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Abstract

This paper undertakes a comparative study of global production sharing by automakers in Japan, the United States and Western Europe, with emphasis on the interlocking relationships among Japanese automakers and parts suppliers within *keiretsu* networks in determining global production sharing of Japanese automakers. The findings suggest that the extent and modality of production sharing by Japanese automakers are significantly different compared to their counterparts in the United States and Western Europe. In particular, for Japanese automakers overseas production by their subsidiary plants is far less important in determining parts and components exports from Japan, given the general tendency of their part suppliers to internationalise their operations following the automakers.

Keywords: Global production sharing, *keiretsu*, automobile industry

JEL classification: F14, L23

Global Production Sharing in the Japanese Automobile Industry: A Comparative Analysis

1. INTRODUCTION

Global production sharing[i] - intra-product specialisation where the production process is sliced into discrete activities which are then allocated across multiple countries - has been a central feature of the automobile industry over past decades. The production process of automobiles is made of marketing, design, testing, pressing, welding, painting, parts production, assembly, logistics, sales and so on. Initially, all of these steps were geographically concentrated and internalised by automakers. However, this integrated production process began to separate as technological developments in transportation and communication made long-distance transactions feasible (Dicken 2003). Furthermore, the development of information technology and the liberalisation of trade and investment have dramatically reduced communication and transaction costs, enabling automakers to outsource an increasing amount of their production process abroad and organise their value chains globally.

Production sharing is particularly important for automakers due to the nature of the product. A car is composed of thousands of parts and components (P&C, hereafter), ranging from engine components to power-train, steering, suspension, brakes, wheels/tyres, exterior/interior trim, and body electronic components. It is not efficient for automakers to produce all these components in-house because of diseconomies of scale and capacity limitation.

The modality and intensity of production sharing with parts suppliers varies according to automakers. The important feature of production sharing by Japanese automakers is the high dependence on their parts suppliers based on a long-standing relationship.[ii] This Japanese-style of production sharing has been called a ‘hybrid’ system, making it possible to gain benefits from both vertical integration and market forces and contributing to the competitiveness of Japanese automakers (Williamson 1979, Womack et al 2007).

The objective of this study is to examine the hypothesis that this unique characteristics of the production system and supplier relationships in Japan matter in determining the extent and modality of production sharing. Specifically, the roles of the 'following-leader' pattern of Japanese overseas investment (i.e. suppliers' investments following automakers' investment abroad) and of interlocking relationships among firms (*keiretsu* networks) in determining the trade in P&C, are analysed. In order to highlight these unique characteristics, the role of global production operations of Japanese automakers in determining trade in P&C are compared with automakers headquartered in the United States, Germany, France, Italy and Sweden.

Research on Japan's peculiarity has so far focused solely on bilateral trade with the United States and Western European countries (Fung 1991, Lawrence 1991). However, there is little research that compares Japanese experiences with those of other countries (Encarnation 1992, Diehl 2001). This study contributes to the latter in two ways. This is the first comparative analysis involving an econometric exercise. The existing literature has been limited to descriptive analysis. This study also analyses a newly-constructed product-level dataset that makes it possible to control for product-specific characteristics that might affect trade flows but are difficult to capture (Head et al 2004).

My methodology involves estimating an augmented version of a gravity equation using three-dimensional panel data covering 6 traditional auto-producing countries: Japan, the United States, Germany, France, Italy, and Sweden (hereafter, TPCs), 49 auto-producing countries, and 90 auto parts over the 7-year period from 2002 to 2008. The automakers headquartered in TPCs are the key players that spread production networks worldwide therefore the performance of other TPCs becomes a benchmark by which to examine Japan's unique features. It is important to incorporate multiple countries into an analysis because the leading automobile producers are expanding production networks encompassing not only developed countries but also developing countries especially newly auto-producing countries (hereafter, NPCs). The period from 2002 to 2008 is chosen for the study due to data availability.

The plan for this chapter is as follows. Section 2 summarises the historical process of production sharing by the Japanese automobile industry followed by discussion of the unique features of global production sharing by Japanese automakers relative to automakers in the United States and Western Europe. In Section 3, the econometric approach, variable construction, and data issues are discussed. Section 4 reports the results. Section 5 concludes.

2. GLOBAL PRODUCTION SHARING

This section overviews the process of production sharing in the Japanese automobile industry and reveals the characteristics in comparison with other TPCs. First, it is shown that the ratio of Japan's P&C trade to total (domestic + overseas) production by Japanese automakers is much smaller than that of other TPCs, suggesting that Japanese automakers are less involved in global production sharing. Second, I discuss possible factors that affect this feature, focusing on the *keiretsu* networks and following-leader pattern of investments.

The Process

At the formative stage, automobile production in Japan was characterised as craftsmanship and the production process was entirely internalised by automakers. Every auto part was customised and the chassis and body were made by hand. In addition, the limited scale of the domestic market and underdeveloped supporting industries prevented automakers from developing production sharing at this stage (*Nihon Jidosha Kogyokai* 1988).

Production sharing began in the 1930s and 1940s when the wartime economy caused skyrocketing military demand for motor vehicles and Japanese automakers subcontracted some auto parts production to independent suppliers as a convenient means of meeting the rapid surges in demand

(Nishiguchi 1994).[iii] This production sharing process was reinforced by technological development in machine tools and development in infrastructure such as national transportation and communication systems, alleviating transaction costs between automakers and parts suppliers. Government policy intervention also mattered. In 1940, the Ministry of Commerce and Industry issued the Rationalisation Outline of the Machinery and Iron and Steel Industries, which was aimed at restructuring the anarchic subcontracting in the Japanese manufacturing industry (Nishiguchi 1994).

Production sharing was orchestrated through a just-in-time delivery system adopted by Japanese automakers in the 1960s and 1970s. In the case of Toyota, the just-in-time system was first introduced in 1954 and had spread to every Toyota factory by 1963. In addition, the just-in-time system began bringing in first-tier suppliers in the 1960s and the just-in-time system was completed in the late 1970s after the oil shocks (Fujimoto 1999).

In the 1960s production sharing with parts suppliers expanded toward not only parts production but also their designs and R&D. The advent of motorisation that led to growing demand for passenger vehicles encouraged Japanese automakers to move into offering a full line of products by increasing the number of basic platforms. This product proliferation meant that workloads increased rapidly, not only in production but also in product development (Fujimoto 1999). Japanese automakers expanded the range of outsourcing to parts suppliers in order to reduce such workload pressure.

The Japanese automobile industry has experienced global production sharing since the middle of the 1980s when Japanese automakers began to increase overseas production as a response to political pressure from the US and Western European governments arising from trade frictions (Figure 1). The unprecedented appreciation of the Japanese yen accelerated the reallocation from exporting to producing abroad further. In the course of internationalisation, Japanese automakers have established international production networks, leading to the development of global production sharing that increases cross-border transactions of P&C.

-Figure 1 about here-

Global production sharing takes four forms.[iv] The first is an intra-firm transaction between automakers' headquarters in Japan and their overseas plants. Second is an inter-firm transaction between headquarters' plants of suppliers in Japan and automakers' overseas plants. Third is an intra-firm transaction between headquarters' plants of suppliers in Japan and their overseas plants. This is the case where a headquarter plant of a supplier in Japan ships sub-components and materials to its overseas affiliate and the affiliate assembles them into the final product supplied to automakers in a given country. Fourth is an inter-firm transaction between headquarters' plants of automakers in Japan and the overseas plants of suppliers. This is the case where an overseas affiliate of a supplier directly ships its products to automakers' plants in Japan.

