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Abstract

In this paper, we analyze both the impact of Japan's foreign direct investment (FDI) into East Asia on trade and the structural changes in trade that have occurred in the region. To do this, we estimate gravity equations using trade data disaggregated to the industry and product levels. Our analysis shows that the impact of FDI on trade varies by industry. Specifically, in the electrical machinery sector, the positive impact of FDI on trade increased substantially from the 1990s, when division of labor was advancing rapidly especially for IT-related products. In the textile industry, which experienced a moderate increase in the division of labor primarily for intermediates, the impact of FDI on trade was positive, although not as great as seen in the electrical machinery industry. On the other hand, in the transportation machinery industry, where production processes were shifted from Japan to other East Asian countries and where Japan's exports were substituted with local production, FDI had virtually no impact on trade.

Key words: Foreign direct investment (FDI), gravity equation, trade structure, vertical specialization, horizontal specialization, fragmentation

JEL classification: F10, F14, F21

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I. Introduction

We analyze both the impact of Japan's foreign direct investment (FDI) into East Asia[1] on trade and the structural changes in trade in East Asia inclusive of Japan. To do this, we estimate gravity equations using trade data disaggregated to the industry and product levels.

Recently, East Asia has become increasingly important to the Japanese economy. Since the late 1980s, Japan has made a high level of direct investments into East Asia, while East Asia has played an increasingly important role as both a manufacturing center for Japanese firms and as a source of final demand for their products. Thus Japan and East Asia have become increasingly dependent on one another both on the supply side and the demand side. Particularly on the supply side, direct investment from Japan has resulted in an increase in exports to Japan of goods produced in East Asia, not only of labor intensive products as in the past but also of IT-related products. This has led to dynamic changes in the structure of trade.

A considerable amount of research has been conducted to date regarding the impact of Japan's FDI on trade. Most of this research estimates gravity equations to examine the relationship between aggregate trade and the total amount of FDI, and finds that FDI from Japan has expanded trade between Japan and other East Asian countries.[2]

The purpose of FDI, however, differs by industry. It can be aimed at setting up labor-intensive assembly lines in East Asia, at producing higher value-added components, or at setting up a local sales network to enable the sale of final goods in that region. It may be inappropriate, therefore, to examine the relationship between FDI and trade without accounting for these differences. If the purpose of FDI differs by industry, not only the trade structures accompanying FDI but also the impact of FDI on trade may be different among industries.

Accordingly, in order to understand accurately the impact of FDI on trade and the mechanism through which it works, it is necessary to examine the relationship between FDI and trade for each industry and individual product category, while taking account of the trade structure for that sector or product. In this paper, we estimate gravity

[1] In this paper, unless noted otherwise, we define East Asia as the nine countries/regions comprising the four newly industrializing economies (NIES 4 -- Korea, Hong Kong, Taiwan, and Singapore), the ASEAN 4 (Indonesia, Thailand, Malaysia, and the Philippines), and China.

[2] See Section III for an overview of the gravity equation.

equations using trade data disaggregated to industry and product categories to make a quantitative analysis of the impact of Japan's direct investments into East Asia on trade in East Asia inclusive of Japan.

Our empirical analysis makes it clear that the impact of FDI on trade differs by industry, reflecting the difference in trade structures. For example, in the electrical machinery industry, the positive impact of FDI on trade increased substantially from the 1990s, when the division of labor – primarily for IT-related products – was advancing rapidly. In the textile industry, FDI had a positive impact on trade, although the extent of the impact was smaller than that of the electrical machinery industry. In contrast, FDI had little impact on trade in the transportation machinery sector, where some portions of the production process in Japan were transferred to assembly lines in East Asia and thus local production served as a substitute for production in Japan. These results suggest that one reason FDI from Japan caused an increase in trade in East Asia inclusive Japan was the rapid division of labor that occurred in sectors such as electrical machinery, and in particular IT-related goods.

This paper is organized as follows. In Section II, we introduce the existing literature analyzing the impact of FDI on trade in relation to trade structure, while noting the limitations of this prior research. In Section III, while considering these limitations, we explain the analytical framework employed in this paper, i.e., the gravity equation, as well as the data set used for our empirical analysis. In Section IV, we show the results of our analysis and investigate the impact of FDI on trade and the relation of this impact with trade structure for each industry and product category. Finally, in Section V, we summarize the empirical results and point out the implications for economic policy of the dynamic changes in trade structure in East Asia. Appendix A introduces theoretical research on the relationship between FDI and trade volume and Appendix B explains the micro foundations of the gravity equation used in this paper.

II. Existing literature on trade structure and the relationship between FDI and trade volume

Trade theory research has shown two contradicting theoretical hypotheses on the relationship between FDI and trade: one is that FDI reduces trade (FDI and trade are substitutes) and the other is that FDI increases trade (FDI and trade are complements).[3] Consequently, there is a need for empirical research to accurately understand the impact that FDI actually has on trade. From this standpoint, a substantial amount of research has been conducted to conclude that FDI from Japan has increased Japan's trade with East Asia; in trade between the US and Latin America, however, FDI was found to have reduced trade volume. As noted above, these differences between regions in the relationship between FDI and trade can be attributed to differences in the purpose of FDI and resulting trade structure.

We begin below by introducing prior empirical research on the relationship between FDI and trade for Japan and East Asia. We then follow with an overview of the concepts regarding trade structure and introduce prior research that examines the structure of trade between Japan and East Asia.

A. Existing literature on the relationship between FDI and trade volume for Japan and East Asia

Eaton and Tamura (1994) estimate equations explaining the flow of trade and foreign direct investment, and then measure the correlation and time lag correlation of the sequence of residuals obtained from both estimations. Finding positive correlation with time lag between the two, Eaton and Tamura concluded that Japan's direct investments into East Asia have expanded trade between Japan and East Asia. Goldberg and Klein (1998) also estimate the impact of Japan's direct investment into East Asia on trade flows between Japan and East Asia using a gravity equation, and conclude that Japan's FDI increased Japan's trade, both exports and imports, with East Asia. Nakamura and Ohyama (1999) also estimate a gravity equation but employ a different analytical framework from Goldberg and Klein (1998). That is, they classify the nine East Asian economies according to their level of development and examine the relationship between trade with Japan and Japanese FDI for each group. Their estimation result shows that Japan's FDI into East Asia increases trade with Japan, regardless of the country's stage of development.

Although much of the literature has found that Japan's direct investment into East Asia expanded trade, Goldberg and Klein (1998) show that U.S. direct investment into Latin America reduced trade between them. This implies that the result that FDI

[3] See Appendix A regarding theoretical research on the relationship between FDI and trade.

increases trade is not applicable to all regions.

These regional differences may be attributable to differences in the objectives of FDI and to resulting differences in trade structure. For example, Brainard (1997) provides empirical evidence that, as a result of horizontal FDI aimed at production for local consumption, the sales by US overseas affiliates in 27 industrialized or newly industrialized economies declined. On the other hand, Head and Ries (2001) show that vertical FDI aimed at lowering production costs through the use of lower-cost labor increases trade. They use data from 932 Japanese manufacturing companies spanning 25 years to conclude that vertical FDI causes a trade increase, primarily of the export of components.

In fact, since individual firms or distinctive industries have different purposes for making FDI or different trade structures relating to that FDI, the relationship between FDI and trade can differ by industry. As far as we know, however, most of the empirical studies carried out so far have examined the relationship between aggregated FDI and aggregated trade across all industries, and thus have not sufficiently clarified the mechanism which lies behind the increase in trade between Japan and East Asia caused by Japan's FDI.[4] Accordingly, it is necessary to analyze the impact of FDI on trade in each industry and to accurately understand the differences in trade structure by industry in order to examine this mechanism.

