

MULTINATIONAL FIRMS AND INTERNATIONAL FRAGMENTATION OF PRODUCTION: THE CASE OF POLAND

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ABSTRACT

The worldwide liberalization of trade and advances in telecommunications, transportation and information management have promoted global production networks in which a vertically integrated production nexus is split into separate stages that are located in different countries. Numerous anecdotal evidence suggests that multinational firms play an important role in international fragmentation of the value chain, however, formal empirical studies are still scarce. This is especially true for the Central European countries that have recently joined the European Union. Therefore, the goal of this study is to evaluate empirically the contribution of multinational firms to international fragmentation of production using bilateral panel data for Poland and its OECD trading partners over the period 1992-2004. The estimation results show that both the volume of trade and the share of intra-industry trade are positively related to the number of multinational firms operating in Poland, however, these relationships are not statistically significant when panel data estimation techniques are used.

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KEYWORDS: Bilateral trade, gravity equation, foreign direct investment, Poland.

1. INTRODUCTION

Multinational firms have frequently been seen as catalysts facilitating economic growth and integration of many developing and transition countries with the world economy. For example, Kamiński and Ng (2000, p. 1) argue that “integration into the production and marketing arrangements of the MNCs rather than the pursuit of an autarchic national development strategy offers the most efficient way to take advantage of growth opportunities offered by the global economy. It also seems to be the only option available today.”

This view is in line with the theory of vertically-integrated multinational enterprise developed by Helpman (1984, 1985) and extended in the subsequent

work by Helpman and Krugman (1985, ch.12 and 13), Venables (1999), Zhang and Markusen (1999), and Markusen (2002). According to this theory multinational firms split up a vertically integrated production process into separate stages that can be located in different countries. This fragmentation of production opens up the new possibilities for exploiting gains from specialization.

In the last few decades the worldwide liberalization of trade and FDI, on the one hand, and advances in telecommunications, transportation and information management, on the other, have promoted the emergence of global production networks in which vertical stages of final goods production are fragmented across countries. Following the fall of communism and the collapse of the central planning in the early 1990s Central and Eastern European countries (CEECs) have started to participate in the international division of labor. The opening up of the CEECs to international trade and foreign investment was reflected in rapidly increasing trade and FDI flows with the OECD countries and the shift from the inter-industry trade towards intra-industry trade.

The main goal of this paper is to study the role of multinational firms in international fragmentation of production in Central and Eastern Europe by focusing on Poland's bilateral trade data before its entry into the European Union in 2004. Poland is the largest country in the region that has attracted a major share of FDI invested in the region, hence it can be treated as a representative country for the whole region.

The structure of this paper is as follows. In Section 2 the survey of the relevant literature is presented. In Section 3 theoretical framework is discussed. In Section 4 statistical methodology and data description are presented. In Section 5 empirical results are discussed. Finally, Section 6 summarizes and concludes with potentially fruitful directions for future studies.

2. LITERATURE REVIEW

International fragmentation of production along with increased flows of FDI has become one of the major stylized facts on globalization and received substantial empirical attention, although not necessarily in the context of transition economies where empirical evidence still remains scarce. For example, Campa and Goldberg (1997), Feenstra (1998), Hummels *et al.* (2001), and Yeats (2001) find that trade in intermediate inputs has grown much faster than trade in final goods in many developed countries and a significant fraction of this trade was intra-firm trade that took place within multinational firms between parents and their affiliates giving rise to vertical production networks. According to Hanson *et al.* (2005, p.664) "the term 'vertical' captures two key features of these networks: (i) within these firms the parent and each affiliate performs a narrow rather than a broad range of production activities, and (ii) the parent and its affiliates are linked by intra-firms flows of inputs and output". Therefore, in the light of the new trade theory vertical production

networks can be seen as a form of vertical FDI through which multinational firms spread across different locations the different activities that they perform such as R&D, input production and input processing.