Figure 2 shows the trend of P&C trade in Japan and its ratio to total (domestic + overseas) production by Japanese automakers. As can be seen, Japan experienced a rapid increase in trade in P&C from 24 billion US dollars in 1988 to 89 billion US dollars in 2008. The development of global production sharing becomes more apparent when looking at the ratio of trade in P&C to total production by Japanese automakers, which indicates the dependence of production sharing across borders.[v] That the ratio tends to rise over the past two decades indicates that the growth of trade in P&C has been faster than that of automobile production by Japanese automakers.

-Figure 2 about here-

However, the most interesting feature of global production sharing in the Japanese automobile industry lies in its limited extent when comparing with others. Although trade in P&C in Japan and its ratio to total production by Japanese automakers is growing, the ratio has been much lower than that of other TPCs (Figure 3). Sweden and Italy were the top two countries, followed by Germany, France and the United States. Japan was at the bottom in both 2001/2 and 2007/8.[vi]

-Figure 3 about here-

The limited degree of global production sharing in Japan is largely explained by the import side. The value of P&C imports to Japan has remained much smaller than exports, leading to a substantial trade surplus over time in automobile P&C. Japan's import value has also been continuously smaller than those of all other TPCs except for Sweden over the past two decades.[vii] The existing literature argues that the existence of a unique vertical network called *keiretsu* - a long-standing business relationship between an automaker and its parts suppliers through personnel exchange, cross-share holding, and information sharing - makes it difficult for foreign companies to penetrate the Japanese market (Lawrence 1991 and Qiu and Spencer 2002). Due to the strong automaker-supplier relationship in Japan, companies outside the production network would face a cost disadvantage in selling their products to insiders of networks.

The empirical issue is whether *keiretsu* networks create trade among insiders of networks across borders. Theory predicts that the strong assembler-supplier relationship in Japan facilitates reverse imports from Japanese affiliates in a host country because it reduces market entry costs for the insiders of production networks (Greaney 2003). Greaney (2005, 2009) and Head et al (2004) present empirical evidence that the existence of a *keiretsu* network facilitates reverse imports from Japanese firms abroad, suggesting that the network trade plays an important role in determining Japan's imports. However, the increase in Japan's auto parts imports might be explained by global sourcing adopted by Japanese automakers since the middle of the 1990s. The shift toward global sourcing has encouraged Japanese automakers to procure auto parts from the most competitive company anywhere in the world, suggesting an increase in auto parts trade with companies outside networks.

Another possible factor that explains the limited degree of global production sharing by Japanese automakers lies in the export side. It is well established that when Japanese automakers build production plants abroad, they attempt to transplant the efficient supplier relationships forged in Japan to achieve their competitive advantages such as the just-in-time inventory system and quality control. As a result, Japanese parts suppliers follow automakers' investment abroad (Head et al 1995, Blonigen et al 2005). This following-leader pattern of Japanese investments seems to substitute auto parts exports from Japan to the extent that exporting and investments are alternative strategies for suppliers. Blonigen (2001) and Head et al (2004) show empirical evidence that there exists a substitution relationship between auto parts exports from Japan and Japanese suppliers' investment abroad.

3. EMPIRICAL ANALYSIS

This section examines the roles of the 'following-leader' pattern of Japanese overseas investment and vertical *keiretsu* networks in determining the trade in P&C by estimating an augmented version of a gravity model with three-dimensional panel data. I first discuss the model specification followed by a discussion on variable construction and data sources.

Model

The gravity equation has become the 'work-horse' for modeling bilateral trade flows. In empirical studies the gravity equation normally takes a stochastic form in order to allow for other factors impacting on trade flows. Also, the multiplicative nature of the gravity equation enables taking natural logs to obtain a constant-elasticity relationship between dependent and independent variables as follows;

$$lnT_{ij} = \alpha_1 + \alpha_2 lnM_i + \alpha_3 lnM_j + \alpha_4 lnD_{ij} + \varepsilon_{ij} \qquad (1)$$

where α_1 is a constant term and ε_{ij} is a stochastic error term assumed to be statistically independent of the regressors. Although the gravity equation explains bilateral trade flows between economies well with just the sizes of the economies and their distances, there is a huge amount of variation in trade that cannot be explained. Therefore, the gravity equation is often augmented with variables such as GDP per capita, adjacency, common language and other variables of interest.

For the purpose of this study, the basic gravity model is augmented by adding a number of other variables, which are discussed here. Overseas production (*OSP*) allows for the role of production networks in determining trade in P&C for TPCs and its coefficient is expected to be positive, suggesting the existence of global production sharing. Domestic auto production (*DAP*) is included to capture the market size and supply capacity of auto parts instead of GDP, which is another essential variable of a gravity equation. Because the dependent variables are specific to trade in auto parts, domestic auto production is a more appropriate variable to capture its market size.[viii] Real per capita GDP (*PGDP*) is used to allow for the fact that more developed countries have better ports and communication systems and other trade-related infrastructure as well as better institutional arrangements for contract enforcement that facilitate trade. Adjacency (*ADJ*) and common language (*LAN*) between countries are included to control for country-specific characteristics that might affect trade flow. The real exchange rate (*RER*) is included to capture the relative competitiveness of traded-goods between economies.

A Japan dummy (*JAP*) is included to see whether Japan's trade pattern of P&C is different from that of other TPCs conditional on the other variables included in the model. The sign of the coefficient is expected to be different between exports and imports. However, the real importance lies in the interpretation of the coefficient. Controlling for overseas production (*OSP*) that captures cross-border transactions among companies within networks, a positive coefficient would imply Japan's P&C trade is more related to arm's-length transactions compared with other TPCs. The interaction term (*JAP*×*OSP*) is the key variable in the model because it allows for testing the key hypothesis in this study. The coefficient for exports is expected to be negative, suggesting the 'following-leader' pattern of Japanese overseas investment substitutes P&C exports from Japan. The coefficient for imports is expected to be positive, implying that vertical *keiretsu* networks facilitate P&C imports into Japan.

A set of year dummy variables (*T*) is included to control for time-varying effects such as technological changes in automobile industries. The inclusion of a set of regional dummy variables (*R*) is important to control for regional differences such as free trade areas and historical links within regions. The importance of regional linkage is reflected in the high intensity of intra-regional trade. A set of host-country dummy variables (C) is included to control for unobservable country-specific characteristics such as trade and industry polices in the host country.