B. Existing literature on East Asian trade structure

1. Overview of trade structure concepts

Trade structure can be broadly classified as either inter-industry trade or intra-industry trade. Intra-industry trade can be further categorized into three major types, (i) vertical specialization, (ii) horizontal specialization, and (iii) fragmentation. Fragmentation has a more diversified production process than vertical specialization and has some aspects of both inter-industry trade and horizontal specialization (Jones and Kierzkowski [1990]).

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[4] Fukao and Okubo (2003) is an exception. They analyze the effects of firm's overseas networks on international trade by estimating gravity equations between Japan and East Asia for trade in four machinery industries: electrical, general, precision, and transportation machinery. Their empirical results support the existence of a trade-enhancing mechanism by which the strengthening of a firm's network increases trade between Japan and East Asia. Lipsey and Ramstetter (2001) examine the relationship between the scale of Japanese foreign affiliates (represented by their employment) and Japan's exports to show a positive correlation between employment at Japanese foreign affiliates and Japan's exports.

a. Inter-industry trade

When the location of a given industry is confined to a particular country, there is no cross-border division of labor in that industry. In this case, the flow of trade in that industry is unidirectional: from the country with the comparative advantage to the country with the comparative disadvantage. Such trade is termed one-way trade or inter-industry trade.

b. Intra-industry trade

In fact, in many manufacturing industries the same industrial good is produced in multiple countries and traded bilaterally. Such goods include components and other intermediate goods as well as final products. This bilateral trade includes the export of components for assembly of the final product overseas, i.e., the international division of labor, as well as countries exporting differentiated final goods to each other. Such bilateral trade is termed intra-industry trade or two-way trade.

Intra-industry trade can be broadly separated into vertical specialization, horizontal specialization, and fragmentation. Fragmentation is a type of vertical specialization with some of the characteristics of both inter-industry trade and horizontal specialization. Aizenman and Marion (2004) define vertical specialization as when a multinational firm diversifies its production process, assigning each process to the country where it can be done at the lowest cost. They define horizontal specialization as when a multinational firm produces the same good or service in multiple countries. Under vertical specialization, components are exported from a country producing the components to another country producing the final goods, and the country producing the final goods exports them to other countries. An exception to this is when a country produces final goods for its own domestic demand, in which case it does not export the final goods to other countries. Under horizontal specialization, multiple countries supply one another with differentiated components and final goods.[5]

Under vertical specialization, the more that production processes are diversified internationally, the greater are the transportation, communications and other service costs for connecting the production processes. Thus diversification is limited to certain production processes, such as the final assembly process. Recent innovations in information technology, however, have caused a dramatic decrease in communications

[5] For a trade model showing intra-industry trade of differentiated products, see Helpman (1981).

and other costs, leading to an increase relative to the past in the number of production processes that have been diversified globally.

These components manufactured by a diversified production processes include common-use parts with wide-ranging applications. These generic components can be used not only for some particular final goods but also for other differentiated final goods in the same category as well as for final goods in other categories.[6] Such production process, which is more diversified than simple vertical specialization and has some features of both inter-industry trade and horizontal specialization, is known as fragmentation.[7] Under fragmentation, the number of countries supplying components and the variety of components being supplied increase greatly compared with under vertical or horizontal specialization.

2. Existing literature on the structure of trade

A substantial amount of research has been conducted on the trade structures of specific industries in East Asia. This research has found large differences in trade structure by industry, and more specifically, has found that for IT-related goods, Japan's direct investment in East Asia has caused dispersion of the production process and deepened interdependence in the supply of components.

For example, Kozu *et al.* (2002) examine the changes in the trade structure between Japan and East Asia for selective industries in the 1990s by scrutinizing changes in exports, imports and a trade specialization coefficient[8] between Japan and East Asia by product. Their main findings are as follows: (i) for IT-related goods, Japan changed its trade structure from specializing in exports of domestic products to East Asia to mutually supplying electronic components such as semiconductors while

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[6] This includes computers, many of whose components are standardized, common-use parts.

[7] Fragmentation is defined differently by distinctive researchers. For example, Feenstra (1998) point out 'disintegration of production' as one of the major characteristics of current trade, although he does not use the terminology, 'fragmentation.' Deardroff (2001), following Feenstra, defines fragmentation as diversification of the production process for final goods into two or more different locations. Jones and Kierzkowski (2003), on the other hand, not only point out international diversification of the production process but also emphasize the elements of horizontal specialization. In this paper, we use the terminology of fragmentation in the sense as defined by Jones and Kierzkowski (2003).

[8] The trade specialization coefficient is defined as (real imports – real exports) / (real imports + real exports).

importing final products from East Asia,[9] (ii) in textiles and household electrical appliances, the division of labor has deepened between East Asia and Japan with Japan becoming primarily an importer, (iii) in the transportation machinery industry, especially for some types of passenger cars with strong local demand in East Asia, the entire production process has shifted into East Asia to satisfy local demand.

Fukao *et al.* (2003) analyze the change in trade structure for distinctive industries within the East Asian region including Japan, from 1996 until 2000. They categorize trade structure into three types: inter-industry trade, vertical specialization and horizontal specialization. To categorize the trade structures, they examine the extent of divergence between exports and imports in each industry, treating a large divergence between exports and imports as inter-industry trade and a small divergence as vertical or horizontal specialization. They also examine differences in the terms of trade across industries and suppose that a large discrepancy between export unit prices and import unit prices indicates vertical specialization[10] and a small divergence suggests horizontal specialization, since the labor intensive production processes are shifted out of Japan under vertical specialization. They then show that vertical specialization advanced the furthest in the electrical machinery and general and precision machinery sectors (Figure 1). They also use data from the electrical machinery industry to investigate whether vertical specialization between Japan and East Asia is affected by Japan's direct investment into East Asia. They then demonstrate that FDI contributed to greater vertical specialization.[11,12]

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[9] Isogai, Morishita and Ruffer (2001) calculate the revealed comparative advantage, with a particular focus on IT-related goods, and conclude that many East Asian economies have improved their comparative advantage in producing them and that the advance in horizontal specialization in the region has led to an expansion of intra-industry trade. Note that the revealed comparative advantage index is the ratio of a good's share of a country's total exports to that of total world exports and indicates the extent of that country's comparative advantage compared with the rest of the world.

[10] For example, when a Japanese firm relocates a labor-intensive production process to East Asia, the ratio of export unit value to import unit value becomes higher in Japan; while at the same time becoming lower in East Asia.

[11] Specifically, they regress the index of vertical specialization in the electrical machinery industry on its FDI, differences in per capita GDP between Japan and each East Asian economies, distance between them, and the size of the electrical machinery industry in each East Asian economy. Note that the difference in per capita GDP shows of the potential for vertical specialization, since a large income gap implies large differences in capital accumulation.

[12] Lipsey (1999) calculates the ratio of sales and exports of US or Japanese overseas affiliates in East Asia

Note that the examination of the changes in trade structure in the aforementioned research is limited to a descriptive analysis, such as observing actual trade flows or indices of trade specialization. Therefore, it is necessary to conduct a more detailed analysis, including estimation of the degree of differentiation in components and final goods, in order to fully understand the actual difference in trade structure by industry.

III. Analytical framework and data set

As far as we know, the research conducted to date lacks a sufficiently detailed analysis of trade structure down to the level of each industry or individual good. Particularly in regards to the trade within East Asia that has grown so rapidly in recent years, there is no research, using data disaggregated to the industry or goods levels, on the relation between the effect of Japan's FDI and differences in trade structure.[13] In this paper, therefore, regarding both trade between Japan and East Asian economies as well as trade among East Asian economies, we try to examine both the effect of FDI on trade and structural change in trade in specific industries, by estimating a gravity equation using country-specific and goods-specific data.