In the context of transition economies, the early study by Djankov and Hoekman (1996) documented very high growth rates of exports to the OECD nations from Central and Eastern European countries. In particular they investigated the role of vertical intra-industry trade in the expansion of their trade to find that it consists of sourcing of inputs from the European Union (EU) suppliers that were used in production of final goods exported by the CEECs to the West. They found a strong relationship between growth in vertical intra-industry trade and export performance. This reliance was the highest in Visegrad-4 (V-4) countries (i.e. the Czech Republic, Hungary, Poland and Slovakia) as well as in Slovenia. Similarly, Kamiński and Ng (2000) documented that trade in parts as well as trade falling within "information revolution", furniture and automotive networks has driven developments in trade in manufactures between CEECs and the EU. In the Polish context Kamiński and Smarzyńska (2001) reported that also Poland in the 1990s experienced faster growth of trade in intermediate inputs that in final products.

More recently, Ando and Kimura (2005) compared international fragmentation of production in Central and Eastern Europe and South East Asia to report two major differences between these regions. In particular, they found that cross border production sharing among the CEECs is weak and the Western Europe is predominantly important as the sales destination of CEE operations, while vertical production networking in South East Asia involves many countries in the region and sales destinations of East Asian products are more diversified. Moreover, in their production networks in Central and Eastern Europe seem far from being completed as imports of key parts and components as well as finished machinery products still seem to be important in the CEECs. However, location advantages of the CEECs for production activities may not be attractive enough to consider them as an export platform to markets outside the EU. In particular, differences in wages between Western Europe and the CEECs are not very large and are decreasing over time. Therefore, labor-intensive production activities may soon be relocated further to the East to latecomers such as Belarus and Ukraine once their institutional environment is improved.

Although the majority of the aforementioned studies documented the increasing shares of intermediate goods in total trade relatively little attention has been paid to the explanation of this phenomenon and to the cross-border operations of multinational firms. It is well known that V-4 countries attracted a substantial amount of FDI in the automotive and consumer electronics industries and it is conventional wisdom that much of the export growth has been associated with investments in these sectors. However, no formal empirical evidence on the role of multinational firms in shaping the pattern of Poland's foreign trade has been presented in the previous studies. Therefore, the present study aims at filling at

least a part of the existing gap in this important fields of study and contributing to the better understanding of the nature of foreign direct investment in Central and Eastern Europe.

3. THEORETICAL FRAMEWORK

In this section we adapt a simple model of a vertically-integrated multinational firm with monopolistic competition developed by Helpman (1984) and extended by Helpman and Krugman (1985, ch. 12 & 13) to investigate the relationship between the number of multinational firms and the total volume of trade as well as the share of intra-industry trade in total trade. The original Helpman model of a vertically-integrated multinational enterprise can be viewed as an extension of the Chamberlin-Heckscher-Ohlin (C-H-O) model to the case in which differences in relative factor endowments between trading partners are so large that trade alone is unable to bring factor price equalization across countries.

When factor rewards are not equalized there is an incentive for firms to internationalize their production activities and split up a vertically integrated production nexus into its separate fragments that differ in terms of their input requirement and locate them in different countries according to their comparative advantage. For example, labor intensive activities, such as assembly of final products, can be performed in labor abundant countries while human capital intensive activities, such as provision of headquarter services or production of intermediate inputs, can be performed in human capital abundant countries. This in turn raises the relative demand for labor in the host country and reduces it in the parent country leading to factor price equalization, while the reverse holds for human capital. Thus in the model of a vertically integrated multinational firm FDI is necessary in bringing down differences in factor rewards across countries and improving the efficiency of world resource allocation.

Both Helpman (1984) and Helpman-Krugman (1985) theoretical frameworks are based on the 2x2x2 C-H-O model with complete specialization in production. These frameworks assume two internationally immobile factors of production: human capital (H) and labor (L), two goods that require inputs of both factors although in different proportions: a human capital intensive differentiated good (X) that is produced in many varieties under monopolistic competition and increasing returns to scale, and a labor intensive homogenous good (Y) produced under perfect competition and constant returns to scale, and two countries: a human capital abundant country (A) and a labor abundant country (B). It must be noted that the aforementioned frameworks are highly stylized and based on the number of simplifying assumptions. In particular, production technologies and consumer preferences are assumed to be the same in both countries.¹ Moreover, it is assumed that there are no barriers to trade and international fragmentation of production is costless.²

Multinational firms are introduced into the differentiated good sector by considering differentiated product X as the outcome of human capital H , labor L and intermediate input Z .³ It is assumed that the intermediate input is also a differentiated product that is not subject to arm's length transactions and must be supplied internally within the firm. The production of this input is assumed to be the most human capital intensive activity, while the assembly to be of intermediate human capital intensity. The intermediate input must be produced before the assembly of good X can take place. The provision of the intermediate input and the assembly can be geographically separated from each other and located in different countries in response to differences in factor rewards across countries.

