0.7105	2003	9.2915	-1.0555
FIN	10.3602	-3.2169	PRT	10.2883	-2.1682	2004	9.6174	-0.9168
FRA	13.3199	-0.9355	ROM	10.7913	0.8138	2005	9.6928	-0.6338
GBR	13.1425	-1.3313	RUS	7.7867	0.7174	2006	9.8103	-0.4183
GER	13.7355	-0.2355	SVK	10.6426	-2.1638	2007	9.9180	-0.2652
GRC	8.7051	-1.8278	SVN	10.1138	-1.5498	2008	9.4170	-0.1180
HRV	7.0083	-2.4667	SWE	10.0873	-2.2343	2009	9.7258	-0.0240
HUN	8.1492	-0.5759	SYR	3.6133	0.9187			
IDN	5.1597	-1.8268	TUN	6.2977	-0.0802			
IND	9.1890	-1.8774	UKR	8.7949	0.3780			
IRL	8.4605	-2.6922	USA	12.3357	-2.2359			
IRN	2.3057	1.4404	ZAF	7.5654	-1.1248			

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