We will begin with an overview of the gravity equation. We will then present a detailed explanation of the analytical framework we employ and the data used for analysis.

A. The gravity equation

The original gravity equation refers to one of the basic laws of classic physics, which says that the gravitational pull between two bodies is inversely proportional to the square of the distance between them. The volume of trade between two countries is also considered to be inversely proportional to the distance between those countries, and in trade theory, the formula expressing this relationship is called the gravity equation, named after the physics concept. Although the gravity equation was originally based on

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to the total exports of each East Asian economy for each industry. Considering the increase in these ratios in the electrical machinery industry, he conjectures that FDI from both countries to East Asia contributed to growth in East Asian exports.

[13] Research on the impact of Japan's FDI into East Asia on the trade between East Asia and third countries has largely focused on trade between East Asia and the US. For example, Goldberg and Klein (1998) and Nakamura and Ohyama (1998) find that Japan's direct investments in East Asia increased trade between East Asia and the US.

this conjecture, many researchers are now using it as an analytical framework, since there is a large body of empirical research demonstrating its high explanatory power, and there has also been recent theoretical research clarifying its microeconomic foundations (Frankel [1998]).[14]

The gravity equation assumes that the trade flow between two countries is proportional to their GDPs and inversely proportional to the distance between them. Other factors that may affect trade flow include population (or per capita income) and cultural and geographic factors (presence of a common language and the proximity of the countries' borders). Other explanatory variables may be included in the equation according to the research objective. In addition, either bilateral trade flow (i.e., exports or imports) or unilateral trade flow (i.e., trade as the sum of exports plus imports) is used as a dependent variable.

First, the basic gravity equation using exports as a dependent variable can be expressed as follows:

$$\begin{aligned} \ln EX_{ij} &= \beta_0 + \beta_{11}\ln(Y_i) + \beta_{12}\ln(Y_j) + \beta_{21}\ln(phY_i) + \beta_{22}\ln(phY_j) \\ &\quad + \gamma \ln Dst_{ij} + \phi_1 Lang_{ij} + \phi_2 Cntg_{ij} + \varepsilon_{ij} \end{aligned} , \qquad (1)$$

where subscript *i* and *j* represent the country, EX_{ij} is the export from country *i* to country *j*, and *Y* , *phY*, and Dst_{ij} denote GDP, per capita GDP, and the distance between country *i* to country *j*, respectively. *Lang* and *Cntg* are dummy variables indicating the existence of a common language and of a contiguous border. In addition to the importer's GDP, the exporter's GDP is also included as an explanatory variable to reflect the impact of the production of exports on the exporting side. GDP per capita is also an explanatory variable because the income level of a country is thought to affect the level of trade flow.

The economic intuition behind each parameter in equation (1) is as follows. First, note that the effect of economic growth in the exporting or importing country on exports is taken as $\beta_{11}+\beta_{21}$ or $\beta_{12}+\beta_{22}$, not as β_{11} or β_{12}.[15] For this reason, $\beta_{11}+\beta_{21}=1$ means the export growth rate is equal to economic growth in the exporting country and $\beta_{11}+\beta_{21}>1$ implies that exports grow faster than the exporter's GDP. The same argument can be applied to $\beta_{12}+\beta_{22}$. It is also useful to examine β_{21} or β_{22}, which isolate the relationship

[14] Please refer to Appendix B for an explanation of the gravity equation's micro foundations.

[15] Since this means $\beta_{11}\ln Y_i + \beta_{21}\ln phY_i = (\beta_{11}+\beta_{21})\ln Y_i - \beta_{21}\ln L_i$ (where *L* is population) , this can be easily confirmed.

between per capita income and exports, with a higher β_{21} or β_{22} implying that exports grow faster relative to increases in income. The parameter indicating the impact of distance on trade, γ, takes a negative sign.[16]

Next, the basic gravity equation using trade as the dependent variable can be expressed using the following equation (2):

$$\ln T_{ij} = \beta_0 + \beta_1 \ln(Y_i Y_j) + \beta_2 \ln(phY_i\, phY_j) + \gamma \ln Dst_{ij} + \phi_1 Lang_{ij} + \phi_2 Cntg_{ij} + \varepsilon_{ij}, \qquad (2)$$

where T_{ij} is the trade between country i and country j. The other notations are the same as those in (1).

The parameters on economic size (Y) and income level (phY) are assumed to differ between the exporting and importing country in equation (1), but in equation (2), the two countries are assumed to use the same parameters. Most empirical studies where exports are used as the dependent variable show that the coefficients are only slightly different on the import side and the export side, and the null hypothesis that they are different is rejected. Many empirical studies, therefore, adopt this assumption that the effects of both the economic size and income level of one country are equal to those of the other to simplify the estimation (Frankel [1998]). Under this assumption, the effect of economic growth in both country i and j are the same and it can be expressed as $\beta_1+\beta_2$.

The choice between equation (1) or (2) depends on the objective of the research. In some papers trying to examine the effect of FDI on either exports or imports between the country conducting FDI and that receiving it, a gravity equation is estimated separately for exports and imports. This includes Goldberg and Klein (1998) and Wei and Frankel (1997). Other works focusing on the total trade volume or trade structure in total trade, e.g., empirical studies examining the impact on trade of the introduction of a common currency or regional trade agreements, or the change in trade structure caused by differences in the characteristics of traded goods, such as whether the goods are differentiated or homogenous, estimate gravity equations on total trade. See Rauch (1996) as an example.

[16] As will be noted later, γ expresses not only the impact of distance but also the effect of the substitution elasticity of goods.

B. Estimated equation and the meanings of the parameters

(1) Estimated equation

As noted earlier, this prior research has found that Japan's considerable direct investment into East Asia has deepened the division of labor and the mutual supply of components between Japan and East Asia, as well as among East Asian countries, and that this has expanded two-way intra-industry trade in the region. This paper aims to examine the effect of Japan's direct investment into East Asia on trade in East Asia inclusive of Japan as well as the resulting changes in trade structure by industry or by goods. To do this, we use a gravity equation with bilateral trade volume as the dependent variable.

Specifically, we estimate the following gravity equation (3) for each industry, a slightly modified version of equation (2) that includes FDI from Japan to East Asia as an explanatory variable.[17,18]

$$\begin{aligned}\ln T_{ij,k} = {} & \beta_{0,k} + \beta_{1,k} \ln(Y_i Y_j) + \beta_{2,k} \ln(phY_i\, phY_j) + \gamma_k \ln Dst_{ij} \\ & + I\eta_{1,k} \ln JFDI_{i,k} + (1-I)\eta_{2,k} \ln(JFDI_{i,k} + JFDI_{j,k}) \ . \\ & + \phi_{1,k} Lang_{ij} + \phi_{2,k} Cntg_{ij} + \varepsilon_{ij,k}\end{aligned} \tag{3}$$

i = East Asian economy, j = East Asian economy or Japan,
$I = 1$ if j = Japan, $I = 0$ if $j \neq$ Japan

Here the subscript k indexes the industry and $JFDI_i$ represents direct investment from Japan into country i. In equation (3), in the case of trade between Japan and an East Asian economy, Japan's direct investment into this economy is an explanatory variable, while in case of trade between two East Asian economies, the total of Japan's direct investment into these economies is the explanatory variable.[19,20]

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[17] A previous paper estimating a gravity equation using industrial data is Bergstrand (1989). He estimates a gravity equation by the SITC-1 categories such as machinery, foods and chemicals for 16 industrialized countries and concludes that differences in trade among industries can be explained by differences in the capital-labor ratio for each industry.

[18] Ideally, the output of each industry, rather than GDP, should be employed as an explanatory variable, for an estimate of the gravity equation for each industry. Due to data availability, however, we use GDP data.

