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Global Production Sharing and the FDI–Trade Nexus: New Evidence from the Japanese Automobile Industry*

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Abstract

The growing importance of global production sharing makes the nexus between outward foreign direct investment (FDI) and trade in parts and components ever more important. This paper examines the impact of overseas operation of upstream firms (parts and components suppliers) on parts and components exports from the home country through a case study of the Japanese automobile industry. The empirical analysis is based on a newly-constructed product-level dataset covering 32 products and 49 host countries over the period 1993 to 2008. It is found that overseas operation of upstream firm lead to additional exports of intermediate goods from the home country. This finding runs counter to the the popular view that the growing overseas activity of multinational enterprises could replace intermediate exports from a home country, thereby depriving the home country of job opportunities.

Keywords:

Global production sharing, foreign direct investment, exports, automobile, Japan

JEL Classification:

F14, F23

Global Production Sharing and the FDI-Trade Nexus:
New Evidence from the Japanese automobile Industry

1. INTRODUCTION

Global production sharing[1] – intra-product specialisation where the production process is sliced into discrete activities, which are then allocated across multiple countries based on factor endowments such as labor, capital and technology – has been a central feature of world manufacturing trade over past decades. The geographically integrated production process began to separate as technological developments in transportation and communication made long-distance transactions feasible. Furthermore, the development of information technology and the liberalisation of trade and investment have dramatically reduced communication and transaction costs, enabling multinational enterprises (MNEs) to outsource an increasing amount of their production process abroad and organise their value chains globally. This has resulted in a steady rise in trade in parts and components across national borders (Yeats 1998, Kimura and Ando 2005, Athukorala and Yamashita 2006).

Given the growing importance of global production sharing in international trade, the analysis of the nexus between outward foreign direct investment (FDI) and trade in *intermediate* goods has become more important than ever. The growing concern in policy circles in industrial countries is the "following – leader" pattern of overseas investments – parts suppliers' investment following their customers' investments abroad – that could replace intermediate exports from a home country thereby depriving the locals of job opportunities and deindustrialising the domestic economy (Navaretti and Falzoni 2004, Yamashita and Fukao 2010). Following-leader investments have emanated from the localisation strategy of MNEs in host countries due to transportation costs and foreign currency risks as well as just-in-time management and modularity (Sturgeon et al. 2008).[2]

The important empirical issue relating to intermediate trade is aggregation bias emanating from the nature of the conventional data such as firm-, industry-, and country-level trade data. Given that firm-level data, for example, does not provide information on trade by products, it is difficult to separate substitution effects from complementary effects. To deal with this problem, previous studies employ product-level data that make it possible to estimate the impact of FDI by upstream firms (e.g. parts suppliers) on intermediate trade controlling for the complementary effects emanating from FDI by downstream firms (e.g. automakers) (Blonigen 2001, Head et al. 2004).

The purpose of this study is to examine the hypothesis that FDI by upstream firms (i.e. parts suppliers) replaces intermediate (i.e. auto parts) exports from home, using the case of the Japanese automobile industry. The focus on the Japanese automobile industry is motivated by the established view that when Japanese automakers build production plants abroad, they attempt to transplant the efficient supplier relationships forged locally to the host country to achieve competitive advantages such as a just-in-time inventory system and quality control (Head et al. 1995, 1999, Banerji and Sambharya 1996, Blonigen et al. 2005). I analyse newly-constructed product-level data on auto parts exports from Japan covering 32 products and 49 countries over the period 1993 to 2008. The model is estimated by the Poisson pseudo-maximum-likelihood (PPML) technique.

The results do not support the substitution hypothesis. Instead, this study finds that auto parts exports from Japan are positively correlated with overseas operations of Japanese parts suppliers. An interesting finding is that the degree of complementarity is stronger than the counterpart between Japanese automakers' FDI and auto parts exports from Japan. These findings are consistent with the fact that Japanese suppliers predominantly sell their products to Japanese automakers at the initial stage but that they are expanding their business with non-Japanese automakers in host countries over time (IRC 2009). In addition, overseas subsidiaries of Japanese suppliers are now exporting their products to automakers in other countries within the region (IRC 2010).

This paper adds to the fledgling literature on the relationship between FDI and trade in intermediate goods and relates closely to Blonigen (2001). As far as I am aware, this is the first paper to find a complementary relationship between FDI by upstream firms (i.e. parts suppliers) and intermediate (i.e. auto parts) exports from home, using product-level data. The other novel contribution is the use of a newly-constructed product-level data set, which enables addressing endogeneity and aggregation biases simultaneously. Previous studies have addressed either one or the other. Estimations in this paper are also for a larger sample of products (32) and cover a wider range of host countries (49) and a more up-to-date period (1993-2008) than used in Blonigen (2001).

The rest of this paper is structured as follows. Section 2 summarises the literature on the relationship between FDI and exports from home and discusses empirical issues with a particular focus on aggregation bias. Section 3 presents the empirical model, data and measurement of variables and discusses the estimation methods. Section 4 reports the estimation results. Section 5 discusses the key results obtained in Section 4. Section 6 concludes.

2. FDI-TRADE NEXUS: EMPIRICAL ISSUES

The FDI-trade nexus itself has been a key focus in international economics since the seminal work of Mundell (1957). However, the nexus of FDI and trade in *intermediate* goods still remains a sparsely researched subject. Relating to the former issue Mundell (1957) shows that capital flow (e.g. FDI) substitutes exports from home in a Heckscher-Ohlin general equilibrium framework. Markusen (1995) points out that the transfer of knowledge-based assets causes substitutability between production abroad and exporting. On the other hand, others argue that imperfect competition and technological differences among economies are important causes of the conditions for complementarity between FDI and exports (Markusen 1984, Wong 1986). Although the theoretical literature postulates the possibility of both substitution and complementarity between FDI and exports from the home country, empirical research has consistently found a complementary relationship between these two variables (Table 1).

