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OUTWARD FOREIGN DIRECT INVESTMENT AND INTERMEDIATE GOODS EXPORTS: EVIDENCE FROM THE USA

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ABSTRACT. This study examines the relationship between outward FDI stocks and final and intermediate goods exports in the US economy over the period from 1989 to 2003. Using finely disaggregated trade data, the panel data estimation indicates that the outward FDI stock and intermediate goods exports are complementary activities, verifying the hypothesis that fragmentation plays an important role in explaining intra-firm trade between different plants within the same multinational companies. In contrast, the results find a weak evidence of substitution effects between final goods exports and outward FDI stocks, providing partial support for the horizontal type FDI models.

JEL Classification: F14; F15; F23.
Keywords: Foreign Direct Investment; Intermediate Goods Exports; Final Goods Exports; Panel Econometrics.

RÉSUMÉ. Cet article étudie la relation entre les stocks d'investissements directs étrangers (IDE) sortants, et les exportations de biens intermédiaires et finaux dans le cas de l'économie américaine, pour la période 1989-2003. S'appuyant sur des données de commerce désagrégées à un niveau fin, l'estimation en panel montre que stocks d'IDE sortants et exportations de biens intermédiaires sont complémentaires ; ceci confirme l'hypothèse selon laquelle la fragmentation explique largement le commerce intra-firme entre les différentes implantations d'une même société multinationale. Par contre, les résultats ne confirment que faiblement un effet de substitution entre exportations de biens finaux et stocks d'IDE sortants, ce qui valide partiellement les enseignements des modèles d'IDE de type horizontal.

Classification *JEL* : F14 ; F15 ; F23.
Mots-clefs : Investissement direct étranger ; exportations de biens intermédiaires ; exportations de produits finaux ; économétrie de panel.

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Introduction

The increased importance of globalization in world trade has created an interest among trade economists. Most researchers seem to agree that increased share of international production fragmentation in the world economy and increased flows of foreign direct investment (FDI) are the two distinctive features of this rapid globalization.[2] Backed up by the reduction in trade barriers and the developments in transportation and communication technologies, firms have established extensive production and distribution networks to take advantage of differences among countries over the last two decades. Recent evidence suggests that the establishment of such networks ultimately led to a surge in intermediate goods trade (Feenstra, 1998; Hummels *et al*., 1999; Yeats, 2001).

Similarly, flows of FDI have increased significantly in recent years induced by the liberalization of capital movements across national borders. Multinationals play a dominant role in international trade, with two-thirds of the world trade being carried out by multinationals. According to the US Bureau of Economic Analysis (BEA) survey of current business, in 1995, trade associated with the US multinational corporations – trade involving the US parents, their foreign affiliates, or both – accounted for 62% of all the US exports of goods and for 39% of all the US imports of goods. Chen *et al*. (2005) found that a significant portion of US exports of manufactured goods carried out by US multinationals is sent to foreign manufacturing affiliates of US multinationals and mainly consists of materials and components for further processing or assembly: the share of US exports to foreign affiliates for further manufacturing had increased from 15.6 per cent in 1977 to 22 per cent in 1999. This evidence suggests that outward FDI flows indeed create trade; therefore, a complementary relationship exists.

The complementary or substitution relationship between FDI and trade, in particular exports, has been a subject of debate in both theoretical and empirical literature since the 1970s. While most theories of the multinational firm indicate that FDI and trade are substitutes, with the exception of Blonigen (2001), Head and Reis (2001), and Swenson (2004), previous empirical studies have almost always uncovered a positive relationship between FDI and exports. The empirical studies noted above suggest that the traditional finding of the complementary relationship between the FDI and trade stems largely from the fact that most empirical work focused on the total trade volumes. They argue that the motivation of final goods and intermediate goods trade presumably differ. In particular, potential complementary effects between the FDI and trade arise mainly from increases in demands for intermediate goods in vertical relationships, and substitution emerges from trade displacement among final goods.

2. There are different types and terms of fragmentation used in the fragmentation literature. These are "outsourcing" by Feenstra and Hanson (1997), "disintegration of production" by Feenstra (1998), "fragmentation" by Deardoff (1998) and Jones and Kierzkowski (2001), "vertical specialization" by Hummels *et al*. (1999), and "intra-product specialization" by Arndt (1997).

This study investigates the relationship between outward FDI and exports by disentangling trade data into final and intermediate goods for the US trade with 25 selected OECD countries over the period of 1989 to 2003. Hence, disaggregation of total trade volumes into final and intermediate goods component could lessen these problems and help us to test for a complementary effects separately from substitution effects. The results show that the FDI appears to lead to a weak substitution effects on final goods exports, unlike previous studies using total trade volumes. On the other hand, the regression results demonstrate a strong positive relationship between the outward FDI stocks and intermediate goods exports, proving that complementary effects are the result of vertical linkages of the MNEs. In addition, the results obtained here confirm the suggestion made by Blonigen (2001) that aggregation bias might simply be the main reason of the traditional finding of complementary effects of FDI on trade.

The structure of this study is as follows. The next section presents a theoretical and empirical literature on FDI-trade linkages. Section 3 outlines the empirical model while section 4 presents the data used in the analysis. Section 5 describes the econometric procedure and discusses the empirical results, and section 6 concludes.

Literature review

In the trade literature, distinguishing between horizontal and vertical FDI is a popular approach to see whether FDI can substitute or create trade. Horizontal FDI consists of the production of the same goods or services in multiple plants in different countries while vertical FDI refers to those multinationals that geographically fragment production by stages. Theoretical literature on horizontal FDI, such as Markusen (1984) and later Brainard (1997) predict that the substitution between FDI and trade prevails over complementary. In Markusen (1984), a multinational firm decides to serve foreign market *via* establishing an affiliate instead of exporting if the additional fixed costs of establishing new plant in the foreign country are less than the fixed cost of a new firm. Another reason to locate abroad in Markusen's (1984) horizontal model is to avoid trade costs, such as tariffs and transport costs. Thus, the choice of multinational firms depends on the trade-off between the gains from locating near consumers and the losses from not locating all production in a single location.