[19] The equation contains GDP and per capita GDP in multiplicative form, whereas it includes Japanese FDI into East Asia in additive form. The inclusion of FDI in multiplicative form would mean the following constraint holds: both Japanese FDI to country i and to country j have the same effect on trade between i and j. This constraint is, however, inappropriate, considering the differences in industrial structures among East Asian countries. We, therefore, include Japanese FDI not in multiplicative form

The existing literature uses either FDI stock data or FDI flow data. That is, some of the research examining the validity of the theoretical conclusions derived from trade theory analyses, and therefore investigating the relationship between flows of production factors and trade volume, utilizes FDI flow data as representing international factor movement (for example, see Goldberg and Klein [1998]). There is other research that focuses on the fact that the stock of FDI is utilized for production, and thus uses FDI stock data (for example, see Wei and Frankel [1997]). Note that both approaches, FDI stock and FDI flow, have their drawbacks. When FDI flow data is employed, it rules out considering the effects of past investment on production. The problem with using FDI stock data is that there exists neither country-specific nor sector-specific data that are adjusted for changes in the depreciation rate or price deflator every year.[21]

Since one of the purposes of our analysis is to examine the relationship between international capital movement and trade, we utilize FDI flow data to estimate equation (3).[22] Specifically, we use the sum of FDI flows one-year prior and two-year prior as the FDI variable.[23] The FDI has an immediate effect on the export of general machinery and other industrial products that form the overseas production base. The impact of the FDI into a particular industry on trade in that industry, however, arises with a time lag, because the impact is not going to occur until the FDI results in increased production

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but in additive form, which implies a less restrictive constraint.

Note that we should use Japan's FDI to country *i* and that to country *j* as different explanatory variables when estimating exports and imports separately. We, however, employ the sum of Japan's FDI to country *i* and to country *j* as an explanatory variable, since we utilize trade volume as the dependent variable.

[20] Ideally, FDI flows among East Asian economies should have been included as an explanatory variable in estimating trade flows among the East Asian economies. Data on multilateral and sectoral FDI flows for the nine East Asian countries are not available at all, however, and under such data limitations, we just use FDI from Japan to East Asia as an explanatory variable.

Note that it is beneficial to include FDI from the U.S. into East Asia as an explanatory variable to compare its effect on trade within East Asia with that of Japan's FDI into East Asia. This is a promising future research topic.

[21] The only available FDI stock data in MOF's (Ministry of Finance) statistics that provides the sector-specific and year-specific FDI is a cumulative sum of past FDI flows since 1951. Fukao *et al.* (2003) employ the level of activity by Japanese affiliated firms' (the ratio of sales by Japanese-affiliated firms to domestic output in Japan) as a proxy for FDI stock.

[22] For a robustness check of our estimation result, we carry out the same regression using FDI stock data (a cumulative sum of FDI flows) in place of FDI data (see footnote 46 for details).

[23] Our use of lagged FDI data alleviates the problem of endogeneity between FDI and trade.

capacity.[24] This is the reason we do not include the same-period FDI as an explanatory variable.

(2) The meanings of parameters

We examine the relationship between the effect of FDI on trade between Japan and East Asia as well as on trade within East Asia and the changes in trade structure by referring to the estimated parameters of equation (3). To do this, we will begin with an explanation of the meanings of each parameter in equation (3).

First, the parameters $\eta_{1,k}$ and $\eta_{2,k}$ indicate the effect of Japan's FDI on trade between Japan and East Asia and that of Japan's FDI on trade between East Asian economies, respectively. Both of these parameters take on a positive value if FDI has a positive effect on trade, and likewise take on a negative value if FDI has a negative effect.

Second, the parameters $\beta_{2,k}$ and γ_k are closely related to trade structure and the changes in these parameter values also reveal changes in trade structure. $\beta_{2,k}$ expresses the relationship between trade volume and income levels (i.e., the degree of economic development) of trading partners. Since it is well known that the countries with higher income have a higher volume of trade,[25] $\beta_{2,k}$ takes on a higher value when using data for rich countries and a lower value when using data for countries with low income. Consequently, when estimating $\beta_{2,k}$ using data for multiple countries, a declining $\beta_{2,k}$ suggests growth in trade with low-income countries; whereas an increasing $\beta_{2,k}$ indicates growth in trade with high-income countries.

The parameter γ_k represents two factors, the costs for transportation and communication, through which distance affects trade, and the substitution elasticity of the differentiated good categorized under sector *k* (see Hummels [1999b] and Hillberry [2002]).[26] The decline in transportation costs and communications costs has diluted the

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[24] Consequently, when using industry-specific data based on our analytical framework to estimate the effect of FDI on trade, the results are likely to indicate a smaller impact than when examining the effect of FDI on trade on an aggregate basis.

[25] Frankel (1998) points out the following four reasons why richer countries trade more than poor ones: (1) as incomes grows, so does trade in luxury goods; (2) exports are more likely to grow in high-income countries because the process of development may be led by the innovation or invention of new products that are demanded as exports by other countries; (3) the more developed countries have more advanced transportation infrastructures; and (4) trade becomes more liberalized as incomes increase.

[26] See Appendix B for further details.

significance of distance and made γ_k greater (or made γ_k a smaller negative number). Furthermore, the greater the number of firms entering a specific industry, the higher is the elasticity of substitution between goods in that industry owing to greater competition in production and export, and the lower is γ_k (the larger the negative number). Given that transportation costs and communication costs are thought to be declining and to contribute to a rise in γ_k,[27] a decreasing γ_k (a larger negative number for γ_k) over time means a higher elasticity of substitution and demonstrates an increase in two-way trade (intra-industry trade) in that industry. On the other hand, a rise in γ_k (a smaller negative number) suggests the possibility of one-way trade (inter-industry trade) in that industry.[28]

Accordingly, by looking at the combination of changes in γ_k and $\beta_{2,k}$, it is possible to categorize the change in trade structure of the industry into one of the following four patterns, based on two different perspectives. One perspective is the type of trade pattern, specifically two-way trade (intra-industry trade) versus one-way trade (inter-industry trade); and the other is the change in the income of trading countries.

(i) declining $\beta_{2,k}$ and declining γ_k: growing two-way trade and an increase in trade with low-income countries

(ii) rising $\beta_{2,k}$ and declining γ_k: growing two-way trade and an increase in trade with high-income countries

(iii) declining $\beta_{2,k}$ and rising γ_k: possibility of growth in one-way trade and trade with low-income countries

(iv) rising $\beta_{2,k}$ and rising γ_k: possibility of growth in one-way trade and trade with high-income countries

Therefore, by estimating equation (3) it is possible to analyze both changes in trade structure and the impact of FDI on trade.

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[27] Nevertheless, Hummels (1999) analyzes changes in worldwide charges for air freight from 1980 until 1993 and finds that transportation costs in the Asian region only declined by an annual rate of 0.3% during that period.

[28] Of course, depending on the size of increase in γ_k caused by the decline in transportation and communication costs and the degree of change in γ_k caused by change in the elasticity of substitution between goods, a rise in γ_k can imply the possibility of an increase in elasticity of substitution and two-way trade in the industry.

C. Estimation Method

We use industry-specific data to estimate equation (3). We make OLS estimates by using real data pooled into two groups – the 1980s and the 1990s – and then comparing the parameters from each group (hereinafter, referred to as pooled OLS regression). Nevertheless, because this method does not fully capture changes in the parameter values over time, we employ another method to overcome this drawback. That is, we also estimate the parameters for each year by using cross-sectional nominal data for each year and investigate the time series of these parameters (hereinafter referred to as cross-section analysis).[29]

Note that there may be cases whereby the estimation results for the coefficients expressing trade structure, $\beta_{2,k}$ and γ_k, are not clear when estimating with industry-specific data. Take, for example, a situation in which a large number of countries supply components and other inputs and a single country assembles them to produce the final goods. In this case, the estimate for γ_k using sector-specific data is going to be affected both by the change in the elasticity of substitution between the components and by the offsetting change in that of the final goods. For this reason, in some industries we use goods-specific data to estimate equation (3), instead of using only sector-specific data.