-Table 1 here-

A positive relationship can be explained by at least two factors (Head and Ries 2004). The expansion of a firm's product in a given foreign market could lead to an increase in demand for the firm's other products. This is called "statistical complementarity". Investment abroad by a downstream firm (e.g. automaker) could also create demand for parts and components, leading to an increase in export demand for upstream firms (e.g. parts suppliers) in a home country. This is called "economic complementarity".

Blonigen (2001) points out that very little evidence of substitution could be caused by aggregation bias emanating from the nature of the conventional data such as firm-, industry- and country-level trade data.[3] Given that firm-level data, for example, do not provide information on trade by product, it is difficult to identify a substitution effect to the extent that the firm is multiproduct.[4] For example, if a firm produces both an intermediate and a final good, it would be possible that overseas production of a final product is associated with exports of intermediate goods from the home country. To the extent that the economic complementarity for the intermediate products offsets the substitution effects arising from the decrease in final products, the relationship between FDI and exports would be complementary.

Economic complementarity also occurs when vertical networks between upstream and downstream firms play an important role (e.g. the automobile industry). This is the case relevant to this study.

Suppose that an intermediate product is produced by an upstream firm A and a final product is produced by a downstream firm B. If only firm B produces a final product in the host country, it would be possible that overseas production of a final product is associated with exports of intermediate goods from an upstream firm A in the home country.

Product-level data enables aggregation bias to be addressed by separating the substitute effects from the complementary effects emanating from the nature of the vertical networks (Blonigen 2001). Suppose that an intermediate product is produced by two upstream firms (A and B) and is sold to a downstream firm. Only upstream firm A produces abroad to supply its product to the downstream firm directly in the host country. Controlling for the economic complementarity for exports from upstream firm B at home, it would be possible to identify substitution effects emanating from the replacement of exports with overseas production by upstream firm A. We call this the "substitution hypothesis".

Previous studies support the substitution hypothesis. Constructing time-series data for 10 products over 1978 to 1991 between Japan and the US, Blonigen (2001) undertakes product-by-product analyses. The analyses find auto parts exports from Japan are positively correlated with overseas production by Japanese automakers but negatively correlated with overseas production by Japanese suppliers. Constructing three-dimensional panel data covering 53 products and 26 countries over 1989-1994, Head et al. (2004) examine the case of the US and find similar results.

The objective of this study is to examine the substitution hypothesis for the case of the Japanese automobile industry. This study extends that of Blonigen (2001) in several ways.[5] The key extension is the use of more comprehensive and up-to-date data. I analyse newly constructed product-level data covering 32 auto parts and 49 countries over the period 1993 to 2008 on exports from Japan. The superiority of using these data is the opportunity to address endogeneity and aggregation bias simultaneously. The endonegeity issue is addressed by controlling for unobserved country-, product- and year-effects whereas aggregation bias is tackled by product-by-product analyses. The increased number of observations also increases estimation efficiency. In addition, an extension of data coverage is prompted by the rapid expansion of global production networks by Japanese automakers and parts suppliers over the past two decades: Asia, and particularly China, is emerging as a centre of global production networks whereas the importance of North America, and particularly the United States, is declining. In line with this compositional change in overseas operations, the destination of auto parts exports from Japan has shifted toward Asia: in 2008 the share of Asia was 40%, followed by North America (31%) and Europe (20%). Thus, the extension of country coverage is more informative.

3. ESTIMATION STRATEGY AND DATA

The Model and Data

This section discusses the estimation model followed by a discussion of the variable construction and estimation method. Following the convention, the estimation of the determinants of auto parts exports employs the following functional specification:

$$\ln EX_{i,j,t} = \alpha + \beta_1 \ln FDI\_M_{j,t} + \beta_2 \ln FDI\_S_{j,t} + \beta_3 \ln DIS_j + \beta_4 \ln GDP_{j,t}$$
$$+ \beta_5 \ln PGDP_{j,t} + \beta_6 \ln NER_{j,t} + \beta_7 NJP_{j,t} + \beta_8 EPI_{i,j,t} + u_{i,j,t} \qquad (1)$$

where subscript *i* stands for the *i* th auto parts: *i* =1,…,32, *j* stands for the *j* th country: *j* =1,…,49 and *t* stands for the year: *t* =1993, 1996, 1999, 2002, 2005, and 2008.[6] The variables are listed and defined below with the expected sign of the coefficient for independent variables in parentheses:

EX	Export value of auto parts *i* from Japan to host country *j* in Japanese yen
FDI_M	Scale of overseas operations by Japanese automakers in host country *j* (+)
FDI_S	Scale of overseas operations by Japanese suppliers in host country *j* (-)
DIS	Distance between Japan and capital of host country *j* (-)
GDP	Gross domestic product (GDP) in host country *j* (+)

PGDP	GDP per capita in country *j* (+)
NER	Nominal exchange rate index in host country *j* (+)
NJP	Share of non-Japanese automobile production in host country *j* (+)
EPI	Index of unit value for auto parts *i* exported to country *j* (-)
α	Constant term
u	Error term

The scale of overseas operations by Japanese automakers (*FDI_M*) is a measure of outward FDI by Japanese automakers into the host country. It is expected that FDI by automakers increases auto parts exports from Japan because of economic complementarities (Head and Ries 2004). The scale of overseas operations by Japanese parts suppliers (*FDI_S*) is used as a measure of outward FDI by Japanese suppliers into the host country. A negative coefficient would support the substitution hypothesis.