More recent versions of the horizontal FDI are found in Hortsmann and Markusen (1992) and Brainard (1997). In Brainard (1997), MNEs face a proximity-concentration trade-off. Firms can either export or establish an affiliate and produced abroad. If firms choose exports rather than production, then they are subject to transport costs and tariffs. In Brainard (1997), firms are most likely to choose to serve the foreign market *via* production if the transport costs and tariffs are high and the plant-level fixed costs are low. If proximity advantages outweigh concentration advantages, there will be substitution relationship between FDI and trade. Horizontal models by Markusen (1984) and Brainard (1997) suggests that FDI will substitute for trade when countries are similar in size, technologies and factor endowments.[3]

Theoretical models based on vertical FDI, such as Helpman (1984), and Helpman and Krugman (1985), however, predict complementary relationship between FDI and trade. In these types of models, the differences in relative factor costs are the driving force behind vertical FDI. They show that vertical FDI creates complementary trade flows of final goods from foreign affiliates to parent firms and intra-firm transfers of intermediate goods (such as headquarters activities) from parent firms to foreign affiliates.[4] In addition, the model suggests that vertical FDI is likely to occur between developed and developing countries.[5]

Recent work by Markusen *et al*. (1996) and Carr *et al*. (2001) have made attempts to combine both horizontal and vertical motives for FDI, known as the knowledge-capital (KK) model. The KK model predicts several combinations of horizontal multinationals, vertical multinationals, and national firms depending on the country characteristics, such as size, size differences, factor endowments differences, trade costs, and investment costs. Consequently, this model suggests that FDI and trade can be substitutes between developed countries while FDI and trade tend to be complements between developed and developing countries.

Despite the strong theoretical reasons for both substitute and complementary relationship between trade and FDI, the majority of existing empirical studies predict a positive relationship. Empirical studies on the relationship between FDI and trade can be grouped into four categories: country-level studies, industry-level studies, firm-level studies, and product-level studies. Studies at the country level include Grubert and Mutti (1991), Eaton and Tamura (1994), Fontagné and Pajot (1997), Pain and Wakelin (1998), Clausing (2000), and Hejazi and Safarian (2001). For instance, employing two-panel data sets on the operations of the US MNEs in 29 host countries and the operations of foreign MNEs in the US for the period of 1977-1994, Clausing (2000) finds that multinational activity positively influences trade (exports and imports). The results obtained also show that the complementary relationship is found to be most significant when the relationship between

3. Some earlier theoretical works on the subject of internationalization have also predicted a substitute relationship between FDI and trade. For instance, ownership, location, and internationalization (OLI) model developed by Dunning (1979) points out that a multinational firm may choose FDI rather than other options such as exporting or licensing arrangements when there are advantages of internationalizing market access operations. For a more detailed discussion on FDI, see Blonigen (2005).

4. International fragmentation of production may also occur without multinationals. A firm can produce the intermediate goods in a foreign affiliate (intra-firm transactions) or it can outsource them to foreign supplier (arm's length transactions). Vertical FDI can therefore be classified as a subset of the fragmentation. Likewise the models of vertical FDI, a number of trade economists analyzed various aspects of international fragmentation (see Sanyal 1983; Hummels *et al.*, 1999; Deardoff, 1998; Feenstra and Hanson, 1997; Arndt, 1997; and Jones and Kierzkowski, 2001).

5. Horst (1976) presents another theoretical channel that generates complementary relationship between FDI and exports. They argue that MNEs often make investment in the host country to establish sale or distribution affiliates not directly related to final goods production. These activities have the objective of increasing market share in the host country, suggesting complementary relationship.

multinational activity and intra-firm trade is considered in the analysis, given the fact that intra-firm trade stimulate exports and imports in intermediate goods. Similarly, Hejazi and Safarian (2001) find that outward FDI leads to an increase in exports using trade and FDI stock data between the US and its 51 trading partners over the period of 1982 to 1994.

Some of empirical studies employ the Granger-causality tests to see whether FDI causes trade or the other way round at the country-level (Pfaffermayr, 1994; Bajo-Rubio and Montero-Munoz, 2001; De Mello Jr. and Fukasaku, 2001; Alguacil and Orts, 2002; and Aizenman and Noy, 2006). For example, adopting a time series approach, Pfaffermayr (1994) finds a significant complementary relationship between the FDI and exports for Austria during the period of 1961-1991, with causation in both directions. In addition, Alguacil and Orts (2002) analyzes the relationship between real exports and outflows of FDI in Spain for the period 1970.I-1992.III. Contrary to the finding of Pfaffermayr (1994), they find that there exists significant causality from FDI to exports, although not in the opposite direction.

Lipsey and Weiss (1981), Brainard (1997), and Swensson (2004) are examples of the studies that analyze the relationship between FDI and trade at the industry level. For instance, the results of Lipsey and Weiss (1981) imply a positive relationship between the US exports and foreign production by the US firms, using 1970 US exports for 40 countries and the level of manufacturing activity by the US firms in those countries. On the other hand, utilizing a 1989 cross-section of the US affiliate sales and trade (exports and imports) activity by country and industry, Brainard (1997) finds strong evidence for the proximity-concentration trade-off, which can be seen as a confirmation of substitution effects of FDI on trade. However, by disaggregating foreign investments into its product, industry, and overall manufacturing components, Swenson (2004) finds that the overall manufacturing FDI has a positive effect on the US imports at the industry level. However, a negative relationship was obtained for the product or industry FDI for almost all industries, unlike previous studies using more aggregated data.