D. Data

The data used in our analysis is as follows. For the trade data, we use the data measured at the 4-digit SITC level categorized by country, industry, and type of goods covering 1980 to 1997 from Feenstra (2000).[30] We compiled the data used for estimates of intermediate goods and final goods in the electrical machinery, textiles and

[29] Since there is no single price index related to global transactions in goods, much of the empirical research in this area faces the problem of choosing a price index for deflating nominal trade figures. For example, Glick and Rose (2002) use the US CPI to deflate nominal data, even for the bilateral trade not involving the US. We use Japan's import and export prices to deflate the nominal trade data for all countries considered in this paper. For details, see section D. below.

[30] The trade data in Feenstra (2000) is initially recompiled by Statistics Canada based on the United Nations international trade statistics and several local statistics (including Taiwan's), and then further re-categorized by type of goods by Feenstra himself. He uses SITC (revision 2) for classification; most of the goods are categorized at the four-digit SITC level, but some goods were only broken down to the three-digit SITC level due to the limited availability of data. The data presented in Feenstra (2000) covers the period from 1980 until 1997.

transportation machinery industries from Feenstra's (2000) original data (for a detailed listing, see Table 1). Specifically, for electrical machinery: IT-related goods, generic intermediate goods used for both IT-related goods and household electrical appliances, and household electrical appliances; for textiles: apparel and intermediate goods; and for transportation equipment: motor vehicles and intermediate goods. We utilize the data on per capita nominal GDP adjusted for purchasing power parity listed in the Penn World Table 6.[31,32] Nominal GDP is computed by multiplying per capita GDP by population. Note that per capita real GDP and real GDP are also from the Penn World Table 6. The distance between countries is based on the great circle distance calculated from the latitude/longitude of each country's capital city (except for China, where distances are calculated from Shanghai). The dummy variable for shared language is one if the two countries share a common language (Chinese, English, etc.), and zero otherwise. The dummy variable for contiguousness is one if the two countries share a land border or are connected via bridge, and zero otherwise. For FDI, we use the data on Japan's foreign direct investment by country and industry, published in the Ministry of Finance's *Monthly Fiscal and Financial Statistics*.

Japan's export and import price indices are used for converting trade and FDI values into real terms. Specifically, the trade and FDI for each industry are deflated by the average of export and import prices for that industry. The trade data by goods is converted into real terms by the export and import prices of the category that corresponds most closely to each good (IT-related goods, generic intermediate goods, apparel, etc.).[33]

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[31] We do not use per capita nominal GDP expressed in U.S. dollars but rather the PPP-based per capita GDP. This is because the former is likely to undervalue the per capita nominal GDP of developing economies and thus may be an inappropriate indicator of the richness of each economy.

[32] This data set is available from the website of the Center for International Comparisons at the University of Pennsylvania (http://pwt.econ.upenn.edu). The center divides gross domestic expenditures into approximately 150 categories and calculates internationally comparable current prices each year from the expenditure and price data for each segment in countries worldwide, using the Geary-Khamis Method. It then calculates GDP based on this price index. See Summers and Heston [1991] for the details of estimation method.

[33] Export prices and import prices are categorized into 7 or 8 industries and approximately 200 types of goods, although the number of categories by industry and by goods differ with each base-year revision, which occurs every five years. For example, export prices using the 1995 base year are classified into 8 industries and 209 types of goods, while import prices are classified into 8 industries and 247 kinds of goods. For converting industry data into real terms, we use the average of export and import prices in

IV. Estimation results

In this Section, we make use of the estimation formula, estimation methods and data explained in the previous section to estimate equation (3). We then examine the effect of FDI on trade and changes in trade structure caused by changes in the estimated parameter values.

Below, let us present the results from both the pooled OLS regression and the cross-section analysis. We not only show the estimates for each industry but also for the intermediate and final goods in those industries where the impacts of FDI on trade differed greatly from the others (electrical machinery, textiles and transportation machinery), in order to examine more closely the changes in trade structures of these industries.[34]

A. Estimation results using industry-specific data

(1) Pooled OLS

a. FDI's impact on trade

Table 2 shows the estimated results of equation (2) using industry-specific data. Looking first at the impact of FDI on trade ($\eta_{1,k}$ and $\eta_{2,k}$), in the electrical machinery industry, FDI's impact was not significantly different from zero in the 1980s, but FDI had a relatively large positive effect on trade between Japan and East Asia as well as on trade within East Asia in the 1990s.[35] In the general and precision machinery industry, the results show that FDI did not boost trade within East Asia in the 1980s and the 1990s, but a positive effect on trade between Japan and East Asia was evident, particular in the 1990s. In the textiles industry, the positive impact on both Japan's trade with East

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order to match price indices with the industry classification of the trade and FDI statistics. Regarding goods-specific data, not all categories have data available on both export and import prices are. Consequently, we use the weighted-average of import prices for apparel and of export prices corresponding to goods listed in Table 1 for all other types of goods, with the weight being the sum of exports and imports of that particular good in the base year.

[34] In both the pooled OLS regression and the cross-section analysis, we estimate White's (1980) heteroskedasticity-consistent standard error, considering the possibility that an error term ε_{ij} may have different variance for different country pairs (*i*-*j*), to adjust heteroskedasticity.

[35] An F-test shows that the effects on Japan-East Asia trade and trade within East Asia in the 1980s are statistically different from those in the 1990s.

Asia and on trade within East Asia was greater in the 1990s than it was in the 1980s.[36] Note that this positive effect in the 1990s was smaller in the textiles industry than in either the electrical machinery industry or the general and precision machinery industry. For the other industries, we found that the effects of FDI on trade were either small or not statistically different from zero. That is, although the effect on trade within East Asia was slightly negative in the transportation machinery industry and slightly positive in the chemical industry during the 1990s, the effects of FDI on trade between Japan and East Asia was not significantly different from zero. In the metal and related products industry, the effects of FDI on both Japan-East Asia trade and trade within East Asia was not significantly different from zero in the 1990s.

The above results lead us to conclude that the effects of FDI on trade differ widely by industry and that the industries can be divided into following three groups according to FDI's effect on trade: (i) those industries where the positive effect of FDI on trade increases beginning in the 1990s and the positive effect is large (the electrical machinery industry and the general and precision machinery industry[37]), (ii) those where FDI's positive effect increased from the 1990s, but is not so large (the textiles industry), and (3) those where FDI's effect on trade is not significantly different from zero (the transportation machinery industry, the chemicals industry, and the metal and related products industry).

b) Changes in trade structure

We look first at $\beta_{2,k}$ and γ_k, the parameters in Table 2 that indicate changes in trade structure. $\beta_{2,k}$, representing changes in the income level of trading partners, declined in the 1990s relative to the 1980s in all industries, and thus indicates an increase in trade with lower income countries. Meanwhile, γ_k, which shows changes in transportation and communication costs and the elasticity of substitution between goods, was not significantly different from zero in any of the industries except chemicals and textiles.

[36] As is the case in the electrical machinery industry, an F-test shows a statistically significant difference in the FDI coefficients between the 1980s and the 1990s in the textiles industry.

[37] The results for the general and precision machinery industry are not so clear. An F-test indicates that FDI's effect on trade between Japan and East Asia (η_1) is not significantly different in the 1980s and the 1990s. On the other hand, η_1 is not significantly different from zero in the 1980, but is significantly different from zero and actually becomes quite high in the 1990s. Therefore, we classify the general and precision machinery industry as one of the industries where the positive impact of FDI on trade increases beginning in the 1990s, and the positive impact is large.