The destination GDP (*GDP*) and distance (*DIS*) are included as measures of market size and trade costs, respectively. In addition to these gravity variables, three other control variables are included. GDP per capita (*PGDP*) is added as a measure of the development level of the destination country. Controlling for development level matters because richer countries tend to have better ports, infrastructure, and communication systems that facilitate trade and FDI. Also, more advanced countries tend to have more developed supporting industries that induce FDI but replace exports from home with local procurement. The control for the exchange rate (*NER*) matters because changes in exchange rate cause changes in the relative price between home and host country, affecting firms' decisions on exporting and FDI. The share of non-Japanese automobile production in the destination country (*NJP*) allows for the control of the export-creating effect. However, data exist for this variable only after 1999. The unit value index (*EPI*) using value/weight ratio index is included to control for price effects.

Japan's disaggregated trade data classified according to the harmonised system (HS) are from the Trade Statistics of Japan compiled by the Ministry of Finance. These data enable identification of auto parts at the 9 digit-level. However, careful attention has to be paid to the classification of auto parts. While parts and components for motor vehicles are mainly classified into HS code 87, a large number of auto parts come under a different heading: tyres and rubber products (40), glass (70), electronic products (84, 85), seats (94), and so on. I classify auto parts based on the Japan Auto Parts Industries Association (JAPIA), which provides comprehensive coverage of auto parts based on the HS code at the 9 digit level. The monetary unit of export value is Japanese yen.

The scale of overseas operations by Japanese suppliers is measured by the number of employees at Japanese suppliers' overseas affiliates in each destination country. The data are extracted from *Nihon no jidoshabuhin kogyo* [Japanese Automotive Parts Industry] compiled by the Japan Auto Parts Industries Association (JAPIA) for various issues. The scale of overseas operations by Japanese automakers is measured by the number of employees at the overseas affiliates of Japanese automakers in each destination country.[7] The data are from *Kaigai kigyo shinshutsu soran* [List of Japanese overseas affiliates] compiled by Toyo Keizai for various issues. Among possible alternatives the number of employees is a better measure of overseas operations by firms for three reasons. First, the number of employees at overseas affiliates is closely correlated with the scale of production. Second, data on the number of employees at overseas subsidiaries are available for both automakers and suppliers. Third, data on the number of employees at overseas subsidiaries are available for a longer period.[8]

Nominal gross domestic product and GDP per capita measured in $US are from the World Development Indicators. Distance, measured using the geographical coordinates of the capital cities, is obtained from the CEPII database. The nominal exchange rate index is constructed based on the formula,

$NER_{j,t}$ = *Japanese Yen per \$US*$_t$ */ Local currency per \$US*$_{j,t}$ = *Japanese yen*$_t$ / *Local currency*$_{j,t}$

where *j* and *t* represent destination country and year, respectively. An increase in the index indicates depreciation of the Japanese yen, which should lead to an expansion of auto parts from Japan. The data for constructing the official exchange rate is obtained from the World Development Indicators. Data on automobile production comes from the International Organization of Motor Vehicle Manufacturers. The export value/weight ratio index is constructed based on the formula

$EPI_{i,j,t}$ = $[(Value_{i,j,t}/Weight_{i,j,t})/(Value_{1993}/Weight_{1993})]*100$

where 1993 is the base year. The data is obtained from the Trade Statistics of Japan compiled by the Ministry of Finance. I report the summary statistics for variables and correlation matrix in Tables 2 and 3.

-Table 2 here-

-Table 3 here-

Estimation Method

An endogeneity problem might arise due to the fact that the error term in equation (1) may include other difficult-to-control-for variables which are correlated with overseas operations by Japanese automakers and suppliers. One such variable may be part-specific characteristics including bulkiness, engineering and designing costs, and asset specificity, which could influence FDI and exports simultaneously (Head et al. 2004). For example, auto parts with higher asset specificity and engineering costs (e.g. catalytic converters, variable valve lift systems) are probably exported from headquarters' plants in a home country to avoid breaches of technology and information. On the other hand, bulky parts such as body and chassis components are expected to be directly supplied in a host country rather than exported from a home country because of higher transportation costs.

Other variables such as country-specific effects (e.g. industrial and trade policies in a host country) and time-varying factors (e.g. technological change and price changes) could affect overseas operations by MNEs and exports from their home countries. The automotive industry in almost all host countries covered in this study has been influenced by import-substitution policies. For example, local content requirements combined with a high tariff on automobile imports are popular among developing countries such as India, Thailand, Vietnam, Indonesia, Brazil, Argentina and Mexico. Such policies affect not only the investment decision by foreign automakers and parts suppliers but also trade flow of parts and components between home and host countries.

One way to overcome the endogeneity problem is to employ an estimation method such as instrumental variable (IV) estimation (Blomstrom et al. 1988, Grubert and Mutti 1991, Clausing 2000). However, IV approaches are not appropriate because of the difficulties in finding an instrument that is correlated with MNE overseas activity, does not determine exports from the home country, and is excludable from the equation (Head and Ries 2001). An alternative method is to use a least squares dummy variables (LSDV) model, allowing controls for time-invariant unobservable factors among host countries such as distance, GDP, and so on. Therefore, in order to mitigate the possibility of endogeneity bias, I include country-, product-, and time-dummy variables into model (1).

The Poisson pseudo-maximum-likelihood (PPML) technique is employed in this study. Estimating the constant-elasticity model (i.e. the log-log model) by ordinary least squares (OLS) might result in inconsistent estimates for two reasons (Silva and Tenreyro 2006). First is the strong assumption that the expected value of the error term is independent from any values of explanatory variables. Violation of this assumption leads to inconsistency of the OLS estimator. Second, the parameters estimated by OLS might be biased under heterosckedasticity. In order to tackle these problems, Silva and Tenreyro (2006) propose the PPML technique as an alternative. They use a multiplicative form of the constant-elasticity model and demonstrate that PPML estimates are less susceptible to bias. One of the useful properties of the PPML estimator is a wide range of applicability including panel data analysis (Wooldridge 1999). Extending the PPML estimator to this study, equation (1) can be rewritten as the multiplicative form of the constant-elasticity model with the conditional expectation:

$$E\,(EX_{i,\,j,t}\,|\,FDI\_M_{j,t}\,FDI\_S_{j,t}\,DIS_j\;GDP_{j,t}\;PGDP_{j,t}\,NER_{j,t}\;NJP_{j,t}\,EPI_{i,j,t})$$
$$= exp\,(\beta_1 \ln FDI\_M_{j,t} + \beta_2 \ln FDI\_S_{j,t} + \beta_3 \ln DIS_j + \beta_4 \ln GDP_{j,t} + \beta_5 \ln PGDP_{j,t} + \beta_6 \ln NER_{j,t} + \beta_7\,NJP_{j,t} + \beta_8\,EPI_{i,j,t}) \quad (2)$$

Thus, equation (2) is estimated by the PPML estimator in this study.