Some other studies, like Lipsey and Weiss (1984) and Head and Reis (2001) employ firm-level data. In this context, Lipsey and Weiss (1984) reveal a positive relationship between the US production in the host country and the US firm's exports to that area. The results obtained also indicate that the complementary effect is most significant between the US production and intermediate goods exports. In related work, Head and Reis (2001) also obtain evidence of a complementary effect employing a panel of 932 Japanese manufacturing firms from 1966 to 1990. On the other hand, they pointed out that this relationship varies across firms depending on the nature of the investment. For the subset of firms that are not vertically integrated, the empirical results point out that firms seem to substitute their own exports.

More recent studies, including Blonigen (2001) suggest that the negative relationship between FDI and trade becomes visible at the product-level studies. With the use of disaggregated product-level data, Blonigen (2001) tests for a substitution effect separately from complementary effects that would arise due to vertical linkages, using the data on

Japanese production and exports to the US for two types of products: automobile parts and automobile for the period of 1978-1991. Blonigen (2001) finds substantial evidence of complementary effect between the production of the Japanese automobiles in the US and Japanese exports of automobile parts to the US whereas the production of Japanese automobile parts production in the US and the Japanese exports of automobile parts to the US are substitutes. In addition, the analysis for final goods (automobile) generally shows a negative relationship between the production of automobile by Japanese firms and Japanese exports of these products to the US.

THE EMPIRICAL MODEL

This paper applies the gravity equation approach to international flows of final and intermediate goods as well as FDI and tries to reconcile the existing evidence about FDI and exports with the standard theory of multinational enterprises.[6] In line with Fontagné and Pajot (1997), Clausing (2000), and Egger (2001), this paper estimates a model of the following logarithmic form:

$$\ln X_{ijt} = \alpha_{ij} + \mu_t + \beta_1 \ln FDI_{ij(t-1)} + \beta_2 \ln RER_{ijt} + \beta_3 \ln SUMGDP_{ijt} + \beta_4 \ln SIMGDP_{ijt} + \beta_5 \ln DGDP_{ijt} + \beta_6 \ln DGDPP_{ijt} + \beta_7 \ln WDIST_{ijt} + \upsilon_{ijt} \quad (1)$$

where X_{ijt} stands for either total manufactured goods exports, final goods exports or intermediate goods exports from the US into country j at time t, $FDI_{ij(t-1)}$ represents the US stocks of outward FDI into sample OECD countries with lag, RER_{ijt} is the real exchange rate between foreign country j and the US at time t. $SUMGDP_{ijt}$ expresses the sum of the GDPs of the US and its trading partner j at time t while $SIMGDP_{ijt}$ denotes the similarity in country size. $DGDP_{ijt}$ and $DGDPP_{ijt}$ indicate the absolute difference in GDP and *per capita* GDP of the US and its trading partner j at time t, respectively. $WDIST_{ijt}$ is the weighted distance between the US's capital and its trading partner's capital at time t. In addition, α_{ij} is the country effect, μ_t is the time effect, and υ_{ijt} is the usual white noise disturbance terms which is distributed randomly and independently.

Again, primary attention is paid to differences between the effects of FDI on final goods exports and intermediate goods exports. Following discussion made by Blonigen (2001) and Head and Ries (2001), we estimate these empirical models by disentangling trade data into final and intermediate goods for the period 1989-2003. The advantage of using disentangled trade data help us to test for a complementary effect separately from substitution effects. The relationship between outward FDI and export is complicated and depends largely on the types of FDI being considered. In the horizontal type of FDI, FDI

6. There are many papers that apply gravity equations to the analysis of the relationship between multinational activity and trade with success, such as Eaton and Tamura (1994), Fontagné and Pajot (1997), Goldberg and Klein (1998), Clausing (2000), Graham (2000), and Egger (2001).

replaces exports since the market is served through local production instead of exports (Brainard, 1997; Markusen, 1984). Thus, the expected sign of β_1 is negative for final goods exports suggesting a substitution relationship between FDI and final goods exports. By contrast, the growth of intra-firm trade in intermediate goods between parent firms and their affiliates in the foreign country has been widely viewed as an expansion of vertical type of FDI, which are expected to exploit differences in factor endowments and technology, as Helpman (1984) and Helpman and Krugman (1985) indicate. In this case, FDI and trade are expected to be complements. As a result, the expected sign of β_1 is positive for intermediate goods exports.

Motivated by the influential work of Helpman (1984) and Helpman and Krugman (1985), several explanatory variables are introduced in the estimations: the sum of bilateral real GDP between the US and its trading partner as a measure of overall bilateral country size ($SUMGDP_{ijt}$), a similarity index of two trading partners' GDPs as a measure of similarity in country size ($SIMDGP_{ijt}$), the absolute difference in real GDPs between two trading partners as a measure of variations in demand and supply sizes ($DGDP_{ijt}$), and finally the absolute difference in real *per capita* GDP between two trading partners as a measure of discrepancies in consumer preferences and tastes ($DGDPP_{ijt}$).

Helpman and Krugman (1985) argue that the trade in manufactured goods tends to increase as the bilateral market size of the two countries ($SUMGDP_{ijt}$) increases due to the presence of economies of scale. Similarly, Ethier (1982) shows 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. 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. Hence, it is expected that trade in final and intermediate goods will be greater with countries that have higher incomes. In addition, the index of similarity in country size ($SIMDGP_{ijt}$) is included to capture the degree of similarity between countries in terms of economic development and demand for variety. It is expected to have a positive impact on both final goods exports and intermediate goods exports as countries with higher levels of development are more prone to trade and have similar demand and production structures, as would be predicted by the Linder hypothesis. When the investment conditions in developing countries such as insufficient infrastructure systems are discouraging, the companies in developed countries avoid shifting their low-skilled production stages into developing countries since the trade-off between the extra costs due to these unpleasant conditions and the cost savings due to cheap labor is not favorable.