Consequently, as long as we used industry-specific data for our analysis, we observed no change in trade structure from the perspective of the elasticity of substitution between goods, although trade with low-income countries did increase.

(2) Cross-section analysis

a. FDI's effect on trade

The results obtained from the cross-section analysis of the effect from Japan's FDI into East Asia on trade between Japan and East Asia and within East Asia are generally consistent with the results from the pooled OLS regression (Figure 2). Specifically, for the electrical machinery industry, the positive effects on Japan-East Asia trade and trade within East Asia reach levels significantly different from zero in 1988 and increase each year after 1988. Furthermore, these positive effects are very large relative to other industries. In the general machinery industry, FDI's effects on Japan-East Asia trade and trade within East Asia are positive and increase beginning in the 1990s. In the textile industry, the positive effect on trade within East Asia remains fairly constant, but the positive effect on trade between Japan and East Asia shows a moderate increase and reaches a level significantly different from zero in the late 1990s. At the same time, in the transportation machinery industry and the metal and related products industry, FDI's effect on trade is not significantly different from zero for nearly the entire period. In the chemicals industry, the positive effect in the late 1980s became smaller, declining to levels not significantly different from zero in the 1990s.

b. Changes in trade structure

The estimator $\beta_{2,k}$ for the chemicals industry declined substantially in the late 1980s and then rose moderately, but it was lower overall in the 1990s than it was in the 1980s. In the other industries, this estimator follows a downward trend fairly consistently (Figure 2). These results are the same as those obtained from the pooled OLS and indicate an increasingly larger presence of low-income countries in East Asian trade over the estimation period.

Next, γ_k for the chemicals industry stayed at a fairly constant negative value throughout the estimation period. In the electrical machinery and textile industries, it became negative and reached levels significantly different from zero at the beginning of the 1990s. In other industries, however, it generally stayed at levels that were not significantly different from zero, although its values fluctuated each year. These results suggest an increase in intra-industry trade after the early 1990s particularly in the electrical machinery and textiles industries, as well as an increase in trade with low-income countries in most industries.

B. Results of estimates using goods-specific data

As explained earlier, differences in trade structure across industries help to explain the differences across industries in FDI's effects on trade. This conjecture is confirmed by the fact that the difference in FDI's effects on trade across industries revealed by our analysis using the industry-specific data is consistent with the difference in trade structure across industries suggested in existing literature such as Kozu *et al.* (2002) and Fukao *et al.* (2003). That is, they show that in the electrical machinery and general and precision machinery industries, where FDI has a large and positive effect on trade, there is a greater degree of vertical specialization and fragmentation. In the textile industry, where the positive impact from FDI is not so large, there is some division of labor between Japan and East Asia, but in the transportation machinery industry, where we observed no positive effects, the focus is on production for local markets.

As mentioned earlier, however, there is a possibility that using industry-specific data may produce biased estimation results if different trade patterns emerge for different goods within the same industry.[38]

For this reason, we focus on three representative industries (electrical machinery, textiles and transportation machinery), one from each of the three industry groups categorized by the effect of FDI on trade. We estimate equation (3) separately for the intermediate goods and final goods of each representative industry to examine both FDI's effect on trade and structural changes in trade for each type good. Note that we use the FDI data by industry that corresponds to these goods in estimating the gravity equation by type of goods.[39,40]

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[38] Hillberry (2002) also estimates a gravity equation by category of goods. Hillberry (2002) uses data for the aggregate trade and the trade of each type good to estimate the trade-blocking effect from international borders (the border effect) using the gravity equation. He shows that the estimated values on the border effects obtained from the trade data for each type of good are much smaller than the estimates from aggregate trade data, and argues that the analysis of border effects using aggregate trade data produces biased results.

[39] Since the pooled OLS uses the data in real terms for estimation, FDI is converted into real terms using the same price index used to convert trade data into real terms for each industry.

[40] The inclusion of dummy variables for country-effect or year-effect caused minimal change in the

(1) Pooled OLS

a. Electrical machinery

The estimation results for the electrical machinery industry (Table 3) show that FDI had a very large positive effect on the trade of IT-related goods in the 1990s, and a relatively large positive impact on generic intermediate goods. For household electrical appliances, however, results varied significantly: the effect was actually negative in the 1980s and not significantly different from zero in the 1990s.

As for the changes in trade structure, $\beta_{2,k}$ was lower in the 1990s for all goods, indicating an expansion of trade with low-income countries in all goods. For generic intermediate goods, γ_k was significantly negative in the 1990s, but for IT-related goods and household electrical appliances, the parameter was not significantly different from zero in either the 1980s or the 1990s.[41]

These results indicate the possibility that, particularly in the case of generic intermediate goods, the participation of low-income countries in the production of these components promotes two-way trade, both between Japan and East Asia and within East Asia, and also deepens the division of labor within East Asia.[42]

b. Textiles

The results for the textiles industry show that the effect of FDI on trade within East Asia was positive and significantly different from zero for intermediate goods and that for final goods, these effects were positive on both Japan-East Asian trade and on trade within East Asia (Table 3).

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estimation results.

[41] The cross-section analysis, however, shows that γ_k declines substantially beginning in the 1990s for IT-related goods, and from 1993 γ_k reaches negative values that are significantly different from zero.

[42] Increases in two-way trade and trade with low-income countries suggest two possibilities: (i) a deepening of the division of labor within East Asia, or (2) an increase in two-way trade between high-income countries (which accounts for the majority of total trade) and a simultaneous increase in one way-trade with (exports to) low-income countries. It is therefore necessary to check actual data on trade flows to determine which of these is correct. This actual data shows that trade between Japan and the NIES accounted for a decreasing share of overall Japan and East Asian trade in generic intermediate goods beginning in the 1990s (1985-89: 48%; 1990-97: 28%). On the other hand, there was a large increase in the share of this trade accounted for by trade between Japan and both ASEAN and China (1985-89: 11%; 1990-97: 16%) as well as by trade between NIES and both ASEAN and China (1985-89: 26%; 1990-97: 41%). This change in trade structure suggests that there has been a deepening of the division of labor with low-income countries, as our analysis has found.

Looking at the parameters describing changes in trade structure, $\beta_{2,k}$ was smaller in the 1990s than in the 1980s for both intermediate goods and apparel, although the decline was extremely small for apparel. The parameter γ_k was negative and significantly different from zero in the 1990s for both intermediate goods and apparel, and the decline in the 1990s was particularly large for intermediate goods. These results suggest no significant change in the structure of trade in apparel, but, in intermediate goods, they suggest an increase in the production and export of such goods by low-income countries and a deepening of the division of labor in Japan and East Asia beginning in the 1990s.

c. Transportation machinery

In the transportation machinery industry, for both automobiles and intermediate goods in the 1990s, FDI's effect on trade between Japan and East Asia was not significantly different from zero, but its effect on trade within East Asia was rather negative (Table 3).

As for the structure of trade, $\beta_{2,k}$ was lower in the 1990s than in the 1980s for both automobiles and intermediate goods, whereas γ_k was not significantly different than zero.

(2) Cross-section analysis

a. Electrical machinery

The estimation results for data disaggregated at the product level in the electrical machinery industry (Figure 3) show a large increase in FDI's effect on trade in IT-related goods from the late 1980s, and an increase in the positive effects on trade in generic intermediate goods from the late 1990s. For household electrical appliances, on the other hand, in most years those effects were positive but not significantly different from zero. Therefore, it appears that FDI increases trade in the electrical machinery industry, particularly for IT-related goods and generic intermediate goods.