4. RESULTS

Table 4 reports PPML estimates with panel data covering almost 7,000 observations. The overall goodness-of-fit of the regression ranges from 0.44 to 0.88, sufficient to conduct an econometric analysis. The first column shows the specification within the simple gravity equation where only overseas operations by automakers are added. The coefficient of overseas operations by automakers (*FDI_M*) is positive and statistically significant at the 1% level, predicting that, overall, a 10% expansion of overseas production by Japanese automakers leads to a 1.5% increase in auto part exports from Japan. Likewise, the second column reveals the existence of a complementary relationship between overseas operations by Japanese suppliers and auto parts exports from Japan. When overseas production by both automakers and suppliers are added to the model (column 3), both coefficients are still positive and significant. However, the interesting point lies in their different magnitudes: the coefficient of overseas operations by suppliers (0.19) is twice as large as that of overseas operations by automakers (0.10). The fourth to seventh columns, which include additional controls, show the robustness of this finding: the coefficients of overseas operations by Japanese suppliers are invariably larger than those of overseas operations by Japanese automakers.

-Table 4 here-

The coefficients of the two central gravity variables have expected signs with significant levels. The negative coefficient of distance reflects the importance of proximity for trade. The economic size for host countries is a highly significant predictor of auto parts exports from Japan. The positive and significant coefficients of GDP per capita support the importance of the development level of the destination country in facilitating trade through better ports, infrastructure, and communication systems. Unexpectedly, the coefficients of nominal exchange rate are negative and statistically significant. However, this result is not meaningful due to the small economic significance of the estimates. The negative coefficients of value/weight ratio index are consistent with expectations however the effects are negligible. This result holds when the value/volume ratio index is included instead of the value/weight ratio index (column 5). The sign of the coefficient of non-Japanese production in the host country is contrary to my initial expectation however, is not economically significant (column 6). It should be noted that the unobservable product-specific characteristics including bulkiness, engineering and designing costs, and asset specificity are important in explaining auto parts exports from Japan. The pseudo R-squared rises to 0.83 after product dummies are added into the model (column 4).

I go one step further by undertaking product-by-product analyses. I estimate equation (2) separately for 32 products. This analysis has two motivations. The first is to address the possible aggregation bias that makes it difficult to identify substitution effects (Blonigen 2001). The second is to compare the estimation result with previous studies, particularly Blonigen (2001), which undertakes product-by-product analyses for 10 auto parts in the case of auto parts exports from Japan.

Table 5 presents the results. Overall each product has enough observations and the goodness-of-fit of each regression is sufficient (columns 3 and 4). As can be seen, the positive and significant coefficients of overseas operations by both automakers and suppliers are found for a wide variety of products. 24 estimates of overseas operations by Japanese automakers are positive and significant with at least a 10% significance level whereas no negative and significant estimate is found. For overseas operations by Japanese suppliers, 23 estimates are positive and significant whereas the negative and significant estimate is not found. The results clearly suggest that overseas operations by Japanese suppliers play a more important role in increasing auto parts exports from Japan than overseas operations by Japanese automakers: in comparison with overseas operations by automakers, the positive and significant coefficients of overseas operations by suppliers are larger for 17 products.

-Table 5 here-

5. DISCUSSION

Through product-by-product analyses, Blonigen (2001) finds that auto parts exports from Japan are positively correlated with overseas operations by Japanese automakers but negatively correlated with overseas operations by Japanese suppliers. The empirical analyses in this study support the former finding but not the latter. Furthermore, it has been found that the complementary relationship between overseas operations by Japanese suppliers and auto parts exports from Japan is stronger than the counterpart between overseas operations by Japanese automakers and auto parts exports from Japan. In order to explore these findings further, this section addresses the following two questions.

Why Do Overseas Operations by Suppliers Complement Exports from Home?

One hypothesis is that the market penetration of Japanese parts suppliers in host countries is expanding over time, leading to an increase in total demand for the firms' products (statistical complementarity). In the beginning Japanese suppliers follow the overseas investments of Japanese automakers, predominantly selling their products to automakers. Their customers are limited because they are not yet recognised in the host country market. At this stage, it is expected that the substitution effects of overseas operations by Japanese suppliers on auto parts exports from Japan is strong as found in Blonigen (2001). The time period covered by the empirical analyses of Blonigen (2001) is 1978-1991 suggesting that these were the formative period of overseas operations by Japanese auto parts suppliers.

In recent years, Japanese auto parts suppliers such as Denso have been expanding their overseas operations to meet expanding demand from both Japanese and non-Japanese automakers (IRC 2009).[9] This growing market penetration of Japanese parts suppliers tends to increase demand for some parts and components produced in Japan. In addition to the domestic market, overseas subsidiaries of Japanese suppliers are exporting their products to automakers in other countries within the regional free trade area such as ASEAN, EU, NAFTA and Mercosur (IRC 2010). The time period covered in this study (1993-2008) could be representative of these new developments.