All models of a vertically integrated multinational firm assume complete specialization in production both at the country and the firm levels. On the one hand, all the resources of the parent country are employed in production of differentiated product (provision of the intermediate input and final product assembly), and the output of the homogenous good equals zero, while the host country produces both differentiated good and supplies the world output of the homogenous good $Y^B = \bar{Y}$. On the other hand, each firm in each country produces a different variety of the differentiated product.

The host country exports the homogenous product and the varieties of differentiated product produced partly by n^B indigenous firms in country B and partly by m multinational firms with their headquarters located in the parent country.⁴ With identical and homothetic consumer preferences assuming that trade is balanced it can be shown that the total volume of trade equals twice the exports of the host country:

$$VT = 2s^A [\bar{Y} + px(n^B + m)] \quad (1)$$

where s_A denotes the share of country A in total world spending $s_A + s_B = 1$, p the relative price of a representative variety of differentiated good X expressed in terms of homogenous good Y , and x the output of a representative variety of differentiated good X .

The relationship between the number of multinational firms and the volume of trade can be summarized in the following proposition:

PROPOSITION 1: The volume of bilateral trade between the parent and the host countries increases with the number of multinational firms operating between them, other things equal.

The theoretical model allows us to study not only the relationship between the number of multinational firms and the volume of trade but also the nexus FDI and the share of intra-industry trade. The volume of intra-industry trade is generally defined as the total volume of trade minus the sum over all sectors of the absolute value of the difference between exports and imports. Hence in this model the volume of intra-industry trade equals:

$$VT_{i-i} = 2px \min \left[s^A (n^B + m), s^B (n^A - m) \right] \quad (2)$$

Dividing (2) by (1) yields the share of intra-industry trade in total trade:

$$s_{i-i} = \frac{VT_{i-i}}{VT} = \frac{px \min \left[s^A (n^B + m), s^B (n^A - m) \right]}{s^A \left[\bar{Y} + px(n^B + m) \right]} \quad (3)$$

It can be noticed that the relationship between the number of multinational firms and the share of intra-industry trade is not clear-cut and depends on the extent of differences in relative factor endowments between the parent and the host countries that in turn determine differences in production structures of their economies. The following two cases can be distinguished. When differences in relative factor endowments are not too large and the parent country is a net exporter of differentiated products, $s^B(n^A - m) > s^A(n^B + m)$, the share of intra-industry trade can be written as:

$$s_{i-i} = \frac{VT_{i-i}}{VT} = \frac{px \left[s^A (n^B + m) \right]}{s^A \left[\bar{Y} + px(n^B + m) \right]} = \frac{px(n^B + m)}{\bar{Y} + px(n^B + m)} \quad (4)$$

In this case it can be easily demonstrated that there exists a positive relationship between the share of intra-industry trade and the number of multinational firms. However, when differences in relative factor endowments between the parent and the host countries grow large the home country becomes a net importer of the differentiated product, $s^B(n^A - m) < s^A(n^B + m)$, the share of intra-industry trade can be written as:

$$s_{i-i} = \frac{VT_{i-i}}{VT} = \frac{px \left[s^B (n^A - m) \right]}{s^A \left[\bar{Y} + px(n^B + m) \right]} \quad (5)$$

Therefore, in the presence of large differences in factor proportions the relationship between the number of multinational firms and the share of intra-industry trade turns negative. The nexus between the number of multinational firms and the share of intra-industry trade can be summarized in the following proposition:

PROPOSITION 2: The share of intra-industry trade in bilateral trade between the parent and the host country depends on the number of multinational firms, however, the direction of this relationship can go either way. When the parent country is a net exporter of differentiated products this relationship is positive, otherwise it is negative.