Regarding structural changes in trade, for IT-related goods, the tempo of decline in $\beta_{2,k}$ accelerates in the 1990s, while γ_k declines substantially to levels significantly different from zero beginning in 1993. For generic intermediate goods, as well, $\beta_{2,k}$ follows a downward trend almost consistently throughout the estimation period, while γ_k declines at a moderate pace to levels significantly different from zero from the early 1990s. For household electrical appliances, meanwhile, although $\beta_{2,k}$ continues to decline throughout the estimation period, γ_k never reaches levels significantly different from zero, although it does decline to some extent.

These results suggest that numerous East Asian countries began to produce and export IT-related goods, particularly beginning in the 1990s, resulting in a rapid expansion of two-way trade of components and a rapid deepening of the division of labor for producing these goods.[43] For generic components, it appears that the gradual increase in the number of East Asian economies producing and exporting them and the resulting growth in two-way trade within East Asia has deepened vertical specialization in East Asia. This interpretation is also consistent with the result of pooled OLS. For household electrical appliances, in contrast, our results indicate that a greater number of low-income countries are getting involved in trade, but that two-way trade has not expanded. There are two possible explanations for this. The first is that the same countries producing household electrical appliances before are still producing them now, but now exporting more to low-income countries than before. The second is that the production process has shifted from high-income countries to low-income countries and production in high-income countries is being substituted by production in low-income countries.[44] The data on trade flows for household electrical appliances in East Asia inclusive of Japan provides clear evidence that Japan's export share is gradually declining (1980-1984: 68%; 1985-1989: 56%; 1990-1997: 42%), while that of the ASEAN 4 is growing rapidly (1980-1984: 0%; 1985-1989: 2%; 1990-1997: 26%). This suggests that household electrical appliances were mainly produced in Japan before, but the production processes are being shifted to low-income countries such as those in ASEAN, and therefore that production in Japan is being substituted by production in these countries.

b. Textiles

The estimation results for textiles (Figure 4) show that FDI's effect on trade in apparel

[43] We can also look at the actual trade flows of IT-related goods to examine changes in trade shares within East Asia and Japan. The share of total trade accounted for by trade between Japan and NIES decreased in the 1990s (1985-89: 43%; 1990-97: 32%), but the share increased for trade between Japan and both ASEAN and China (1985-89: 10%; 1990-97: 13%), as well as for trade between NIES and both ASEAN and China (1985-89: 26%; 1990-97: 41%). These changes indicate a rapidly increasing division of labor with low-income countries in the production of IT-related goods.

[44] We estimate a gravity equation using trade volume (exports plus imports) as the dependent variable. Consequently, a declining $\beta_{2,k}$ and constant γ_k are consistent with both of these possibilities. In this case, it is possible to determine which is more plausible by using actual trade flow data to check for changes in the exporting country and its trading partners.

was positive but not significantly different from zero in the 1990s. For intermediate goods, although FDI's effect on Japan-East Asian trade was not significantly different from zero, its effect on trade within East Asia was consistently positive to the same degree since the mid-1980s.

Turning to the structure of trade, for apparel both $\beta_{2,k}$ and γ_k remain nearly constant during the estimation period. For intermediate goods, $\beta_{2,k}$ follows a downward trend throughout the estimation period, while γ_k shows a moderate declining trend beginning in the 1990s.

These results suggest there has been no significant change in the trade structure for apparel, but suggest the possibility that, for intermediate goods, a gradual increase in production and export by low-income countries and the resultant growth in two-way trade has deepened the division of labor within East Asia.[45]

c. Transportation machinery

In the transportation machinery industry (Figure 5), FDI's effect on trade has been fairly constant, in spite of some fluctuations, throughout the estimation period for both motor vehicles and intermediates, but not significantly different from zero.

As for trade structure, $\beta_{2,k}$ followed a declining path during nearly the entire estimation period for both vehicles and intermediate goods, while γ_k did not exhibit much change and remained at levels not significantly different from zero.

These results suggest two possibilities. The first possibility is that the countries that produced household electrical appliances before are producing them now, but exports to low-income countries are growing. The second is that the production process in high-income countries is shifting to low-income countries and the production in high-income countries is being substituted by production in low-income countries. The data on trade flows for motor vehicles and intermediate goods shows that Japan's exports to East Asia account for a high percentage of the total trade within East Asia inclusive of Japan and that the countries receiving Japan's exports have not changed significantly. This implies that the first possibility is unlikely, and that it is reasonable to conclude

[45] As in footnotes 42 and 43, the actual trade flow data for intermediates shows that the share of trade accounted for by trade between Japan and NIES decreased (1985-89: 18%; 1990-97: 8%). On the other hand, that of trade between Japan and both ASEAN and China did not change (1985-89: 8%; 1990-97: 8%), but that of trade between NIES and both ASEAN and China increased (1985-89: 47%; 1990-97: 59%). This implies an increasing division of labor among East Asian countries.

that a trade structure as described in second possibility has emerged.

C. Summary of estimation results: FDI's impact on trade and structural changes in trade

The results obtained from the pooled OLS regression and cross-section analysis are summarized below.[46]

Regarding FDI's effects on trade, both pooled OLS and cross-section analysis confirm that there are significant differences across industries. Specifically, in the electrical machinery and the general and precision machinery industries, the positive effects of FDI on trade increased from the early 1990s, and those positive effects are large. In the textiles industry, the positive effects of FDI on trade increased from the early 1990s, but those effects are not that large. In the transportation machinery, chemicals, and metal and related products industries, FDI's effects on trade are not significantly different from zero. Especially in the electrical machinery industry, FDI's effect on trade for IT-related goods increased sharply from the early 1990s, while the positive effect for generic intermediate goods was also comparatively high. For household electrical appliances, however, no definite positive effects were observed and there were large differences in FDI's effects across product categories.

Next, we move on to a summary of the estimation results related to changes in trade structure for the representative industries of the three groups categorized by the effect of FDI on trade (electrical machinery, textiles, and transportation machinery industries). In the electrical machinery industry, the cross-section analysis showed many East Asian countries started to produce and export IT-related goods from the early 1990s and a rapid deepening of the division of the production process for these goods. For generic intermediate goods, both the pooled OLS and cross-section analysis confirm

[46] We use FDI flow data for estimating the gravity equation, but as a robustness check we do the same regression on equation (3) using FDI stock data. For FDI stock data, we use the cumulative sum from 1951 in the Ministry of Finance's *Monthly Fiscal and Financial Statistics*. The results of estimations with FDI stock data are almost the same as the results with FDI flow data (thus, we have not reported the detailed results using FDI stock data in this paper). That is, FDI's effect on trade is the highest in the electrical machinery industry and the second highest in the general and precision machinery industry, with the textiles industry ranking third. The effects of other industries are not statistically different from zero. In addition, the effects of FDI on trade for each type of good are the same as the results using FDI flow data. The results of our parameter estimates indicate a growing division of labor in IT-related goods, generic intermediate goods and textile intermediates.

a deepening of vertical specialization in East Asia. For household electrical appliances, both the pooled OLS and the cross-section analysis confirm growth in trade with low-income countries but neither shows any observed changes in the elasticity of substitution between goods, implying that the production process has shifted to low-income countries and that production in high-income countries is being substituted by that in low-income countries.

In the textile sector, both the pooled OLS and cross-section analysis show clearly that low-income countries have increased their production and export of intermediate goods and that the division of labor has deepened in these goods, but that there has been no major change in the trade structure for apparel. Finally, for motor vehicles and their intermediates, both pooled OLS and cross-section analysis show growth in trade with low-income countries but no change in the elasticity of substitution between goods. For these goods, a structural change has occurred on the production side, as production processes shifted to low-income countries, and thus production in high-income countries was being substituted by production in low-income countries.

IV. Concluding Remarks

In this paper, we examine the effect of Japan's direct investment into East Asia on trade and resultant changes in trade structure, using trade data disaggregated to the industry and product levels.