The augmented version of the gravity equation is:

$$\ln T\_P\&C_{i,j,t} = \alpha + \beta_1 \ln OSP_{i,j,t} + \beta_2 \ln DAP_{i,t} + \beta_3 \ln DAP_{j,t} + \beta_4 \ln DIS_{i,j} + \beta_5 \ln PGDP_{i,t} + \beta_6 \ln PGDP_{j,t} + \beta_7 ADJ_{i,j} + \beta_8 LAN_{i,j} + \beta_9 \ln RER_{i,j,t} + \beta_{10} JAP_i + \beta_{11}(JAP_i \times \ln OSP_{i,j,t}) + \delta T + \omega R + \partial C + u_{i,j,t} \quad (2)$$

where subscript *i* stands for sample countries including Japan, the United States, Germany, France, Italy, and Sweden, *j* stands for trading partners covering 49 countries worldwide and *t* stands for the years from 2002 to 2008.[ix] The ln before variables stands for the natural logarithm. The dependent variable (*T_P&C*) has three different forms of real bilateral trade values of parts and components: (1) total trade, (2) exports, and (3) imports. The independent variables are listed and defined below, with the expected signs of the regression coefficients given in brackets:

OSP	Overseas production in country *j* by automobile producers headquartered in country *i* (+)
DAP	Domestic auto production in country *i* and country *j* (+)
DIS	Distance between capital cities in country *i* and country *j* (-)
PGDP	Real per capita GDP in country *i* and country *j* (+)
ADJ	A binary variable assuming the value 1 if country *i* and country *j* share a common land border and 0 otherwise (+)
LAN	A binary variable assuming the value 1 if country *i* and country *j* share a common official language and 0 otherwise (+)
RER	An index of bilateral real exchange rate which measures the international competitiveness of country *i* against country *j* (+or-)
JAP	A binary variable assuming the value 1 if country *i* is Japan and 0 otherwise (+or-)
T	A set of time dummy variables
R	A set of regional dummy variables

C	A set of host country dummy variables
α	A constant term
u	A stochastic error term

Data and estimation method

Data on domestic auto production (*DAP*) are extracted from the website of the International Organisation of Motor Vehicle Manufacturers, which provides information on the volume of motor vehicle production in each country. Real per capita GDP (*PGDP*) measured in $US at constant 2005 prices is from the World Development Indicators. Distance (*DIS*), adjacency (*ADJ*), and common language (*LAN*) between countries are obtained from the CEPII database. Distance is measured using the geographical coordinates of the capital cities. The adjacency dummy variable indicates whether the two countries are contiguous. The common language is a dummy variable indicating whether countries share a common official language. The real exchange rate (*RER*) is constructed based on the formula,

$$RER_{ij} = NER_{ij} * (P_j^W / P_i^D)$$

where *NER* is the nominal exchange rate index, P^W is the producer price measured by the wholesale price index, and P^D is the domestic price measured by the GDP deflator. These data are obtained from the World Development Indicators.

Data on overseas production (*OSP*) are obtained from the International Organisation of Motor Vehicle Manufacturers, which provides information on production volume by manufacturer and country. Using these data, I calculate overseas production in each trading country by automobile producers headquartered in the TPCs. The automobile producers classified by the location of their headquarters are listed in Appendix 3. While a classification based on ownership would be more appropriate, this study does not employ such a classification for two reasons. First is the difficulty because there are wide varieties of degree of ownership and alliances.[x] In addition, the degree of ownership has changed over time and alliances between automakers have sometimes been dissolved.[xi] On the other hand, the locations of their headquarters can be easily identified because they normally do not move even when merged into another company (e.g. Opel has been headquartered in Germany). Second, the ownership-based calculation might lead to more measurement error, causing a biased and inconsistent estimator. As an example, take the Nissan (Japanese auto maker) and Renault (French automobile producer) alliance, in which Nissan owns a 15% Renault share and Renault owns a 44% Nissan share. Suppose that Nissan has an overseas plant in Thailand but Renault does not. If Nissan is regarded as a subsidiary of Renault, Nissan's overseas plant in Thailand belongs to Renault. This treatment is able to capture the impact of intra-firm trade between Renault's headquarters in France and the overseas plant in Thailand on trade in P&C between France and Thailand. However, it fails to capture the impact of intra-firm trade between Nissan's headquarters in Japan and the overseas plant in Thailand on bilateral trade between Japan and Thailand. Since the latter has a more significant implication for bilateral trade in P&C, the measurement based on their headquarters' location is more appropriate rather than one based on ownership.

A detailed list of variable definitions and data sources is provided in Appendix 4. Summary statistics are presented in Table 1.

-Table 1 about here-

The model is estimated by the fixed effect model (FEM) that controls for host country-specific characteristics and time effects by adding dummy variables. The selection of estimation model between the FEM and the random effect model (REM) is based on the underlying assumption: the FEM allows the unobserved host country effects to be correlated with explanatory variables whereas the REM does not (Wooldridge 2002). In this study, it is suspected that unobserved country-specific factors such as trade and industry policy in the host country are strongly correlated with overseas production of the automakers (Head and Ries 2001). Historically, the import-substitution policy in the developing countries and the creation of a free trade area has played an important role in encouraging automakers to set up production plants in the host country. This leads to superiority of the FEM over the REM.[xii]

Estimation is carried out in two steps. The first is to estimate determinants of total trade (exports + imports) in order to see the impact of production networks on total P&C trade as well as Japan's unique features controlling for other relevant variables. The second step is to estimate determinants of exports and imports, separately. This treatment matters because the overseas production of Japanese automakers is expected to have different effects on exports and imports as already discussed. Overseas production of Japanese automakers induces Japanese suppliers' investment to substitute exports of P&C from Japan. On the other hand, the expansion of global production networks might increase reverse imports from insiders of the vertical *keiretsu* networks.

4. RESULTS

Table 2 reports the augmented gravity equation estimated using three-dimensional panel data. With 6 sample countries, 49 trading partners, and the 7 years from 2002 to 2008 and allowing for missing observations, the estimates are based on 823 observations for total trade, 800 for exports and 793 for imports.

-Table 2 about here-

The first three columns show estimates for total trade. As can be seen in the first column, the coefficient of overseas production (*OSP*), which captures the impact of cross-border production networks on total trade in P&C, is positive and significant as expected. This suggests the existence of a causal relationship between production networks and P&C trade. This result is robust to adding other relevant variables to the estimating equation (Column 2). After controlling for the relevant variables, on average, a 1% expansion of overseas production by automobile producers leads to a 0.23% increase in P&C trade with that trade partner for TPCs. The interpretation is that global production sharing plays an important role in determining trade flows. The coefficients of the two central gravity variables have expected signs with significant levels. Auto production for both reporter and partner are positive and a highly significant predictor of bilateral trade in auto parts.[xiii] Distance is negative and significant at the 1 per cent level, reflecting the importance of proximity for trade. The positive and significant coefficient of the adjacency dummy supports the importance of geographical clusters in the automobile industry. The coefficient of partners' GDP per capita is a positive and significant predictor of bilateral trade whereas that of reporters' counterpart is statistically insignificant. This unexpected result is not meaningful because reporters, that are TPCs, are all developed countries with better ports and communications systems and other trade-related infrastructure as well as better institutional arrangements for contract enforcement that facilitate trade. Common language does not seem to be an important determinant of trade in P&C. This is not surprising because a global sourcing that procures auto parts from the most competitive company anywhere in the world has been a common strategy among global automakers and suppliers. The coefficient of the real exchange rate (*RER*) is negative and significant at the 10 percent level. However, the interpretation is not suggestive because the dependent variable includes both exports and imports.

The third column shows results when the Japan dummy (*JAP*) and its interaction term with overseas production (*JAP*×Log (*OSP*)) are added. Both coefficients are not statistically significant, suggesting the pattern of Japan's total P&C trade is not different from that of the other TPCs. However, it remains unclear about Japan's uniqueness because the focus so far has been on total trade (exports + imports). More importantly, as discussed above, the overseas production of Japanese automakers is expected to have different implications for auto parts exports and imports, respectively. It would seem, therefore, that further investigation is needed by estimating determinants of exports and imports separately.