Although the theoretical framework predicts that the share of intra-industry trade is related to the number of multinational firms in production activities in the host country the direction of this influence cannot be identified *a priori* and has to be determined empirically. As the differences in relative factor endowments between Poland and its OECD trading partners are not that large and are steadily decreasing

over time due to the on-going process of income convergence we should expect a positive rather than a negative relationship between the number of multinational firms and the share of intra-industry trade in bilateral trade.

4. STATISTICAL METHODOLOGY AND DATA DESCRIPTION

In the preceding section we discussed two main research hypotheses concerning the relationships between the number of multinational firms and the volume and the structure of international trade derived directly from a theoretical model of the vertically-integrated multinational enterprise. The first hypothesis postulated a positive impact of multinational firms on the volume of bilateral trade due to intra-firm trade in parts and components between Poland and its OECD trading partners. The second hypothesis predicted a positive nexus between the number of multinational firms and the share of intra-industry trade in bilateral trade between Poland and OECD countries due to the increased volume of intra-industry trade.

However, in addition to the number of multinational firms there are also other factors that influence the volume and the structure of trade that must be taken into account in our empirical study. These factors include country-pair characteristics such as country size, factor proportions, trade costs, etc. Such factors are frequently stressed by the trade theory and find support in numerous empirical studies. Therefore, the impact of these factors must be controlled for in our estimating equations. Moreover, in addition to the explanatory variables derived directly from the theoretical model there might also exist factors that are country specific. Examples of such factor include contiguity, common culture, mental proximity or historical ties.

The impact of country-specific effects on the volume and the structure of trade can be captured by employing appropriate estimation techniques that allow controlling for such effects. It has been frequently argued that the impact of the factors that are country-pair specific and orthogonal to the included explanatory variables can be appropriately captured using the fixed effects estimator. However, it may happen for some reasons that country-specific effects may be random instead of fixed. Therefore, to test for robustness of empirical results our equations must be re-estimated using also the random effects estimator. The Hausman test will be used to determine the proper estimation format.

Moreover, in addition to allowing for country specific effects we must also control for trade policy changes and business cycle effects resulting from the opening up of Poland's economy to international trade and FDI in the 1990s. Therefore, to study the relationship between the number of multinational firms and the volume and the structure of trade we employ the generalized estimating equation which can be specified as follows:

$$\ln TRADE_{it} = \alpha_0 + \alpha_1 \ln MNE_{it} + \alpha_2 \ln GDPSUM_{it} + \alpha_3 \ln GDPSIM_{it} + \alpha_4 \ln HLDIFF_{it} + \alpha_5 \ln HLSUM_{it} + \alpha_6 \ln DISTANCE_i + u_t + v_i + \varepsilon_{ijt} \quad (6)$$

where: $TRADE_{it}$ is the bilateral volume of trade or the share of intra-industry trade in total bilateral trade between Poland and country i in year t , depending on the model specification; MNE_{it} is the number of multinational firms coming from the i -th OECD trading partner that operated in Poland in year t ; GDP_{SIM}_{it} is the measure of GDP similarity of Poland and its i -th trading partner in year t ; GDP_{SUM}_{it} is the sum of GDP of Poland and its i -th trading partner in year t ; $HLDIFF_{it}$ is the measure of the absolute difference in human capital-labor ratios between Poland and its i -th partner in year t ; $HLSUM_{it}$ is the measure of the sum of human capital-labor ratios between Poland and its i -th partner in year t ; $DISTANCE_i$ is the measure of geographic distance between Poland and its i -th trading partner; u_t is the individual time effect; v_{it} is the individual country effect that may be fixed or random, depending on the specification; ε_{it} is the error term and α 's are the parameters that need to be estimated; $i = 1, \dots, 29, t = 1992, \dots, 2004$. All variables except the share of intra-industry trade are expressed in logs. If multinational firms are indeed contributing to international fragmentation of production and the development of trade in intermediate products between Poland and the OECD countries the estimated parameters on the MNE variable should display a positive sign and be statistically significant.