To examine these arguments, I undertake additional analyses by estimating equation (2) by years and regions. Table 6 shows a difference in coefficients of overseas operations by Japanese parts suppliers between 1990s and 2000s: in the 1990s the coefficients range from 0.12 to 0.16 whereas the range in the 2000s is between 0.23 and 0.30. The result suggests that the dynamics of overseas operations by Japanese parts suppliers occurred over the past two decades, strengthening the complementary relationship between FDI and trade.[10]

-Table 6 here-

The results suggest a significant complementarity between overseas operations by Japanese suppliers and auto parts exports from Japan for Europe and North America (Table 7, columns 2 and 3). This makes sense due to their large automobile production and established free trade areas such as EU and NAFTA. However, further investigation using pooled estimates with interaction terms between the regional dummies and overseas operations by Japanese parts suppliers suggest that comparing with other regions the complementarity is larger only for North America but not Europe (columns 5 and 6). This result could be explained by the larger size of overseas subsidiaries in North America.

-Table 7 here-

Why Are Overseas Operations of Automakers and Exports Complementary?

Japanese automakers have gradually expanded their local procurements in host countries. In the case of Toyota local procurements in North America and Europe reached 80% to 90% by 2008 (IRC 2009). The increasing overseas operations of Japanese parts suppliers and the existence of competitive suppliers enables such a high local procurement in these regions. On the other hand, the local procurement in developing countries is still limited. In China, the local procurement for Land Cruiser is still less than 40% while in India, the local procurements for Innova and Altis are 55% and 35%, respectively (IRC 2009). This low local procurement is mainly due to the absence of competitive suppliers in these countries although components suppliers have begun to follow the automakers in setting up plants there. Thus, many components are imported from Japan. One of the underlying factors that could cause complementary effects of overseas operations by Japanese automakers on auto parts exports from Japan is that developing countries, particularly in Asia, have been emerging as a centre of global production networks for Japanese automakers over the past two decades. The largest coefficient of overseas operations by Japanese automakers for Asia (0.26) suggests the important role of economic complementarity in that region (Table 7).

The strong vertical linkages between Japanese automakers and their suppliers can be another factor explaining the complementary relationship between overseas operations by Japanese automakers and auto parts exports from Japan. The vertical linkages within production networks between Japanese automakers and their suppliers is characterised by a long-standing and stable hierarchical structure of division of labour (Nishiguchi 1994). It is well documented that the nature of the strong vertical network limits the degree of substitutability between local procurement within host countries and auto parts exports from Japan (Swenson 1997, Hackett and Srinivasan 1998). At the same time, the strong vertical network could reduce the complementarity by facilitating following-leader investment of suppliers that could substitute for local procurement of auto parts exports from Japan. In fact, the estimation results show that the magnitudes of the positive coefficients of overseas operations by Japanese automakers on Japan’s auto parts exports are smaller when overseas operations by suppliers are included in the model (Table 4). However, the positive coefficient of overseas operations by Japanese automakers remains statistically significant indicating that the export-creating effect of the vertical linkage is large enough to offset the export-reducing effects.

6. CONCLUSION

The objective of this study was to examine the substitution hypothesis that FDI by upstream firms replaces intermediate exports from home, using the case of the Japanese automobile industry. In analysing newly-constructed product-level data, the results do not support the hypothesis. They instead indicate that auto parts exports from Japan and overseas operations by Japanese parts suppliers are complementary.The results of this study cast doubt on the popular view that the growing overseas activity of MNEs could replace exports from a home country thereby depriving the locals of job opportunities and deindustrialising the domestic economy. The expansion of overseas operations of MNEs under ongoing global production sharing could in fact strengthen trade relations between home and host countries.

However, care is needed to in generalising the findings of this study due to the unique features of the automobile industry. The automobile industry is characterised by imperfect competition resulting from the important role of knowledge-based intangible assets produced by highly skilled labor and R&D. For example, since automobile production inevitably accompanies negative externalities such as air pollution, greenhouse gas emissions and road accidents, the large amount of investment are required to mitigate these problems. The oligopolistic nature of automobile industry resulting from such large investments may create a complementary FDI-trade nexus. In addition, complementarity might emanate from differences in management practices among MNEs. It is well-known that the degree of decentralization by Japanese MNEs to their overseas subsidiaries is limited relative to that of US and European MNEs. Headquarter plants in Japan play an important role as a buffer to meet fluctuation of market demand in host countries, possibly strengthening trade relations between home and host countries.

Table 1: Summary of previous research[1]

Author	*Period*[2]	*Dependent Variable*[3]	*Measurement of MNEs' Overseas Activities*[4]	*Results*[5]	*Data*[6]	*Control Variables*[7]	*Method*[8]
Lipsey and Weiss (1981)	1970	US Exports, industry-level	Net sales of US affiliates including manufacturing and non-manufacturing	Complement	Cross-section (44 destinations)	GDP, Distance, Dummy for membership in EEC	OLS
Lipsey and Weiss (1984)	1970	Exports of US Parent Firms	Sales of manufacturing affiliates minus their imports from the US	Complement	Cross-section (1090 firms, 5 areas)	Scale of parent's firm, GDP, Sales by non-manufacturing affiliates	OLS
Blomstrom, Lipsey and Kulchycky (1988)	1982	US Exports, industry-level	Net sales of US affiliates in industry	Mixed	Cross-section (countries)	GDP, Per capita GDP	OLS, 2SLS
Blomstrom, Lipsey and Kulchycky (1988)	1978	Swedish Exports, industry-level	Net local sales	Complement	Cross-section (countries)	GDP, Per capita GDP	OLS, 2SLS
Chedor, Mucchielli and Soubaya (2002)	1993	Intra-Firm Exports of French Firms	Number of employees at French overseas affiliates	Complement	Cross-section (firm, 21 destinations)	Firm's characteristics (size, capital intensity, R&D), GDP and Distance	OLS
Kim (2000)	1994	South Korea's Exports, industry-level	Value of outward FDI	Complement	Cross-section (9 industries and 57 countries)	GDP, PGDP, Dummy for membership in EEC	OLS
Yamawaki (1991)	1986	Total Japanese Exports to US markets, industry-level	Total employment of Japanese distribution affiliates in US	Complement	Cross-section (44 industries)	Total industry employment in US, Total industry employment in Japan, etc	OLS
Lipsey, Ramstetter and Blomstrom (2000)	1986-1992	Exports of Japanese parent firms	Number of employees in parent's affiliates	Complement	Cross-section (firms, regions)	GDP, Per capita GDP, Distance, Total sales of parent	OLS