The fourth to sixth columns of Table 2 show estimates related to exports. The fourth column, controlling for gravity and other relevant variables, shows a similar result to that for total trade in the second column. The effect of overseas production is positive and significant at the 1 percent level, predicting that a 1% expansion of overseas production leads to an increase in P&C exports to that country by 0.27%. The interpretation is that a cross-border transaction within networks plays an important role in determining P&C exports for TPCs. The fifth column shows results when the Japan dummy (*JAP*) and its interaction term with overseas production (*JAP*×Log (*OSP*)) are added. The coefficient of the Japan dummy is positive and significant at the 5 percent level, suggesting that, after allowing for the other relevant variables, on average, Japan exports more P&C than other TPCs. However, the coefficient of the interaction term is statistically insignificant. The sixth column reports the results when country dummy variables are added to control for time-invariant aspects of industrial policy of individual host countries (partners).[xiv] This variable addition is justified because the relationship between overseas production and trade flows could well be influenced by country-specific distortions in trade and industry policy. With this specification, the coefficient of the interaction term between the Japan dummy and overseas production (*JAP*×Log (*OSP*)) becomes negative and significant at the 1 percent level. The result suggests that the magnitude of the interlink between Japan's P&C exports and overseas production by Japanese automakers is 0.23 percentage points smaller comparing with the magnitude of the average relationship estimated for all TPCs. The interpretation is as follows: import substitution and local content requirement policies in host countries encourage automakers to build plants in these countries and parts suppliers to follow them. As discussed above, following-leader investment that probably substitutes a direct supply of P&C for exports from home country, is more prevalent among Japanese automakers and their suppliers in comparison with the case of the US and European counterparts.

The seventh to ninth columns of Table 2 show estimates related to imports. Interestingly, the results are very similar to those for exports. The coefficient of overseas production (*OSP*) is positive and significant in all three equations, suggesting that production networks facilitate imports of P&C. Overall, the gravity variables are statistically significant with the expected signs. However, the signs of the coefficients of the Japan dummy (*JAP*) and its interaction term with overseas production (*JAP*×Log

(*OSP*)) are different from those of the exports equations. As can be seen in the eighth column, the coefficient of the Japan dummy is negative and significant at the 1 percent level and that of the interaction term is positive and highly significant. Japan's P&C imports is 6.73% smaller but the interlink between Japan's P&C imports and overseas production by Japanese car makers is 0.43 percentage points larger than is the case for other TPCs.

The ninth column shows the result when country dummies are added as in the case of exports. The coefficient of the Japan dummy is still negative and significant (10 percent level) whereas that of the interaction term becomes insignificant. However, the result might implicitly reflect Japan's smaller involvement with arms-length transactions with companies outside networks comparing with those of other TPCs. This is because the negative coefficient of the Japan dummy controlling for overseas production probably captures the role of cross-border production sharing with companies outside networks. That is to say, the result implies that the proportion of P&C imports that Japan is engaging with global production sharing within networks is higher than for the counterparts of other TPCs.

On the other hand, another interpretation of the result in the ninth column is possible. The development of information technology and its prevalence are facilitating a shift in the assembler-supplier relationships in Japan from the closed form with stability to the open form with flexibility (Steffensen 1998). For example, the CAD/CAM (computer-aided design and computer-aided manufacturing) and Japanese automotive Network eXchange (JNX) would reduce the communication and transaction costs when overseas suppliers do business with Japanese automakers.[xv] Therefore, the increase in Japan's auto parts imports might be attributed to growth in overseas procurement beyond the *keiretsu* networks by Japanese automakers, leading to a smaller difference in global production sharing between Japanese automakers and the US and European automakers.

5. CONCLUSION

In this paper, I have undertaken a comparative analysis of global production sharing by automakers in Japan, the United States and Western Europe, with emphasis on the roles of the following-leader pattern of Japanese overseas investment and interlocking relationships among firms (*keiretsu* networks) in determining global production sharing of Japanese automakers. The results suggest that the relationship between parts and components exports from home country and overseas production is much weaker for the Japanese automakers compared to their counterparts headquartered in the United States, Germany, France, Italy and Sweden. This finding is consistent with following-leader relationship between Japanese automakers and their part suppliers. By contrast, no such statistically significant difference in the relationship between imports of parts and components to the home country and overseas production. This implies the overseas procurement patterns among automakers in TPCs are more similar than before.

The findings of this study in relation to the following-leader patterns of overseas operations of Japanese automakers are consistent with those of Blonigen (2001). That study focused solely on the experiences of Japan, while a specific focus on the relationship between overseas part suppliers and final assemblers. However, this study has placed this unique feature of global operations of Japanese automakers in comparative perspective. Nevertheless, the findings in this study and Blonigen (2001) could complement each other to support the existence of the following-leader pattern of investments by parts suppliers.

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NOTES

[i] 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).

[ii] Production sharing in the US automobile industry is characterised as vertical integration through mergers and acquisitions of parts suppliers. On the other hand, production sharing in the European automobile industry is characterised as arm’s length-transactions through the market. See Shimokawa (1994) for more information.

[iii] For example, Toyota found it necessary to externalise part of their production activities, leading to increasing reliance on purchasing from parts suppliers: the share of purchased parts in the manufacturing cost per vehicle was 51% in 1936 but had risen to 66% by 1939 (Nishiguchi 1994).

[iv] This paper focuses on the production sharing between headquarters and overseas subsidiaries. Although global production sharing could also facilitate trade in P&C among their overseas subsidiaries, this study is not able to capture it due to data limitations.

[v] The total auto production by automakers represents the demand size of auto parts therefore the ratio suggests the degree of global production sharing for each automaker.

[vi] This limited degree of global production sharing by Japanese automakers can be observed using the share of P&C in total automobile trade (P&C + final goods), which is commonly used as an indicator of the intensity of global production sharing (Yeats 1998, Athukorala and Yamashita 2006). In 2007/8, Sweden (57%) was a top country which has the largest share of P&C in total automobile trade, followed by France (51%), Italy (49%), Germany (45%) and the United States (44%). Japan was at the bottom with a 38% share.

[vii] In 2007/8, the United States (105 billion US$) was a top importer of automobile P&C, followed by Germany (74 billion), France (39 billion), Italy (22 billion), Japan (19 billion) and Sweden (13 billion).

[viii] I thank Theresa M. Greaney for this point.

[ix] Refer to Appendix 2 for the list of 49 trading partners.

[x] For example, while Opel, a German carmaker, has been a complete subsidiary of General Motors since 1929, Mazda, a Japanese automobile producer, has been more loosely allied with Ford.

[xi] For example, Chrysler, a US carmaker was purchased by Daimler Benz, a German car maker, creating a combined entity, DaimlerChrysler in 1998. However, this alliance was dissolved in 2007.

[xii] I acknowledge that the FEM has disadvantages (Wooldridge 2002). First, the introduction of many variables into the model reduces the degrees of freedom. Second, as the number of independent variables increases, the problem of multicollinearity is more likely to arise. Third, the FEM makes it difficult to identify the impacts of time-invariant variables such as distance, language, and adjacency.

[xiii] Reporter includes 6 TPCs (Japan, United States, Germany, France, Italy, and Sweden) and partner includes 49 auto-producing countries.