Our dependent variables in the estimating equations are the log of bilateral volume of Poland's trade and the share of intra-industry trade in total trade with the OECD countries. The volume of trade is defined as the sum of exports and imports while the share of intra-industry trade in total trade is calculated as the Grubel-Lloyd (1975) index using SITC 3-digit product categories. The data on Polish bilateral trade flows were culled from the *Yearbook of Foreign Trade Statistics* published annually by the Central Statistical Office (CSO) of Poland. Bilateral trade data were originally expressed in the current US dollars and to assure their comparability between the years of our sample were converted to constant 2000 prices using the US GDP deflator. Data on the US GDP deflator were obtained from the *World Development Indicators* (WDI) CD-ROM (2006) published by the World Bank.

The main explanatory variable is the log of the number of multinational firms coming from a particular OECD country. This number is obtained from the annual publication of Central Statistical Office (CSO) of Poland entitled *The Economic Activity of Entities with Foreign Capital Participation in Poland*. Our main control variables include the logs of the country size variables and the logs of factor proportion variables as well as geographic distance. The country size variables can be calculated using GDP volumes for Poland and its OECD trading partners. The GDP data comes from the WDI CD-ROM and is expressed in constant 2000 US dollars and evaluated in PPP terms. The absolute size of trading countries is measured by the sum of GDPs of Poland and its OECD trading partner. The relative country size calculated using a two-country version of Helpman's (1987) size similarity index that describes the dispersion of GDP within a country-pair.

Trade models with incomplete specialization in production predict that trade is affected by the factor proportion variables and their impact differs across different

models. To control for their impact on trade we include both sums and differences in relative factor endowments of trading countries.⁵ Unfortunately, we cannot use direct measures of factor proportions as the human capital stock per worker data is not available. Therefore, to proxy for the human capital-labor sums and differences between Poland and its OECD trading partners we use per capita GDP sums and differences. Data on GDP per capita used to compute these sums and differences also come from the WDI CD-ROM and are expressed in constant 2000 US dollars and evaluated in PPP terms to assure their cross-country comparability.

Recent trade models predict also that distance negatively affects both the volume and the share of intra-industry trade in total trade.⁶ The role of distance in the determination of the bilateral volume and the structure of trade has been confirmed by many empirical studies of bilateral trade flows that find distance a significant barrier to international trade. Therefore, we also include in our regressions a measure of geographic distance between the capitals of trading partners. We choose to measure distance in the simplest possible way by using a "as the crow flies" distance between the capital city of Poland - Warsaw and the capitals of Poland's OECD trading partners expressed in kilometers. The distance data is available on-line at: <http://www.indo.com/distance>. Finally, to control for business cycle effects and trade policy changes we include also into the specification time dummies for particular years of our sample.

5. ESTIMATION RESULTS

In this section we present and discuss two sets of estimation results obtained for the volume of trade and the share of intra-industry trade in Poland's trade with the OECD countries, respectively. The estimation results for the volume of trade are presented in Table 1, while the estimation results for the share of intra-industry trade in total trade are presented in Table 2.

The baseline estimates for the relationship between volume of trade and the number of multinational firms obtained via the traditional OLS approach that assumes the equality of country specific effects across all trading partners but without controlling for individual time specific effects are presented in column (1) of Table 1. These results show that the estimated parameter on the MNE variable displays the expected positive sign and is statistically significant already at the 1% level of statistical significance. Moreover, all estimated parameters on control variables are also statistically significant at the 1% level of statistical significance.