According to Helpman and Krugman (1985), differences in market size indicate differences in their ability to manufacture differentiated products; as countries become more similar in terms of their market size, the potential for overlapping demand for differentiated products is enhanced and, therefore, $DGDP_{ijt}$ is expected to be negative for final goods trade (trade is intra-industry nature). Regarding intermediate goods, Grossman and Helpman (2005) argue that the size of the host country can affect the thickness of its market which positively impact on the location of outsourcing activity. Firms are more likely to find a trading partner in a large host markets with the appropriate skills that match the needs of final goods producers. This suggests a negative relationship between intermediate exports and differences in market sizes. On the other hand, there are also reasons to believe that large markets are most likely to be served by local production due to the fact that the availability of local input producers in the host market should reduce the dependence on the imports of intermediate goods from the US. Consequently, the differences in market size could have an uncertain effect on imports of intermediates.

Linder (1961) and other studies argued that as *per capita* incomes of two countries become equal, their tastes and preferences also become similar. Hence, the trade in final goods rises as the absolute difference in *per capita* ($DGDPP_{ijt}$) declines. However, *per capita* income differences have also been used as a measure of relative factor endowments. According to Helpman and Krugman (1985), a greater differential in *per capita* incomes would imply a greater disparity in the relative factor endowments, which would be reflected in the lower relative levels of intra-industry trade. Thus, there is an expected negative relationship between bilateral inequality in *per capita* GDP and the trade in final goods. Turning now to the intermediate goods, Helpman (1984) shows that vertical type of FDI increases with differences in relative factor endowments. Assuming that fragmentation typically occurs with vertical type of FDI, trade in intermediate goods would be expected to be high when there are large differences in relative factor endowments across trading countries. Likewise, Feenstra and Hanson's (1997) model of outsourcing predicts that fragmentation is more likely to take place between countries with dissimilar factor endowments.

The remaining independent variables that influence the export values are the real exchange rate and the weighted distance. It is expected that a real exchange rate depreciation of the dollar implies an advantage for the US exports at foreign markets. Thus, one would expect β_2 to be negative for both final and intermediate goods exports since the real exchange rate in this study is defined as the number of foreign currency unit per US dollar so that RER_{ijt} falls with a depreciation of the dollar. The weighted distance ($WDIST_{ijt}$) is included to proxy for transport and other trade costs. Distance will increase the transaction costs including insurance and transportation costs. Hence, it is predicted that the relationship between the distance and both of the dependent variables to be negative, *i.e.* $\beta_7 < 0$. However, the magnitude of this effect on export volumes could be different across different product groups. Considering trade in intermediate goods, small changes in transportation costs have a major effect on fragmentation decisions because of multiple boarder-crossing involved in the value added chain. In contrast, distance is likely to affect less the final goods trade in which goods pass the border only once.

Description of the data

To investigate the relationship between trade and FDI in the US economy, we estimate equation (1) for a panel of 25 OECD countries for the period 1989 to 2003.[7] Data on nominal bilateral exports in current dollars at the five-digit SITC (Standard International Trade Classification) Revision 3 were obtained from United States International Trade Commission's (USITC) website (http//www.usitc.gov). The first step to calculate export volumes in final and intermediate goods is to select the intermediate goods and final goods in the bilateral trade data. Following Hummels *et al*. (1999), the United Nations Broad Economic Categories (BEC) classification scheme is employed to distinguish intermediate goods from final goods.[8]

As shown in TABLE A1.1, the BEC includes 19 basic categories, which are classified as capital goods (categories 41 and 521), consumption goods (categories 112, 122, 522, and 6), intermediate goods (categories 111, 121, 2, 3, 42, and 53), and intermediate goods and consumption or final goods (categories 321 and 51). The BEC scheme has a major disadvantage. Some of categories such as motor spirit (321) and passenger motor cars (51) are could be consumed directly by consumers or used as intermediates in the related industry. To overcome this problem, the regression analysis will be conducted for both sub samples with or without categories motor spirit (321) and passenger motor cars (51). In order to select the final and intermediate goods from the trade data, the concordance table developed by the United Nations Statistics Division is used to map the SITC (Rev.3) codes to the BEC codes.[9] As a consequence, about 2156 items are considered as final goods and 1079 items are considered as intermediate goods out of 2781 items from the 5-digit level of SITC.[10] Once, values of final goods exports and intermediate goods exports are calculated at country level, the US PPI is used to convert the trade data into constant dollars for each type of good. The US PPI (2000=100) data were taken from IMF International Financial Statistics (IFS) CD-ROM.

Outward FDI stock data in current dollars are taken from the OECD International Direct Investment Statistics Yearbook. As a measure of multinational activity in the host countries, outward FDI stock is chosen rather than outward FDI flows since the stock data is more complete than the flows data. Some researchers argue that outward FDI stock is an imperfect proxy for multinational activity since multinational companies may also engage in

7. The countries used for estimation are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. Three remaining OECD countries, namely Czech Republic, Iceland, and Slovak Republic, are excluded from the estimations due to the lack of information on outward FDI stocks.
8. Yeats (2001) proposes a different approach to select the intermediate goods from the trade data. Goods recorded in the trade data as parts or components should be considered as intermediate goods. However, this method may create the subjectivity of the researchers on the selection of intermediate goods.
9. The concordance table from BEC to SITC Rev.3 is acquired from the United Nations Statistics Division web page (http://unstats.un.org).
10. Since this study deals with only manufacturing industries, non-manufactured industries are dropped from calculations. 2781 items are left out of 3141 items of SITC Rev.3.

many activities in the host countries that one would not expect to have any relationship with export, such as real estate investment. Nonetheless, considering the limited availability of the data, outward FDI stock data may be the best available proxy. Since the past value of FDI should exert a major influence on the current exports, lagged outward FDI stock variable is entered into equations. As with the trade data, the outward FDI stock data is converted to constant 2000 dollars using the US PPI (2000=100).