[xiv] I exclude regional dummy variables and variables to capture country specific characteristics such as distance, adjacent dummy and language dummy.

[xv] On the contrary, Morita and Nakahara (2004) show that the information-technology revolution can strengthen several aspects of vertical networks.

REFERENCES

Athukorala, P.C., Yamashita, N., 2006. Production fragmentation and trade integration: East Asia in a global context. *The North American Journal of Economics and Finance* 17, 233-256.

Blonigen, B.A., 2001. In search of substitution between foreign production and exports. *Journal of. International Economics* 53, 81-104.

Blonigen, B.A., Ellis, C. J., Fausten, D., 2005. Industrial groupings and foreign direct investment. *Journal of International Economics* 65, 75– 91.

Dicken, P., 2003. *Global Shift: Reshaping the Global Economic Map in the 21st Century*. New York: The Guilford Press.

Diehl, M., 2001. International Trade in Intermediate Inputs: The Case of the Automobile Industry. *Kiel Working Paper*, No. 1027.

Encarnation, D. J., 1992. *Rivals Beyond Trade: America versus Japan in Global Competition.* New York: Cornel University Press.

Fujimoto, T., 1999. *The Evolution of a Manufacturing System at Toyota*. New York: Oxford University Press.

Fung, K.C., 1991. Characteristics of Japanese industrial groups and their potential impact on US-Japan trade. In: Baldwin, R. (Eds.). *Empirical Studies of Commercial Policy*. Chicago: University of Chicago Press, 137-168.

Greaney, T. M., 2003. Reverse Importing and Asymmetric Trade and FDI: A Networks Explanation. *Journal of International Economics* 61, 453-465.

Greaney, T.M., 2005. Measuring network effects on trade: Are Japanese affiliates distinctive?. *Journal of Japanese and International Economics* 19, 194-214.

Greaney, T.M., 2009. Measuring network effects on trade: A reexamination. *Japan and the World Economy* 21, 219-225.

Head, K., Ries, J., Swenson, D., 1995. Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States. *Journal of International Economics* 38, 223-247.

Head, K., Ries, J., 2001. Overseas Investment and Firm Exports. *Review of International Economics* 9, 108-122.

Head, K., Ries, J., Spencer, B.J., 2004. Vertical Networks and Auto Parts Exports: Is Japan different? *Journal of Economics and Management Strategy* 13, 37-67.

Helpman, E., 2006. Trade, FDI, and the Organization of Firms. *Journal of Economics Literature* XLIV, 589-630.

Jones, R.W., Kierzkowski, H., 1990. The Role of Services in Production and International Trade: A Theoritical Framework. In: Jones, R., Krueger, A.O., (Eds.). *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*. Oxford: Basil Blackwell, 31-47.

Lawrence, R.Z., 1991. Efficient or Exclusionist?: The Import Behavior of Japanese Corporate Groups. *Brookings Papers on Economic Activity* 1, 311-330.

Morita, H., Nakahara, H., 2004. Impacts of the Information-Technology Revolution on Japanese Manufacturer-Supplier Relationships. *Journal of the Japanese and International Economics* 18, 390-415.

Nihon Jidosha Kogyokai [Japan Automobile Manufacturers Association (JAMA)]., 1988. *Nihon jidosha sangyoshi* [History of Japanese automobile history]. Tokyo: Nihon Jidosha Kogyokai.

Nishiguchi, T., 1994. *Strategic Industrial Sourcing: the Japanese Advantage*. New York: Oxford University Press.

Qiu, L.D., Spencer, B.J., 2002. Keiretsu and Relationship-Specific Investment: Implications for Market-Opening Trade Policy. *Journal of International Economics* 58, 49-79.

Shimokawa, K., 1994. *The Japanese Automobile Industry: A Business History*. London: The Athlone Press.

Steffensen, S.K., 1998. Informational network industrialization and Japanese business management. *Journal of Organizational Change Management* 11, 515-529.

Williamson, O, E., 1979. Transaction-Cost Economics: The Governance of Contractual Relations. *The Journal of Law and Economics* 22, 233-261.

Womack, J.P., Jones, D.T., Roos, D., 2007. *The Machine That Changed the World: The Story of Lean Production-- Toyota's Secret Weapon in the Global Car Wars That Is Now Revolutionizing World Industry*. New York: Free Press.

Wooldridge, J.M., 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Massachusetts and London: The MIT Press.

Yeats, A.J., 1998. Just How Big is Global Production Sharing? *Policy Research Working Paper* 1871, Washington, DC: The World Bank.

Table 1: Summary statistics[1]

Variables	Units	Mean	Standard Deviation	Min	Max
Log P&C Total Trade[2]	US$	19.52	2.29	7.62	24.78
Log P&C Exports	US$	18.96	2.22	7.62	24.32
Log P&C Imports	US$	17.87	3.37	4.9	23.99
Log Domestic Production, Reporter	Volume	14.99	1.24	4.36	16.32
Log Domestic Production, Partner	Volume	12.79	2.19	4.36	16.32
Log Overseas Production	Volume	10.94	2.29	0.69	15.03
Log Per Capita GDP, Reporter	US$	10.23	0.25	9.88	10.61
Log Per Capita GDP, Partner	US$	8.68	1.3	5.91	10.61
Log Distance	km	8.35	1.06	5.16	9.83
Log Real Exchange Rate	Index	4.61	0.14	4.04	5.14
Adjacency Dummy	Binary	0.07	0.25	0	1
Common-Language Dummy	Binary	0.06	0.24	0	1
Japan Dummy	Binary	0.16	0.37	0	1

Notes:

[1] The summary statistics are for three dimensional data (reporter, partner, year). Reporter includes 6 countries (Japan, United States, Germany, France, Italy, and Sweden), Partner covers 49 auto-producing countries listed in Appendix 2 and time period is 7 years from 2002 to 2008.Three dimensional dataset (reporter, partner and year) Time period is 7 years from 2002 to 2008.