To investigate the robustness of these estimates in column (2) we control for the individual time effects by adding to the specification of our estimating equation time dummy variables for specific years of our sample. The importance of controlling for time effects is confirmed by the F-test that shows that these dummy variables are jointly statistically significant. However, our empirical results obtained when individual time effects are taken into account do not change much compared to the

Table 1
Volume of Trade Regression Results
(t- and z-stats in parentheses)

<i>Variable</i>	(1)	(2)	(3)	(4)
MNE	0.045*** (3.89)	0.044*** (3.90)	0.014 (1.00)	0.015 (1.23)
GDPDISP	0.938*** (18.16)	0.864*** (16.27)	-1.283 (1.35)	0.782*** (5.39)
GDPSUM	1.714*** (39.50)	1.682*** (39.11)	-1.767 (0.99)	1.701*** (13.16)
HLDIFF	-0.367*** (4.61)	-0.066 (0.65)	0.247 (1.46)	0.191 (1.40)
HLSUM	1.510*** (6.93)	0.469 (1.49)	2.125 (1.61)	-0.231 (0.51)
DISTANCE	-1.177*** (34.02)	-1.187*** (35.03)		-1.246*** (13.52)
CONSTANT	-36.086*** (18.99)	-27.542*** (10.37)	35.296 (0.99)	-22.841*** (4.82)
Time effects	NO	YES	YES	YES
F-test for time effects (p-val)		2.44 (0.005)	3.32 (0.000)	56.60 (0.000)
Country effects	NO	NO	FIXED	RANDOM
F-test for country effects (p-val)			23.96 (0.000)	
LM-test for country effects (p-val)				856.77 (0.000)
Hausman-test (p-val)				19.12 (0.936)
R ² (within)			0.725	0.721
R ² (between)			0.167	0.928
R ² (overall)	0.900	0.904	0.082	0.906

N = 377 in all specifications.

baseline OLS estimation results reported in column (1). The estimated parameter on the MNE variable remains positive and statistically significant at the 1% level of statistical significance. Also almost all control variables are statistically significant at the 1% level except the factor proportion variables that lose their previous statistical significance.

To verify the robustness of the OLS estimates we exploit the panel nature of our dataset and re-estimate our equation allowing for country-pair specific effects. In column (3) we report estimation results obtained using the fixed effects estimator and in column (4) we report parameter estimates obtained using the random effects estimator. The appropriateness of controlling for individual country effects in the case of fixed effects is confirmed by the F-test while in the case of random effects it is

confirmed by the LM test. However, the Hausman test favors the use of the random effects as the appropriate estimation format.

In both cases the estimated parameter on the MNE variable displays a positive sign, however, it is statistically not significant which suggests that the volume of Polish foreign trade is not related to the number of foreign firms operating in Poland. The majority of control variables are now not statistically significant.

Table 2
Share of Intra-Industry Trade Regression Results
(t- and z-stats in parentheses)

<i>Variable</i>	(1)	(2)	(3)	(4)
MNE	0.005*** (2.64)	0.005*** (2.82)	0.004 (1.56)	0.004 (1.81)
GDPDISP	0.036*** (4.40)	0.020*** (2.48)	-0.172 (0.97)	0.006 (0.27)
GDPSUM	0.067*** (9.63)	0.060*** (8.92)	-0.155 (0.47)	0.059*** (3.24)
HLDIFF	-0.096*** (7.59)	-0.096** (1.82)	0.012 (0.38)	0.001 (0.05)
HLSUM	0.312*** (8.99)	0.099** (2.02)	0.071 (0.29)	-0.030 (0.39)
DISTANCE	-0.090*** (16.43)	-0.092*** (17.49)		-0.096*** (7.37)
CONSTANT	-3.238*** (10.70)	-1.454*** (3.52)	3.320 (0.50)	-0.453 (0.59)
Time effects	NO	YES	YES	YES
F-test for time effects		3.97	2.75	57.39
(p-val)		(0.000)	(0.001)	(0.000)
Country effects	No	No	Fixed	Random
F-test for country effects			13.24	
(p-val)			(0.000)	
LM-test for country effects				512.95
(p-val)				(0.000)
Hausman-test				3.54
(p-val)				(0.999)
R ² (within)			0.526	0.523
R ² (between)			0.009	0.741
R ² (overall)	0.630	0.663	0.007	0.671

N = 377 in all specifications.

The estimation results for the share of intra-industry trade that are presented in Table 2 are direct counterparts of those reported in Table 1. The baseline estimates obtained via the traditional OLS approach and without controlling for individual time

effects are presented in column (1) in Table 2. The parameter estimate on the MNE variable, similarly to the one obtained in the case of the volume of trade regression, also displays a positive sign, it is statistically significant at the 1% level. Moreover, all the parameter on control variables are also statistically significant at the 1% level.