Data on the US and its trading partners nominal bilateral exchange rates and Consumer Price Index (CPI) come from IMF's International Financial Statistics CD-ROM. Real exchange rate between two countries (RER_{ijt}) is then calculated as the product of nominal bilateral exchange rate and relative price levels in each country. The data on GDP and *per capita* GDP for the US and 25 OECD countries in current dollars are obtained from World Bank's World Development Indicators CD-ROM. The US GDP deflator is employed to convert the GDP and *per capita* GDPs data into constant dollars. The GDP deflator data is acquired from the IFS. The size of markets is proxied by sum of GDPs of the US and its trading partner ($SUMGDP_{ijt} = GDP_{it} + GDP_{jt}$). Following Helpman (1987), the degree of similarity between countries is calculated as follows:

$$SIMGDP_{ijt} = \ln\left[1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2\right] \quad (2)$$

with $0 \leqslant SIMGDP_{ijt} \leqslant 0.5$, indicating that the index obtains the value $^1/_2$ when the two countries are equal in size. In addition, the absolute difference in market size is defined as ($DGDP_{ijt} = \left|GDP_{it} - GDP_{jt}\right|$) while the absolute difference in *per capita* GDPS is given as $DGDPP_{ijt} = \left|GDPP_{it} - GDPP_{jt}\right|$. At last, in line with Balassa and Bauwens (1987), the geographical distance variable is defined as the weighted distance between the US and its partner country *j*:

$$WDIST_{ijt} = \frac{DIST_j * GDP_{jt}}{\sum_{j=1}^{25} GDP_{jt}} \quad (3)$$

The distance, denoted as $DIST_j$, is the direct distance in kilometers between the US's capital and its trading partners' capital and taken from the United States Department of Agriculture's web page (http://www.usda.gov).[11]

11. As nicely pointed out by Egger (2001), weighted distance variable must be used in the panel regressions to capture the effects of transport costs on trade since distance is itself a time-invariant variable.

Econometric procedure and results

Giving the longitudinal nature of the dataset, the standard panel data analysis technique will be used to empirically investigate the relationship between the exports and outward FDI stocks, which can be performed by both fixed and random effects models as described by Baltagi (1995).[12] Before preceding the estimation of equation (1), stationarity of the variables should be confirmed in order to provide valid empirical evidence on the relationship between the exports and outward FDI stocks. For this purpose, the panel unit root test proposed by Levin *et al*. (2002, hereafter LLC), was employed to examine the stationarity of variables used in the regressions. Table 1 shows test statistics and p-values from the LLC for the model with an individual constant trend and a time- and individual constant trend. In the first case, the null hypothesis of a unit root can be easily rejected for all variables except $DGDP_{it}$ with lag 1. Adding a time trend to the test procedures, the LLC have to reject the null hypothesis of a unit root at the 1% level for all variables with lag 1. As a result, all time series variables are used in levels in the regressions.

In order to be able to choose between the two possible estimation models, several statistical tests were performed. As reported in table 2, the Chow test confirms the appropriateness of fixed effects model whereas the Breusch-Pagan test advocates the use of the random effects model. Consequently, the question of model selection naturally arises. To decide whether the fixed effects model or random effects model is appropriate, the Hausman specification

Table 1 - Panel unit root tests by Levin, Lin and Chu (2002)

Variables	t-star (level LLC)	
	Constant without time trend	Constant and trend
X_{ijt} (total goods)	–4.8449***	–4.6387***
X_{ijt} (final goods)	–3.9309***	–5.4871***
X_{ijt} (intermediate goods)	–5.2046***	–5.0217***
FDI_{ijt}	–10.9202***	–7.2408***
RER_{ijt}	–7.5374***	–5.9617***
$SUMGDP_{ijt}$	–1.8757**	–2.8318***
$SIMGDP_{ijt}$	–2.1292**	–4.8528***
$DGDP_{ijt}$	–1.0299	–5.4790***
$DGDPP_{ijt}$	–7.9201***	–6.8769***
$WDIST_{ijt}$	–2.6761***	–4.6911***

Notes: The null hypothesis is that the series is non-stationary, or contains a unit root.
***, **, and * indicate the rejection of the null hypothesis of non-stationarity at significance levels of 1%, 5%, and 10%, respectively.

12. Table A1.2 provides the definition and expected signs of variables used in the regressions while table A1.3 presents the descriptive statistics for the variables.

test can be applied under the null hypothesis that individual effects are uncorrelated with the other regressors in the model. As evident in TABLE 2, the resulting Hausman test statistics in all three models strongly indicate that the fixed effects model should be preferred over the random effects model.[13]

TABLE 2 presents the results of fixed effect estimations.[14] The dependent variables of column 1 to column 3 are exports of total manufactured goods, final goods, and intermediate goods, respectively. The first column reveals positive and statistically significant evidence between the US total manufacturing exports and the US stocks of outward FDI, consistent with the most empirical examinations that suggest a strong complementary relationship between trade and FDI. In column (2), however, FDI exerts a negative but weak impact on the US exports of final goods, as was expected by the theory. Hence, the disaggregated data show a weak substitution effect, unlike previous studies at a more aggregate level. At the same time, the results of column (3) in TABLE 2 support the hypothesis that FDI stimulates exports of intermediate goods, consistent with the theoretical expectation that vertical type of FDI complements rather than substitutes for trade.[15] This is an important result, since it confirms the view that MNEs are increasingly using foreign outsourcing as they fragment their production process into stages.