Lipsey and Ramstetter (2003)	1986-1995	Japan's Exports, industry-level	Number of employment in Japanese affiliates	Complement	Cross-section (96-98 countries)	GDP, Per capita GDP, Distance	OLS
Head and Ries (2001)	1966-1991	Japanese automaker's exports to world	Number of new manufacturing investment by automakers	Substitute	Panel data (932 firms, 25 years)	Time-varying firm characteristics (Size, Capital Intensity, Labour Productivity, Wage)	OLS
		Japanese supplier's exports to world	Number of new manufacturing investment by suppliers/by automakers	Complement/ Complement	Panel data (932 firms, 25 years)	Time-varying firm characteristics (Size, Capital Intensity, Labour Productivity, Wage)	OLS
Blonigen (2001)	1978-1991	Japan's auto parts exports to US, product-level	Number of employees of Japanese suppliers' plants in US/ Number of vehicles produced by Japanese automakers in US	Substitute/ Complement	Time series (14 years)	Price, capital, US automobile production	OLS, SUR
Head, Ries and Spencer (2004)	1989-1994	US auto parts exports, product-level	Number of employees of US affiliates related to automobile industry/ Number of vehicles produced by Big 3	Substitute/ Complement	Panel data (53 products, 26 countries, 5 years)	Distance, Per capita GDP, Dummy for Mexico and Canada, Dummy for language, and communist	OLS

Notes:

[1] A large number of studies relevant to the relationship between FDI and exports from home country are not listed here due to the space limitation. Since this study examines the case of the Japanese automobile industry, I focus only on literature related to developed countries including the United States, France, Sweden, Japan and South Korea. Also, this study focuses on the analysis at a disaggregated level therefore I focus only on industry-, firm-, and product-level analyses.

[2] Period of analysis.

[3] Dependent variables relating to exports from home country measured by various definitions according to the authors.

[4] Key variables related to MNE’s overseas activities.

[5] Relationships between FDI and exports from home country derived from the regression analysis.

[6] Data sets employed in each study.

[7] Control variables. EEC represents European Economic Community.

[8] Estimation methods. SUR represents seemingly unrelated regression. 2SLS represents of two stage least squares.

Table 2: Summary statistics

Variables	Obs.	Mean	Standard Deviation	Min	Max
Ln Auto part exports, Japanese yen	9,013	11.88	2.78	5.31	19.72
Ln Overseas operations by suppliers	9,688	5.84	4.02	0	12.62
Ln Overseas operations by automakers	9,688	3.87	4.16	0	11.36
Ln GDP, $US	9,688	25.89	1.47	19.09	30.09
Ln GDP per capita, $US	9,688	8.65	1.39	5.55	10.65
Ln Distance, km	9,547	8.99	0.54	7.05	9.83
Ln Nominal exchange rate index	9,688	2.75	2.69	-5.06	9.22
Share of non-Japanese automobile production, %	6,976	77.64	32.94	-50	100
Index of value/weight ratio	7,588	160.45	869.86	0.13	53299.48

Table 3: Correlation matrix

	FDI_S	*FDI_M*	*GDP*	*PGDP*	*DIS*	*NER*	*NJP*	*EPI*
Ln Overseas operations by suppliers (*FDI_S*)	1							
Ln Overseas Operations by automakers (*FDI_M*)	0.58	1						
Ln GDP (*GDP*)	0.44	0.28	1					
Ln GDP per capita (*PGDP*)	-0.05	-0.30	0.41	1				
Ln Distance (*DIS*)	-0.29	0.05	0.05	0.23	1			
Ln Nominal exchange rate index (*NER*)	-0.09	-0.06	0.34	0.65	0.43	1		
Share of non-Japanese automobile production (*NJP*)	-0.42	-0.62	0.13	0.51	0.24	0.38	1	
Index of value/weight ratio (*EPI*)	-0.02	-0.02	-0.03	0.02	0.01	0.00	0.02	1

Table 4: Poisson pseudo-maximum-likelihood (PPML) estimation

Dependent variable: Exports of auto parts from Japan (*EX*)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln Overseas operations by Japanese automakers (*FDI_M*)	0.15***		0.10***	0.10***	0.06***	0.05***	0.02
	(0.01)		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Ln Overseas operations by Japanese suppliers (*FDI_S*)		0.30***	0.19***	0.20***	0.12***	0.16***	0.06**
		(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)
Ln Distance from Japan (*DIS*)	-0.35***	0.04	-0.18**	-0.22***	-0.19**	-0.29***	-8.66***
	(0.07)	(0.07)	(0.08)	(0.05)	(0.07)	(0.06)	(2.41)
Ln GDP in the Host Country (*GDP*)	0.65***	0.48***	0.47***	0.47***	0.52***	0.59***	-2.27***
	(0.04)	(0.05)	(0.05)	(0.03)	(0.05)	(0.04)	(0.73)
Ln GDP per capita in the host country (*PGDP*)	0.23***	0.11***	0.22***	0.23***	0.28***	0.20***	4.10***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)	(0.76)
Ln Nominal exchange rate (*NER*)	-0.11***	-0.05**	-0.07***	-0.07***	-0.03	-0.02	-0.15***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.06)
Index of value/weight ratio (*EPI*)	-0.001**	-0.001**	-0.001**	-0.00		-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)
Index of value/volume ratio					-0.001***		
					(0.00)		
Share of non-Japanese production in the host country (*NJP*)						-0.01***	
						(0.00)	
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummy	No	No	No	Yes	Yes	Yes	Yes
Country dummy	No	No	No	No	No	No	Yes
Observations	7,241	7,241	7,241	7,241	3,032	4,731	7,241
Pseudo R-squares	0.44	0.44	0.46	0.83	0.76	0.85	0.88