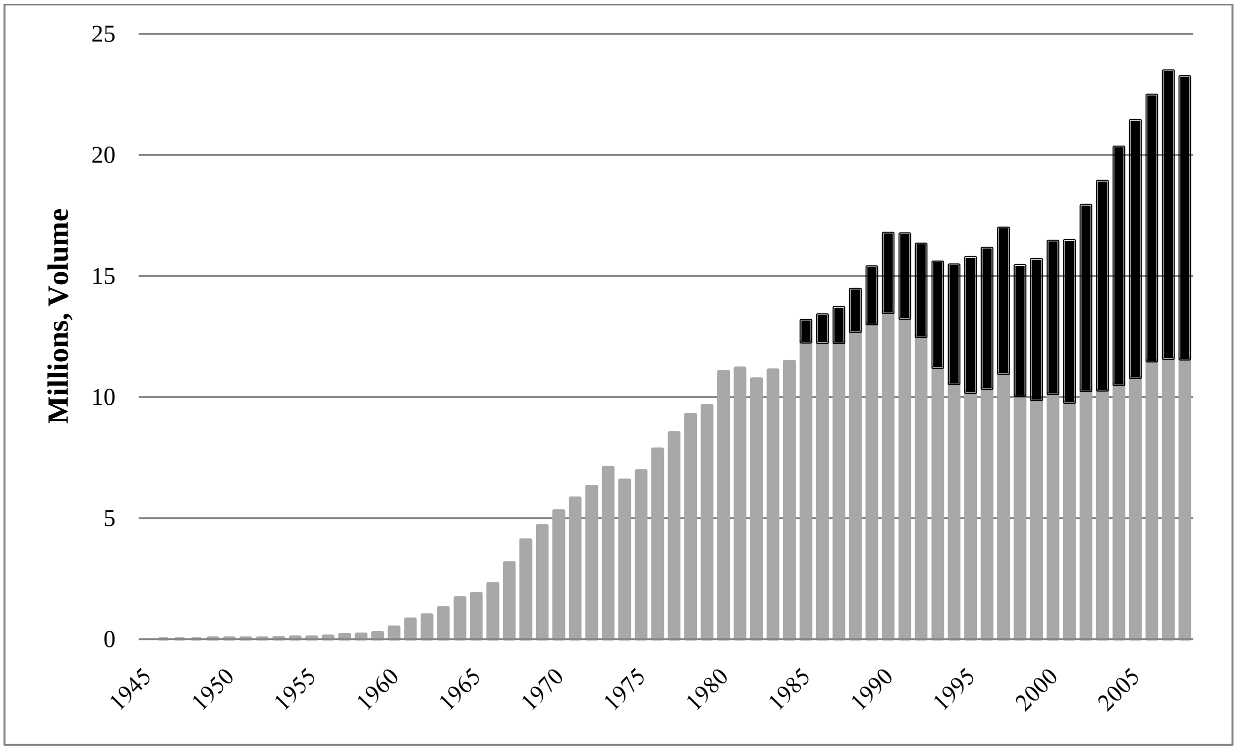
[2] P&C stand for parts and components. Total trade is exports plus imports.

Table 2: Regression results of determinants of parts and component (P&C) trade with three dimensional panel data[1]

Dependent Variables[2]	Total Trade			Exports			Imports		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log Overseas Production (*OSP*)	0.59***	0.23***	0.22***	0.27***	0.26***	0.42***	0.24***	0.14***	0.40***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.04)
Log Domestic Production, Reporter (*DAP*)		0.39***	0.38***	0.38***	0.30***	0.24***	0.30***	0.52***	0.42***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	(0.05)	(0.06)
Log Domestic Production, Partner (*DAP*)		0.33***	0.33***	0.25***	0.27***	-0.09	0.69***	0.60***	-0.24
		(0.03)	(0.03)	(0.03)	(0.02)	(0.15)	(0.05)	(0.06)	(0.19)
Log Per Capita GDP, Reporter (*PGDP*)		0.03	-0.17	-0.00	-0.98***	-2.72***	-1.24***	0.73***	-1.06***
		(0.14)	(0.20)	(0.14)	(0.19)	(0.21)	(0.31)	(0.32)	(0.26)
Log Per Capita GDP, Partner (*PGDP*)		0.32***	0.32***	0.41***	0.41***	1.53	0.41***	0.39***	0.60
		(0.04)	(0.04)	(0.03)	(0.03)	(1.03)	(0.07)	(0.07)	(1.44)
Log Distance (*DIS*)		-0.77***	-0.77***	-0.79***	-0.77***		-0.79***	-0.82***	
		(0.05)	(0.05)	(0.05)	(0.04)		(0.10)	(0.10)	
Adjacent Dummy (*ADJ*)		0.51***	0.52***	0.37***	0.37***		0.54***	0.68***	
		(0.13)	(0.13)	(0.11)	(0.12)		(0.25)	(0.21)	
Language Dummy (*LAN*)		-0.04	0.06	-0.20*	0.23		0.73***	-0.01	
		(0.14)	(0.17)	(0.11)	(0.15)		(0.26)	(0.25)	
Log Real Exchange Rate (*RER*)		-0.46*	-0.52*	-0.34	-0.46*	-0.15	-0.99	-1.13*	-0.62
		(0.28)	(0.28)	(0.28)	(0.26)	(0.32)	(0.61)	(0.58)	(0.42)
Japan Dummy (*JPN*)			-0.29		0.85**	3.38**		-6.73***	-1.71*
			(0.40)		(0.39)	(0.58)		(1.21)	(0.90)
*JPN**Log(*OSP)*			0.04		0.01	-0.23***		0.43***	-0.03
			(0.03)		(0.03)	(0.05)		(0.10)	(0.07)
Year Dummy	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional Dummy	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Country Dummy (Partner)	No	No	No	No	No	Yes	No	No	Yes
R-Squared	0.47	0.78	0.78	0.77	0.80	0.75	0.67	0.70	0.86
Observations	823	800	800	800	800	718	793	793	718

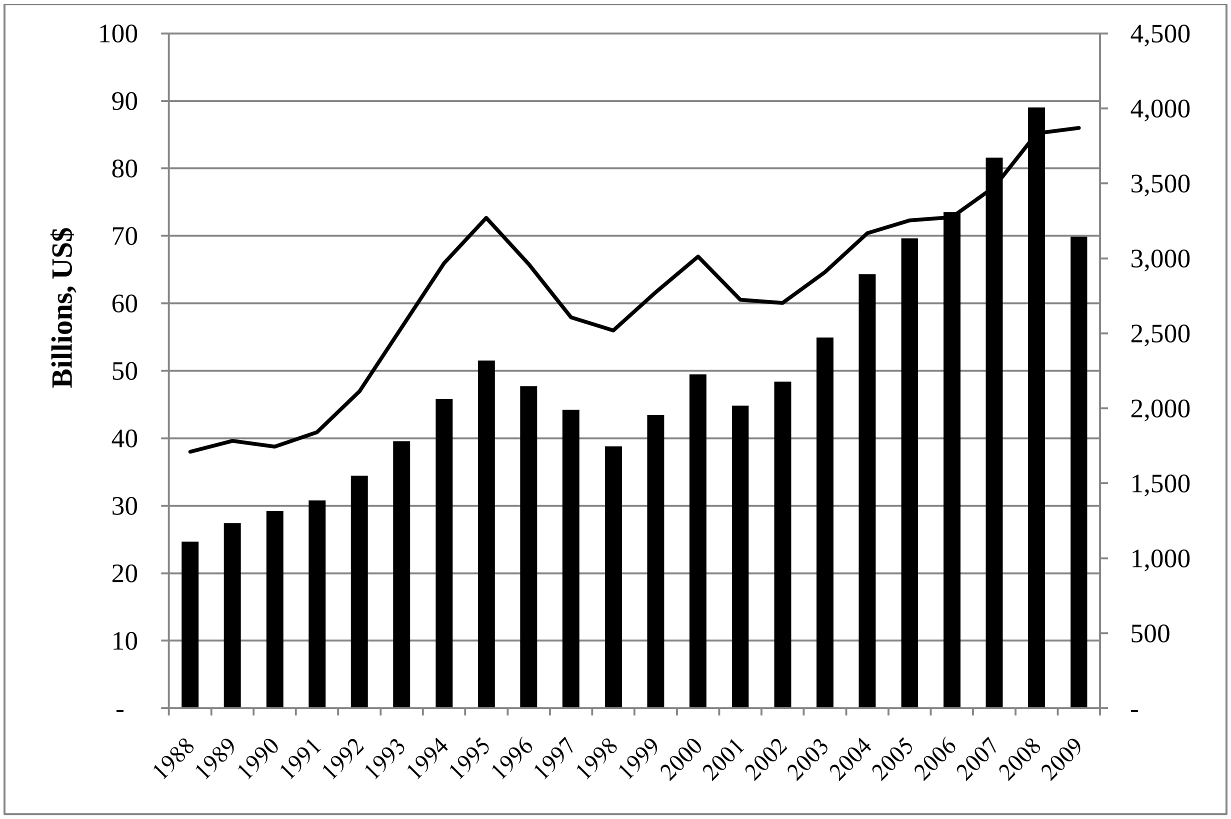
Notes:
[1] Three dimensional data is made of reporter, partner and year. Reporter includes 6 countries (Japan, United States, Germany, France, Italy, and Sweden), Partner covers 49 auto-producing countries listed in Appendix 2 and time period is 7 years from 2002 to 2008. Figures in the parentheses are standard errors corrected for heteroskedasticity. *** significant at 1%, ** significant at 5%, * significant 10%.
[2] Dependent variables are log of parts and components (P&C) trade including total trade (exports+imports), exports and imports in US$.