In general, it appears that there was a significant effect of the US outward FDI stocks in raising the US exports of intermediate goods whereas a weak negative relationship between the final goods exports and FDI. Similar findings also emerge in Lipsey and Weiss (1984) and Blonigen (2001). It is clear from these gravity equation results that the generality of the empirical works highlighting a complementary relationship between the FDI and trade mainly originates from the aggregation bias. Thus, this study confirms the suggestion made by Blonigen (2001) and Swenson (2004) that the identification of complementary and substitution effects of FDI requires finer disaggregation of trade data.

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13. Since fixed effects estimations generate more efficient estimates, the results from random effects estimations are not presented in this paper to save space.

14. In order to simultaneously account for autocorrelation and heteroscedasticity, the fixed effects regressions are conducted using the Newey-West method which generates robust standard errors in the presence of autocorrelation within panels and heteroscedasticity across panels. Besides addressing the problem of heteroscedasticity and auto-correlation, collinearity among independent variables are also examined and reported in APPENDIX 1, TABLE A1.4. After an examination of collinearity among independent variables it is found that some of the explanatory variables is highly correlated with each other. To determine the severity of the problem, the variance inflation factor (VIF) method is conducted by controlling for fixed effects in panel data. It is found that the VIF of the absolute difference is 2.32, which is below the cut-off point prescribed by the thumb rule that VIF should not be more than 10. Therefore, the relatively high correlation between these two variables is less likely to cause estimation problems. All estimations are performed in Stata 8.

15. Although we do not report the detailed results here, we performed the fixed effects regressions by using several different specifications of the equation (1). First, the inclusion of the contemporaneous outward FDI stocks or FDI flow variable into equations makes no qualitative change in the findings. Besides, the assignment of capital goods (321 and 51) between final goods and intermediate goods leads to similar results to the reported ones. Overall, it is concluded that the results seem to be robust to specification changes and the inclusion of these variables does not affect the key coefficients of interest relating FDI activity and exports.

Table 2 - Effects of outward FDI on the US exports using fixed effects model, 1989-2003

Independent variables	Dependent variables		
	Total goods exports	**Final goods exports**	**Intermediate goods exports**
FDI_{ijt}	0.0410*	–0.0024	0.0527**
	(1.72)	(–0.08)	(2.12)
RER_{ijt}	0.5312*	0.6556***	0.5542***
	(1.72)	(2.73)	(–2.89)
$SUMGDP_{ijt}$	1.1788***	1.2092***	1.0401***
	(5.61)	(4.43)	(4.76)
$SIMGDP_{ijt}$	0.9940***	1.0483***	0.9394***
	(4.61)	(3.74)	(4.19)
$DGDP_{ijt}$	–0.3550**	–0.2019	–0.3256*
	(–2.01)	(–0.88)	(–1.77)
$DGDPP_{ijt}$	0.0515*	–0.0057	0.0731**
	(1.75)	(–0.15)	(2.39)
$WDIST_{ijt}$	–0.2022**	–0.0403	–0.2159**
	(–1.96)	(–0.30)	(–2.02)
CONSTANT	–2.1094	–7.4377	0.3246
	(–0.34)	(–0.92)	(0.05)
R^2 within	0.4854	0.5012	0.4653
F	41.37***	49.23***	38.16***
Chow test	180.55***	108.37***	161.95***
Wooldridge test for autocorrelation: F (1,24)	4.796**	2.392	4.350**
LR-test for heteroscedasticity: χ^2 (24)	422.61***	310.21***	398.95***
Breusch-Pagan LM test for random effects: χ^2 (1)	1213.49***	1022.16***	1165.17***
Hausman specification test: χ^2 (7)	44.48***	106.19***	55.27***
No. of groups	25	25	25
No. of observations	375	375	375

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Reported t-values in parentheses are constructed using standard errors that are autocorrelation and heteroskedastic consistent, following White (1980). The coefficients for country and time dummies are not reported here in order to save space.

It is also useful to assess whether the results are robust to consideration of different subsets of the data. Recent paper by Blonigen and Wang (2004) has shown that the pooling of wealthy and poor countries in empirical FDI studies often leads to spurious conclusions. In order to shed some more light on the impacts on exports of FDI in countries with different technological levels, the sample of countries is broken into core and periphery countries based on *per capita* income differences.[16] As pointed out above, we may expect that there should be some disparities on the impacts of FDI on exports between core and periphery countries sample. The

16. In this study, the countries that are considered as developing (periphery) countries are Greece, Hungary, Korea, Mexico, Poland, Portugal, and Turkey while the developed (core) countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

results for the estimations of equation (1), using data for core countries and periphery countries reveals a positive but statistically insignificant relationship between FDI and exports in all regressions.[17] In addition, it is evident that the relationships between explanatory variables and exports statistically weaken in both core and periphery countries' models.[18] There is one reason why this might be the case. As suggested by Blonigen and Wang (2004), splitting the sample in more and less advanced countries reduces the observation size, and thereby efficiency.