Notes:
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels. Clustered heteroscedasticity-consistent standard errors are in parentheses. Coefficients on constants, year dummies, product dummies and country dummies are not reported. The smaller observations in columns 5 and 6 result from the data limitations. Weight data is available for almost all of the products whereas volume data is limited into only 14 products out of 37. Production data is available only from 1999.

Table 5: Poisson pseudo-maximum-likelihood estimation (PPML) by products

Dependent variable: Exports of auto parts from Japan (*EX*)		Ln Overseas operations by Japanese automakers (*FDI_M*)	Ln Overseas operations by Japanese suppliers (*FDI_S*)	R^2	Number of observations
1	Tire	0.01	-0.01	0.73	263
2	Glass	0.04	0.09	0.54	255
3	Leaf springs	0.06	0.11	0.74	186
4	Mountings	0.23***	0.30**	0.83	216
5	Engine	0.19***	0.19***	0.79	265
6	Engine parts	0.10***	0.31***	0.85	262
7	Air Conditioners	0.01	0.05	0.61	215
8	Filters	0.09***	0.09**	0.66	261
9	Jacks/hoists	0.08***	0.21***	0.55	176
10	Shafts and cranks	0.04**	0.39***	0.86	259
11	Gaskets	0.07***	0.07	0.75	256
12	Electric engine parts	0.02	0.17***	0.83	261
13	Component of electric engine parts	0.10***	0.63***	0.83	245
14	Lighting/signaling equipment	0.11***	0.09**	0.72	262
15	Component of lighting/signaling equipment	0.12***	0.25***	0.79	256
16	Speakers	-0.04	0.27***	0.69	74
17	Lamps	0.06***	0.32***	0.84	253
18	Wire harness	0.15***	0.05	0.82	240
19	Chassis and body	0.09*	0.46***	0.70	100
20	Bumpers	0.07**	0.04	0.69	256
21	Seat belts	0.09**	0.40***	0.59	169
22	Body parts	0.16***	0.16**	0.81	267
23	Gear box	0.10***	0.23***	0.84	252
24	Transmission	0.15***	0.36***	0.79	237
25	Wheels	0.04	0.25***	0.86	246
26	Mufflers and exhaust pipes	0.11***	0.08**	0.78	234
27	Clutches	0.05*	0.30***	0.72	258
28	Steering wheels	0.12***	0.11**	0.69	224
29	Other parts of motor vehicles	0.18***	0.33***	0.90	266
30	Motorcycle parts	0.02	0.45***	0.65	253
31	Clocks	0.22***	0.22	0.66	114
32	Seats	0.22***	-0.15	0.60	160
Pooled estimate with time dummies		0.10***	0.19***	0.46	7,241
Pooled estimate with time & country dummies		0.02	0.06**	0.51	7,241

Notes:
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels. Standard errors and coefficients on other variables (distance, GDP, GDP per capita, exchange rate, value/weight ratio index) are not reported. Time-specific effects are controlled for, but not reported.

Table 6: Poisson pseudo-maximum-likelihood (PPML) estimation by years

Dependent variable: Exports of auto parts from Japan (*EX*)	1993	1996	1999	2002	2005	2008	Pooled Estimates
Ln Overseas operations by Japanese automakers (*FDI_M*)	0.11***	0.11***	0.10***	0.13***	0.08***	0.07***	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.01)
Ln Overseas operations by Japanese suppliers (*FDI_S*)	0.16***	0.16***	0.12***	0.23***	0.30***	0.23***	0.20***
	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.06)	(0.02)
Ln Distance from Japan (*DIS*)	-0.25	-0.16	-0.26***	-0.22**	-0.22**	-0.22***	-0.22***
	(0.15)	(0.12)	(0.10)	(0.10)	(0.09)	(0.08)	(0.05)
Ln GDP in the Host Country (*GDP*)	0.56***	0.46***	0.58***	0.43***	0.39***	0.41***	0.47***
	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)	(0.03)
Ln GDP per capita in the host country (*PGDP*)	0.16***	0.26***	0.32***	0.34***	0.21***	0.12**	0.23***
	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.02)
Ln Nominal exchange rate (*NER*)	-0.10***	-0.12***	-0.04	-0.11***	-0.02	-0.02	-0.07***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)
Index of value/weight ratio (*EPI*)		-0.00	-0.00	-0.001*	-0.001	-0.001*	-0.00
		(0.00)	(0.00)	(0.00)	(0.001)	(0.001)	(0.00)
Year dummy	No	No	No	No	No	No	Yes
Product dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1,284	1,226	1,181	1,176	1,179	1,195	7,241
Pseudo R-squares	0.82	0.80	0.85	0.87	0.87	0.83	0.83

Notes:
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels. Clustered heteroscedasticity-consistent standard errors are in parentheses. Coefficients on constants, year dummies and product dummies are not reported.