Figure 1: Total production of Japanese automakers, 1945-2008



Notes:
Total production consists of domestic production and overseas production. The gray bar shows domestic production volume of Japanese automakers. The black bar shows overseas production volume of Japanese automakers. Data on overseas production before 1985 are not available.
Source:
Japan Automobile Manufactures Association (JAMA)

Figure 2: Trade in parts and components (P&C) in Japan[1] and its ratio to total production by Japanese automakers[2], 1988-2009



Notes:

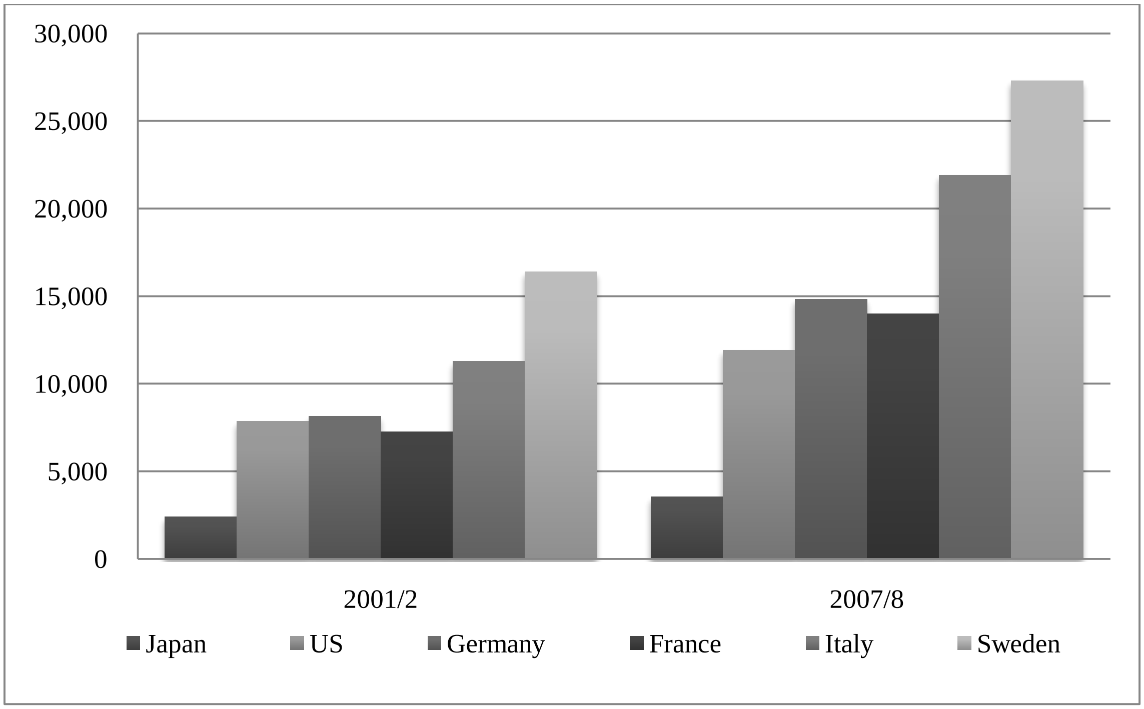
[1]The bar shows trade in parts and components (P&C) in Japan presented on the left axis. The P&C are listed in Appendix 1.

[2]The line shows the ratio of total trade in P&C in Japan to total (domestic + overseas) production by Japanese automakers. This ratio is presented on the right axis.

Sources:

Compiled from UN Comtrade Database and Japan Automobile Manufactures Association (JAMA)

Figure 3: Ratio of trade in parts and components (P&C) to auto production: A comparison with traditional auto producing countries (TPCs), 2001/2 and 2007/2008



Note:
The values are two-year averages. The bars are ordered as follows for both 2001/2 and 2007/8: Japan. The top left is Japan followed by the United States, Germany, France, Italy and Sweden.
Sources:
Compiled from UN Comtrade Database, International Organisation of Motor Vehicle Manufacturers (OICA)

Appendix 1: List of parts and components (P&C)

Serial Number	HS Code	Name
1	392690	Articles of plastics&articles of other materials of headings 39.01 to 39.14, n.e.s. in Ch 39
2	400910	Rubber tube, pipe or hose not reinforced, no fittings
3	400920	Rubber tube, pipe, hose, metal reinforced, no fitting
4	400930	Rubber tube, pipe, hose textile-reinforced no fitting
5	400940	Rubber tube, pipe or hose, reinforced nes, no fitting
6	401110	Pneumatic tyres new of rubber for motor cars
7	401120	New pneumatic tyres, of rubber, of a kind used on buses/lorries
8	401140	Pneumatic tyres new of rubber for motorcycles
9	401199	Pneumatic tyres new of rubber nes
10	401220	Pneumatic tyres used
11	401310	Inner tubes of rubber for motor vehicles
12	401691	Floor coverings, mats of rubber except cellular, hard
13	401699	Articles of vulcanised rubber nes, except hard rubber
14	570242	Carpets of manmade yarn, woven pile, made up,nes
15	570320	Carpets nylon, polyamides, tufted
16	570330	Carpets of other manmade textile materials, tufted
17	570490	Carpets of felt of textile materials, > 0.3 m2
18	700711	Safety glass (tempered) for vehicles, aircraft, etc
19	700721	Safety glass (laminated) for vehicles, aircraft, etc
20	700910	Rear-view mirrors for vehicles
21	732010	Leaf springs/leaves thereof, iron or steel
22	732020	Springs, helical, iron or steel
23	732090	Springs, iron or steel, except helical/leaf
24	830120	Locks of a kind used for motor vehicles of base metal
25	830230	Motor vehicle mountings, fittings, of base metal, nes
26	840729	Marine propulsion spark-ignition engines nes
27	840731	Engines, spark-ignition reciprocating, <50 cc
28	840732	Engines, spark-ignition reciprocating, 50-250 cc
29	840733	Engines, spark-ignition reciprocating, 250-1000 cc
30	840734	Engines, spark-ignition reciprocating, over 1000 cc
31	840790	Engines, spark-ignition type nes
32	840820	Engines, diesel, for motor vehicles
33	840991	Parts for spark-ignition engines except aircraft
34	840999	Parts for diesel and semi-diesel engines
35	841459	Electric fans, motor > 125 watts
36	841490	Parts of vacuum pumps, compressors,fans,blowers,hoods
37	841590	Parts for air conditioners
38	842123	Oil/petrol filters for internal combustion engines
39	842129	Filtering/purifying machinery for liquids nes
40	842131	Intake air filters for internal combustion engines
41	842199	Parts for filter/purifying machines for liquid/gas
42	842542	Hydraulic jacks/hoists except for garages
43	848310	Transmission shafts and cranks, cam and crank shafts
44	848320	Bearing housings etc incorporating ball/roller bearin
45	848330	Bearing housings, shafts, without ball/roller bearing
46	848350	Flywheels & pulleys, incl. pulley blocks
47	848390	Parts of power transmission etc equipment