A temporal causality between outward FDI stocks and exports may also exist in the other direction. Market seeking-FDI may start off by exporting to the host country and subsequently switch to FDI once they have established a certain level of demand for a product in the host country. Following this logic, a long-run positive relationship is hypothesized between home-country exports and outward FDI stocks. In the current study, bivariate Granger causality tests are conducted to examine possible causal relationships between outward FDI stocks (FDI_{ijt}) and exports (X_{ijt}). The Granger causality tests are hence based on the following two regressions:

$$\ln X_{ijt} = \alpha_{ij} + \mu_t + \sum_{l=1}^{p} \gamma_l \ln FDI_{ij(t-l)} + \sum_{l=1}^{p} \beta_l \ln X_{ij(t-l)} + \upsilon_{ijt} \quad (4)$$

$$\ln FDI_{ijt} = \alpha_{ij} + \mu_t + \sum_{l=1}^{p} \lambda_l \ln FDI_{ij(t-l)} + \sum_{l=1}^{p} \phi_l \ln X_{ij(t-l)} + \mu_{ijt} \quad (5)$$

where X_{ijt} and FDI_{ijt} stand for exports and FDI, respectively; γ, β, λ, and ϕ are parameters; υ and μ are error terms; and p denotes the number of lags used in the regressions.

The Granger-Causality tests reported in TABLE 3 are conventional F-tests of the null hypothesis that outward FDI stocks Granger-cause exports, or alternatively exports Granger-cause outward FDI stocks towards host country. As indicated in TABLE 3, the direction of causality suggested by the Granger causality test is quite sensitive to the specification of the lag length. When one lag is applied, there is a two-way casual link between outward FDI stocks and exports. In contrast, the results with four lags imply that the direction of causality tends to go primarily from FDI stocks to final goods and intermediate goods exports, although not in the opposite direction. Given the fact that Akaike Information Criterion (AIC) estimate is minimized at a lag length of four for each independent variable tested, these results are thus generally consistent with the findings of several empirical studies that suggest a causal relationship running from FDI to exports.[19]

17. Regression results for the core and periphery countries not reported in detail in the current study are available from the author on request.

18. Instead of splitting the sample into two subgroups, the equation (1) is also estimated with the inclusion of the multiplicative dummy variable that captures the differentiated impact on exports of FDI in countries with different technological levels. Although not shown here, introduction of multiplicative dummy does not provide any meaningful relationship between FDI and exports.

19. The existence of some evidence of a one-way causal link running from FDI to trade is also presented by Alguacil and Orts (2002). In contrast, a number of recent papers (Pfaffermayr, 1994; De Mello Jr. and Fukasaku, 2000; Bajo-Rubio and Montero-Munoz, 2001; Aizenman and Noy, 2006) indicate that the causality between FDI and trade runs significantly in both ways.

Table 3 - Causality tests for FDI and exports

Test for causality of	By	No. of lags			
		1	2	3	4
X_{ijt} (total goods)	FDI_{ijt}	9.52***	2.76*	0.66	1.89
X_{ijt} (final goods)	FDI_{ijt}	6.95***	2.06	1.63	2.36*
X_{ijt} (intermediate goods)	FDI_{ijt}	12.75***	3.93**	0.84	2.26*
FDI_{ijt}	X_{ijt} (final goods)	3.96**	1.06	0.72	0.69
FDI_{ijt}	X_{ijt} (final goods)	6.99***	1.21	1.06	0.77
FDI_{ijt}	X_{ijt} (intermediate goods)	9.33***	1.21	1.08	1.22

Note: Granger causality tests are performed by F-tests of the hypothesis that the coefficients of the lagged causal variables are significantly different from zero. ***, **, and * denote the significance at the 1%, 5%, and 10%, respectively. The Akaike information criterion (AIC) indicates that the optimal number of lags for each equation is 4.

Concerning the macroeconomic variables, the results in all three columns show that $SUMGDP_{ijt}$ has a positive and significant association with the exports, as was predicted by the theory. In addition, $SIMGDP_{ijt}$ turns out to have positive and statistically significance influence on the all types of exports, in line with the predictions of this study. On the other hand, the hypothesis concerning differences in size between trading partners, ($DGDP_{ijt}$), performed less well. This variable carried the correct sign in all three regressions, but was not statistically significant in all three regressions. Finally, the estimated coefficients of $DGDPP_{ijt}$ in the regression of final goods are negative but not statistically significant. The negative estimate of the coefficient of $DGDPP_{ijt}$ in the regression of final goods confirms the Linder hypothesis that similar countries trade more with similar countries. This finding is also consistent with the predictions of Helpman and Krugman (1985) that differences in GDP *per capita*, proxy for differences in factor endowments, will be negatively related to trade (intra-industry trade). The most striking result, however, is the positive sign obtained for the differences in GDP *per capita* in intermediate goods model. The results illustrate that dissimilarities in GDP *per capita*, proxy for differences in factor endowments, have a positive and significant effect on trade. This is in line with the predictions of both Helpman and Krugman's (1985) and Feenstra and Hanson's (1997) theoretical model that the volume of vertical trade or outsourcing will tend to increase with greater differences in factor endowments between two countries.

Contrary to our expectations, the real exchange rate has the positive and significant expectation on exports for all product groups. Lastly, the coefficients on distance variable have the predicted signs in all three regressions, but only the coefficients of the distance on the total exports and intermediate goods exports model are statistically significant. However, intermediate goods have the largest elasticity in absolute form among three models, meaning that distance discourages trade in intermediates the most. According to this result, transportation costs significantly hamper the fragmentation of production across countries, verifying the hypothesis developed by Jones and Kierzkowski (2001) that cross-border outsourcing is more favorable if service link costs are lowered.

Conclusions

While theoretical models have put forward complementary and substitution effects of FDI on international trade, the results of most of the empirical literature tend to be in favour of complementary effects. Complementary effects are present especially in exports, as a result obtained using aggregate data. A few studies by Grubert and Mutti (1991), Lipsey and Weiss (1984), Head and Ries (2001), and Blonigen (2001) suggest that exports of intermediate goods from parents to manufacturing affiliates may be responsible for the frequent of finding complementary relationship between them. Empirically, however, most of these empirical studies do not distinguish between intermediate goods and final goods in the identification of the substitution and complementary effects of FDI on trade.