Table 7: Poisson pseudo-maximum-likelihood (PPML) estimation by regions

Dependent variable: Exports of auto parts from Japan (*EX*)	Asia	Europe	North America	South America	Pooled Estimates	Pooled Estimates
Ln Overseas operations by Japanese	0.26***	0.04***	0.06**	0.08***	0.08***	0.09***
automakers (*FDI_M*)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)
Ln Overseas operations by Japanese	0.03	0.22***	0.47	-0.07*	0.21***	0.17***
suppliers (*FDI_S*)	(0.03)	(0.02)	(0.45)	(0.04)	(0.03)	(0.02)
Ln Distance from Japan (*DIS*)	-0.05	-3.20***	111.51	-0.46	-0.19***	-0.38***
	(0.09)	(0.46)	(95.54)	(0.97)	(0.05)	(0.05)
Ln GDP in the Host Country (*GDP*)	0.42***	0.22***	-2.97	1.46***	0.43***	0.35***
	(0.04)	(0.07)	(2.86)	(0.18)	(0.03)	(0.03)
Ln GDP per capita in the host country	0.66***	0.40***	8.62	-0.67***	0.24***	0.18***
(*PGDP*)	(0.06)	(0.09)	(7.01)	(0.18)	(0.02)	(0.02)
Ln Nominal exchange rate (*NER*)	-0.06***	0.16***	-0.28	-0.06*	-0.03**	-0.02*
	(0.015)	(0.053)	(0.398)	(0.034)	(0.013)	(0.013)
Index of value/weight ratio (*EPI*)	-0.001*	-0.00	-0.001	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Europe dummy (*ERD*)					0.01	
					(0.23)	
*ERD*FDI_S*					-0.06**	
					(0.02)	
North America dummy (*NAD*)						-1.86***
						(0.37)
*NAD*FDI_S*						0.22***
						(0.03)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Product dummy	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	2,453	2,879	542	780	7,241	7,241
Pseudo R-squares	0.79	0.71	0.96	0.87	0.83	0.83

Notes:
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels. Clustered heteroscedasticity-consistent standard errors are in parentheses. Coefficients on constants, year dummies and product dummies are not reported.

Appendix : List of Countries

Asia	Europe	North America	South America	Others
China	Austria	Canada	Argentina	Australia
Hong Kong	Belgium	Mexico	Brazil	South Africa
India	Bulgaria	United States	Columbia	New Zealand
Indonesia	Czech Republic		Ecuador	Samoa
Iran	Finland		Peru	Saudi Arabia
Malaysia	France		Venezuela	
Pakistan	Germany			
Philippines	Hungary			
Republic of Korea	Ireland			
Singapore	Italy			
Sri Lanka	Netherlands			
Taiwan	Norway			
Thailand	Poland			
Viet Nam	Portugal			
	Romania			
	Russia			
	Slovakia			
	Spain			
	Sweden			
	Turkey			
	United Kingdom			

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NOTES

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[1] In the recent literature an array of alternative terms have been used to describe this phenomenon including 'fragmentation' and 'international outsourcing' (Jones and Kierzkowski 1990, Helpman 2006).

[2] The modularity results in large modules (e.g. Cockpit Module, Chassis Module, Axle Module, Front/Rear End Module, Door Module), which are more difficult and expensive to ship over long distances and are more likely to be coordinated tightly with the final assembly process, leading to the co-location of automaker and parts suppliers (Sturgeon et al. 2008).

[3] The other statistical concern is possible endogeneity bias resulting from omitted variables that simultaneously determine FDI and exports. For example, liberalisation policy favourable to trade and FDI in a host country might encourage home-country's MNEs to increase both exports from the home country and the activities of their overseas affiliates in the same host country. Also, firm- and industry-heterogeneity might cause upward bias. Helpman et al. (2004) suggest that firm-heterogeneity in terms of productivity and size matters as determinants of firms' exports and FDI. Previous research attempts to reduce omitted variable bias in two ways. One is to control for as many observable variables as possible at the country-, industry-, and firm-levels (Lipsey and Weiss 1981, Lipsey and Weiss 1984, Yamawaki 1991, Kim 2000, Head and Ries 2001, Chedor et al. 2002). The other is to employ an estimation method such as instrumental variable (IV) estimation (Blomstrom et al. 1988, Grubert and Mutti 1991, Clausing 2000). However, previous studies have not found a substitution relationship between FDI and exports overall notwithstanding the efforts to reduce possible endogeneity bias.

[4] The multiproduct nature is a common feature of contemporary multinational enterprises. For example, automakers produce a wide variety of products, ranging from commercial cars (trucks and buses) and passenger cars to intermediate products such as engines, engine parts and transmission. In addition, it is common that auto parts suppliers involve several type s of products.

[5] It is important to note that the differences between this study and Blonigen (2001) are not only the data set used but also model specification. This study examines determinants of auto parts exports from Japan by estimating a gravity equation whereas Blonigen (2001) estimates a demand function.

[6] See Table 5 for the list of auto parts and the Appendix for the list of host countries.

[7] I exclude non-manufacturing affiliates such as those involved in R&D, distribution, insurance and other non-manufacturing services.

[8] A comparison with official estimates by the Ministry of Economy, Trade and Industry (METI) and adjustments to those estimates by the Research Institute of Economy, Trade and Industry (RIETI) suggests that the coverage of the Toyo Keizai data on Japanese affiliates may have become increasingly poor in recent years. I thank a reviewer for this point. This data limitation needs to be taken into account in interpreting the results. Unfortunately there are no alternative data sources to check the robustness of the results.

[9] As of 2009, Denso is selling products to GM, Ford and Chrysler in North America, VW, Volvo, Jaguar, Daimler, Audi, Land Rover, Fiat, Iveco, Maserati, Porche, Ford, SEAT, Renault, Alfa Romeo, Ferrari, Lamborghini, Lancia, PSA, and BMW in Europe, GM, BMW, Hyundai, and Tata in Asia (IRC 2009).

[10] Ideally, it would have been more appropriate to compare the estimation results using data for the years between 1978 and 1991. Unfortunately, data limitations do not allow for this because this paper and Blonigen (2001) employ different data sources for exports, overseas operations by Japanese automakers and parts suppliers. The earliest year for which data are available is 1993.

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