In column (2) we report estimation results obtained also by OLS but having controlled for individual time effects. In this case the parameter estimate on the MNE variable still displays the positive sign and remains statistically significant at the 1% level, although statistical significance of some of the control variables decreases.

In columns (3) and (4) we report estimation results obtained via the fixed and the random effects estimators, respectively. Similar to the case of trade volume regressions, both the F-test and the LM test confirm the appropriateness of controlling for individual country effects, while the Hausman test advocates the use of the random effects as the appropriate estimation format. Moreover, it can be noticed that, in both cases the estimated parameter on the MNE variable displays a positive sign, but it is not statistically significant. This applies both to the case of the fixed and the random effects estimators.

Therefore, it can be concluded that statistically significant relationship exists neither between the volume of trade and the number of multinational firms operating in Poland nor between the share of the intra-industry trade and the number of multinational firms.

6. CONCLUSION

In this paper we studied the role of multinational firms coming from the OECD countries in international fragmentation of production processes in Poland using bilateral panel data. Two complementary research hypotheses concerning the impact of multinational firms on the volume and the structure of Poland's foreign trade were tested empirically. It was found that although the number of multinational firms is positively related both to the volume and the share of intra-industry trade in total bilateral trade between Poland and OECD countries these relationships are statistically significant only when the simple OLS estimation techniques are used. The use of more appropriate panel data techniques changes, however, drastically the empirical role of the multinational firms in development of the trade volume and the share of intra-industry trade.

Therefore, other than cost reduction motives may explain the operation of multinational firms in Poland. These findings are in line with the findings of other studies pointing at host market seeking rather than efficiency seeking as the primary reason for investing in Poland. Therefore, it can be concluded that at the aggregate country level multinational firms that operate in Poland are more interested in serving the local market rather than cross-border production sharing.

This does not, however, mean that vertical activity of multinational firms is non-existent or unimportant. There are many examples of multinational firms and

industries in which that operate that export most of their output produced in Poland to the world markets. Therefore, the assembled macroeconomic evidence should, however, be complemented by in future by more detailed industry-specific studies. Therefore, in future work in order to identify industries where potentially international fragmentation of production may occur statistical data at lower levels of aggregation should be used.

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NOTES

1. The symmetry of the setup on the supply side has been recently criticized by the firm heterogeneity strand in the new international economics literature that stresses productivity differences. However, these new studies, such as Helpman *et al.* (2004), focus mainly on horizontally integrated MNE and the choice between exporting and FDI. In the case of international fragmentation aimed at cost reduction the symmetry does not change, however, the positive relationship between vertically-integrated MNE and trade predicted by the theory.
2. According to Shatz and Venables (2000, p. 132) relaxing these assumptions brings two new forces into play: "The first is that transport costs on trade in final goods destroy factor price equalization (...); the consequent factor price differentials increase the incentives to split the production. The second is that costs of splitting production (...) make multinational production less attractive. Whether firms go multinational – and where they locate different activities – depends on the interaction between these forces".
3. The main model predictions easily generalize to more complex settings with many intermediate goods, hence the intermediate input can be treated as a complex product that includes many varieties of intermediate inputs.
4. In the extreme case of the model either n^B or m can be equal to zero. If $n^B = 0$ all output of the differentiated product is supplied by subsidiaries of multinational firms and there are no indigenous firms operating in sector X in country B. If $m = 0$ there is no foreign involvement in production activities in country B and the model simplifies to the standard C-H-O model with complete specialization in production.
5. It is often argued that if there is incomplete specialization in production, the impact of factor proportion variables is correctly measured only when both capital-labor sums and differences are simultaneously included in the estimating equation (Cieřlik, 2005; 2009).
6. Recent theories of firm heterogeneity and trade provide a rationale for the negative relationship between firm export participation and distance. As trade costs increase with distance lower-productivity firms no longer find it profitable to incur the costs of exporting. See Bernard *et al.* (2007) for the recent survey of this literature.

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