Unlike previous studies, this paper presented a first empirical analysis distinguishing between final goods and intermediate goods exports in explaining the frequent finding of complementary relationship between FDI and exports. The advantage of using disentangled trade data help us to test for a complementary effect separately from substitution effects. The empirical results of our gravity equation analysis demonstrate that the disaggregation of bilateral trade flows into final and intermediate goods provides meaningful information for the analysis of the relationship between the FDI and trade. The results confirm the basic proposition that the effects of FDI on final goods exports and intermediate goods exports are different. In particular, the regression results demonstrate a strong positive relationship between the US intermediate exports and outward FDI stocks, as was expected by the theory of vertical FDI. In contrast, the results find a weak evidence of substitution effects between the US final goods exports and outward FDI stocks, which is in line with the theory of horizontal FDI. In addition, this study, hence, reinforces the suggestion made by Blonigen (2001) that the most of the existence empirical studies showing complementarity relationship between trade and FDI can be due to the aggregation bias.

The complementary relationship found between outward FDI and intermediate goods exports give strong support to the hypothesis that international fragmentation plays a great role in explaining the intra-firm trade between different plants within the same multinational companies. The results in this paper, however, leave some unanswered questions for future research. The link between outward FDI and fragmentation has not been fully established. The trade data used in this paper provides information only on the export values of a given product at country-level. Hence, it is difficult to track an intermediate good once it is imported with the currently available trade data. The exported input could be used primarily for the production of a final good by local companies other than by vertically integrated MNEs. Therefore, it may be worthwhile to investigate this link in more detail using firm-level data in a future study to confirm whether the finding of complementary relationship between outward FDI and intermediate goods exports truly reflects outsourcing activities of MNEs.

K. T.[20]

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Appendix 1

Table A1.1 - The United Nations broad economic categories classification scheme

Commodity categories	End-use classes
1. Food categories	
11. Primary	
111. Mainly for industry	Intermediate goods
112. Mainly for household consumption	Consumption goods
12. Processed	
121. Mainly for industry	Intermediate goods
122. Mainly for household consumption	Consumption goods
2. Industrial supplies not elsewhere specified	
21. Primary	Intermediate goods
22. Processed	Intermediate goods
3. Fuels and lubricants	
31. Primary	Intermediate goods
32. Processed	Intermediate goods
321. Motor Spirit	Intermediate goods and consumption goods
322. Other	Intermediate goods
4. Capital goods (except transport equipment), and parts and accessories thereof	
41. Capital goods (except transport equipment)	Capital goods
42. Parts and accessories	Intermediate goods
5. Transport equipment and parts and accessories thereof	
51. Passenger motor cars	Intermediate goods and consumption goods
52. Other	
521. Industrial	Capital goods
522. Non-industrial	Consumption goods
53. Parts and accessories	Intermediate goods
6. Consumer goods not elsewhere specified	
61. Durable	Consumption goods
62. Semi-durable	Consumption goods
63. Non-durable	Consumption goods
7. Goods not elsewhere specified	

Table A1.2 - Variable definition and expected signs

Variable definition	Expected signs		
	Total exports	Final exports	Intermediate exports
FDI_{ijt}= The US outward foreign direct investment stocks into its trading partners	+/–	–	+
RER_{ijt}= Real Exchange rate between the US and its trading partner	–	–	–
$SUMGDP_{ijt}$= The sum of GDPs of the US and its trading partner	+	+	+
$SIMGDP_{ijt}$= Index of similarity in GDP per capita between the US and its trading partner	+	+	+
$DGDP_{ijt}$= Absolute difference of GDP between the US and its trading partner	+/–	–	+/–
$DGDPP_{ijt}$= Absolute difference of GDP per capita between the US and its trading partner	+/–	–	+
$WDIST_{ijt}$= The weighted distance between the US's capital and its trading partner's capital	–	–	–

Table A1.3 - Descriptive statistics of selected variables (1989-2003 averages)

Variable	Mean	Standard deviation	Minimum	Maximum	Observations
X_{ijt} (total goods)	22.37	1.53	18.68	25.82	375
X_{ijt} (final goods)	21.50	1.43	18.00	24.74	375
X_{ijt} (intermediate goods)	22.19	1.54	18.49	25.62	375
FDI_{ijt}	22.98	1.72	15.04	26.29	365
RER_{ijt}	2.99	3.11	–0.55	13.63	373
$SUMGDP_{ijt}$	29.82	0.15	29.57	30.30	375
$SIMGDP_{ijt}$	0.10	0.10	0.001	0.48	375
$DGDP_{ijt}$	29.66	0.22	28.43	29.95	375
$DGDPP_{ijt}$	9.05	0.84	4.62	10.27	374
$WDIST_{ijt}$	1.82	1.95	–0.54	9.29	375

Note: All variables are in natural logarithmic form except $SIMGDP_{ijt}$.

Table A1.4 - Correlation matrix between explanatory variables

Variables	FDI_{ijt}	RER_{ijt}	$SUMGDP_{ijt}$	$SIMGDP_{ijt}$	$DGDP_{ijt}$	$DGDPP_{ijt}$	WDISTijt
FDI_{ijt}	1.0000						
RER_{ijt}	0.3157	1.0000					
$SUMGDP_{ijt}$	0.7509	0.4632	1.0000				
$SIMGDP_{ijt}$	0.1718	0.8301	0.3687	1.0000			
$DGDP_{ijt}$	0.6635	0.5477	0.9089	0.4399	1.0000		
$DGDPP_{ijt}$	0.0068	0.0960	0.1411	0.3587	0.1803	1.0000	
$WDIST_{ijt}$	0.5375	0.6176	0.8391	0.6634	0.8607	0.2916	1.0000

Note: Correlation matrix is generated by regressing one independent variable on the other (and controlling for fixed effects in panel data).

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