48	848410	Gaskets & similar joints of metal sheeting combined with other material/of 2/more layers of metal
49	850211	Generating sets, diesel, output < 75 kVA
50	850710	Lead-acid electric accumulators (vehicle)
51	851110	Sparking plugs
52	851120	Ignition magnetos, magneto-generators and flywheels
53	851130	Distributors and ignition coils
54	851140	Starter motors
55	851150	Generators and alternators
56	851180	Glow plugs & other ignition or starting equipment nes
57	851190	Parts of electrical ignition or starting equipment
58	851220	Lighting/visual signalling equipment nes
59	851230	Sound signalling equipment
60	851240	Windscreen wipers, defrosters & demisters of a kind used for cycles/motor vehicles
61	851290	Parts of cycle & vehicle light, signal, etc equipment
62	852719	Radio-broadcast receivers capable of operating without an external source of power (excl. of 8527.12 & 8527.13)
63	852721	Radio receivers, external power,sound reproduce/recor
64	852729	Radio receivers, external power, not sound reproducer
65	853910	Sealed beam lamp units
66	853921	Filament lamps, tungsten halogen
67	853990	Parts of electric filament or discharge lamps
68	854430	Ignition/other wiring sets for vehicles/aircraft/ship
69	854460	Electric conductors, for over 1,000 volts, nes
70	870710	Bodies for passenger carrying vehicles
71	870790	Bodies for tractors, buses, trucks etc
72	870810	Bumpers & parts thereof of the motor vehicles of 87.01-87.05
73	870821	Safety seat belts for motor vehicles
74	870829	Parts and accessories of bodies nes for motor vehicle
75	870831	Mounted brake linings for motor vehicles
76	870839	Brake system parts except linings for motor vehicles
77	870840	Transmissions for motor vehicles
78	870850	Drive axles with differential for motor vehicles
79	870860	Non-driving axles/parts for motor vehicles
80	870870	Wheels including parts/accessories for motor vehicles
81	870880	Shock absorbers for motor vehicles
82	870891	Radiators for motor vehicles
83	870892	Mufflers and exhaust pipes for motor vehicles
84	870893	Clutches and parts thereof for motor vehicles
85	870894	Steering wheels, columns & boxes for motor vehicles
86	870899	Motor vehicle parts nes
87	871411	Motorcycle saddles
88	871419	Motorcycle parts except saddles
89	910400	Instrument panel clocks etc for vehicles/aircraft etc
90	940120	Seats, motor vehicles

Source: Japan Auto Parts Industries Association (JAPIA)

Appendix 2: List of trading partners

Asia	Americas	Europe	Others
China	Argentina	Austria	Australia
India	Brazil	Belgium	Botswana
Indonesia	Canada	Czech Republic.	Egypt
Iran	Chile	Finland	Kenya
Japan	Colombia	France	Morocco
Malaysia	Ecuador	Germany	Nigeria
Pakistan	Mexico	Hungary	South Africa
Philippines	Uruguay	Italy	Tunisia
South Korea	United States	Netherlands	
Thailand	Venezuela	Poland	
Viet Nam		Portugal	
		Romania	
		Russian Federation	
		Slovakia	
		Slovenia	
		Spain	
		Sweden	
		Turkey	
		United Kingdom	
		Uzbekistan	

Appendix 3: List of automobile producers according to locations of headquarters

Japan	United States	Germany	France	Italy	Sweden
Daihatsu	Cadillac	Audi	Bugatti	Alfa Romeo	Saab
Hino	Chevrolet	BMW	Citroen	Ferrari	Scania
Honda	Chrysler	Evobus	Renault	Fiat	Volvo
Isuzu	Ford	MAN	Peugeot	Iveco Trucks	
Mazda	Freightliner	Mercedes-Benz	Renault Trucks	Lamborghini	
Mitsubishi	General Motors	Mini		Lancia	
Mitsubishi Fuso	Hummer	Neoplan		Maserati	
Nissan	Jeep	Opel			
Subaru	Navistar	Porsche			
Suzuki	Paccar	Smart			
Toyota	Pontiac	Unimog			
	Sterling	VolksWagen			
	Western Star				

Source: International Organisation of Motor Vehicle Manufacturers (OICA): http://www.oica.net/

Appendix 4: List of definitions and data sources of variables

Variables	Definition	Data Source
E_P&C	Real value of exports of parts and components in US$, deflated by motor vehicle parts manufacturing sub-index of the US producer price index at 2002	UN Comtrade: (http://comtrade.un.org/) US Bureau of Labour Statistics: (http://www.bls.gov/)
I_P&C	Real value of imports of parts and components in US$, deflated by motor vehicle parts manufacturing sub-index of the US producer price index at 2002	UN Comtrade: (http://comtrade.un.org/) US Bureau of Labour Statistics: (http://www.bls.gov/)
E_CBU	Real value of trade in completely-built units in US$, deflated by motor vehicle manufacturing sub-index of the US producer price index at 2002	UN Comtrade: (http://comtrade.un.org/) US Bureau of Labour Statistics: (http://www.bls.gov/)
I_CBU	Real value of trade in completely-built units in US$, deflated by motor vehicle manufacturing sub-index of the US producer price index at 2002	UN Comtrade: (http://comtrade.un.org/) US Bureau of Labour Statistics: (http://www.bls.gov/)
DAP	Volume of domestic auto production	International Organisation of Motor Vehicle Manufacturers: (http://oica.net/category/about-us/)
MRK	Volume of domestic auto sales	Automotive information platform: (http://www.marklines.com/en/index.jsp). *Nikkan Jidosha Shinbun* and *Nikkan Jidosha Kaigisho* [Automobile Newspaper and Automobile Business Association of Japan] (2008).
OSP	Volume of overseas production by automobile producers headquartered in traditional auto-producing countries (TPCs)	International Organisation of Motor Vehicle Manufacturers: (http://oica.net/category/about-us/)
PGDP	Real per capita GDP in US$ (at 2002 price)	World Development Indicators: (http://www.worldbank.org/)
RER	Real exchange rate, $RER_{ij} = NER_{ij} * (P_j^w / P_i^D)$ where *NER* is the nominal exchange rate index, P^W is the producer price measured by the wholesale price index, and P^D is the domestic price measured by the GDP deflator	World Development Indicators: (http://www.worldbank.org/)
DIS	Geographical distance between the capital cities in kilometres	CEPII database: (http://www.cepii.fr/anglaisgraph/bdd/fdi.htm)
ADJ	Dummy variable indicating whether the two countries are contiguous	CEPII database: (http://www.cepii.fr/anglaisgraph/bdd/fdi.htm)
LAN	Dummy variable indicating whether the two countries share a common official language	CEPII database: (http://www.cepii.fr/anglaisgraph/bdd/fdi.htm)

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