Our analysis has shown that differences between industries in FDI's effect on trade can be traced to differences in trade structure between those industries. That is, in the electrical machinery industry, where the division of labor has advanced rapidly since the early 1990s, especially for IT-related goods, the positive effect from FDI on trade increased substantially in the 1990s. In the textile sector, where there has been a moderate deepening of trade specialization primarily for intermediate goods, FDI's effect on trade has been positive but not so large as that in the electrical machinery sector. In contrast, in the transportation machinery industry, where the production process has shifted from Japan to East Asia and Japan's exports have been substituted by local production in East Asia, FDI has had virtually no impact on trade.

These results suggest that the complementary relationship between Japan's FDI and trade shown by prior research can be traced to the rapid advance of the division of labor in industries such as the electrical machinery industry, particularly for IT-related goods.[47] We confirm this by examining the share of sales (by destination) and supply (by origin) for Japan's overseas affiliates in East Asia in each industry (Table 4). As the table show, in industries where FDI's effects on trades are positive, such as electrical machinery and textiles, the ratio of exports to Japan and to East Asia over total sales is high (57.8% for the electric machinery industry and 34.2% for the textiles industry). In addition, the electrical machinery industry is highly dependent on East Asia not only for sales but also for supply (26.4%), indicating a deepening of the division of labor in East Asia. By contrast, in the transportation machinery industry, most goods are supplied either from Japan or from local production (90.7% in total), while most sales are for local consumption (81.1%). This suggests that the division of labor has not advanced much for this industry in East Asia.

We conclude this paper by noting the implications that these dynamic changes to trade structure in Japan and East Asia have for the economic policy choices facing Japan.

Trade theory suggests that the shift of production processes overseas based on the principle of comparative advantage should have positive effects on the macroeconomy. On the production side, without any distortion, the changes in Japan's terms of trade caused by globalization of the production process should induce a shift of resources from industries with a comparative disadvantage to those with a comparative advantage, thus ensuring that resources are fully employed. On the demand side, the improvement in terms of trade raises real income and increases economic welfare. In the real world, however, although such major structural changes in the economy bring long-term benefits, over the short run these changes create concern over the hollowing out of industry and lead to conflicts over shifts in the distribution of income between the winners and losers. For this reason, in actual policy implementation, it is often the case that the government imposes import restrictions and other protectionist measures to protect the industries with comparative disadvantages.[48]

Even though such policies may provide short run "pain relief," they are likely to

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[47] Of course, another mechanism could be contributing to the positive effect of FDI on trade. This is the likelihood that Japanese overseas affiliates will purchase capital goods from Japanese manufacturers with whom they have longstanding business relationships, a factor that may increase trade between Japan and East Asia.

[48] A number of research papers examine this matter. For example, Grossman and Helpman (1994) show theoretically how anti-competitive policies tend to result from political lobbying.

have negative long run effects on the economy. That is, they make it impossible for countries to take advantage of the benefits of broader and deeper trade relations, such as expanded markets and diversification of trading partners. Lack of flexibility of fiscal expenditure is likely to preserve inefficiency of the economy and amplify this negative effect. Accordingly, it is necessary to construct an efficient economic structure through a reallocation of productive resources that adapts to changes in trade structure. On this matter, Otani, Shiratsuka and Nakakuki (2004) point out that it is difficult for the market mechanism alone to resolve the misallocation of productive resources, because the process of resource reallocation inevitably causes conflicts between economic agents. They conclude that it is difficult to achieve an efficient allocation of productive resources without taking specific policy measures aimed at facilitating that reallocation. These policy measures should include not only a transfer of real resources from the agent gaining from the reallocation to the agent losing (Bhagwati [1971]) but also deregulation to facilitate the flexible movement of labor and capital so as to promote the creation of higher value-added industries.

Appendix A. Theoretical research on the relationship between FDI and Trade

In the field of trade theory, there have been a number of theoretical papers examining the relationship between FDI and trade between the investing and recipient countries, specifically looking at the question of whether an increase in a country's FDI increases or decreases trade with the recipient country.

The Hecksher-Ohlin model shows a substitutive relationship between international factor movement and trade. The model assumes two countries, home and foreign; each is endowed with two types of production factors, capital and labor, and each produces the same good with the same production technology. It is also assumed that capital can move across borders but labor cannot, and that the home country has a relatively larger quantity of capital. If the capital were not internationally mobile, the rate of return on capital would be lower in the home country than in the foreign country, and the former would be able to produce capital-intensive goods at a relatively lower cost. This would result in the home country exporting capital-intensive goods and importing labor-intensive goods. Supposing that capital moves from the home to foreign country in response to the difference in return on capital, however, would mean that the return on capital equalizes in the home and foreign country. When this happens, the difference in production factor prices -- the impetus for international trade -- vanishes, causing the countries to no longer engage in trade. Accordingly, international factor movement decreases the volume of trade between the home and foreign country.[49]

Under the specific-factors model,[50] on the other hand, the research finds a complementary relationship between international factor movement and trade. This model assumes both the home and foreign countries are endowed with three types of production factors: labor, which can move freely among sectors, and land and capital, both of which are specific factors that are exclusively used for production in a single sector. It is also assumed that capital can move across borders but other factors cannot. It is assumed that machinery is produced by labor and capital, and food by labor and land, and that the home country has relatively more fertile land and a greater scarcity of capital. In the case where capital is internationally immobile, the home country exports food and imports machinery. In this case, the return on land is lower in the home country than in the foreign country. Since the wages in the home food sector are higher than wages in the foreign food sector, relatively more workers are employed in the home food sector than in the foreign food sector and, likewise, relatively fewer workers are employed in the home machinery sector. This can create a situation whereby the return on capital in the home machinery sector is lower than that in the foreign machinery sector. In this case, if capital flows from the home country to the foreign country in response to the difference in return on capital between the two, the production of machinery will decline in the home country and increase in the foreign country. Consequently, international capital movement increases the volume of bilateral trade.[51]

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[49] The HeckshER-Ohlin model was proposed by Hecksher (1949) and Ohlin (1933) and named after these prominent economists. See Mundell (1957) for a theoretical study examining the relation between international factor movement and trade based on this model. Note that Markusen (1983) shows theoretically that international factor movement and trade become complementary with each other even in this model when dropping the assumptions of perfect competition, the use of the same technology both in the home and foreign countries, and constant returns to scale in the production function.

[50] For more on the specific-factors model, see Jones (1971).

[51] Of course, there will also be cases where the return on capital in the home machinery sector is higher than that of the foreign country. In such cases, capital flows from the foreign country to the home country, and machinery exports from the foreign country to the home country decline. Accordingly, the specific-

Appendix B. Micro foundations of the gravity equation

Appendix B. derives a gravity equation linking distance with trade flows based on the standard model of Fujita, Krugman and Venables (1999) to explain the effect of distance on trade. There is a large body of research using the same model, including Hillberry (2002), Hummels (1999) and Redding-Venables (2004).

The utility function U_i of a representative consumer in country i is given by the following equation.

$$U_i = \prod_k (C_{i,k})^{\eta_k} \text{, provided that } X_{i,k} = (\sum_i c_{i,k}^{(\sigma_k - 1)/\sigma_k})^{\sigma_k/(\sigma_k - 1)}, \quad \text{(A1)}$$

where $C_{i,k}$ is the index of consumption for industry k goods by the representative consumer in country i. $c_{i,k}$ is the consumption of goods in industry k, σ_k is the elasticity of substitution between the industry k goods, and η_k is the share of income spent on the industry k goods. Denoting the price of the industry k good in country i as $p_{ij,k}$, the price index $G_{j,k}$ for industry k goods corresponding to the utility function defined in equation (A1) can be expressed as follows.

$$G_{i,k} = (\sum_k p_{i,k}^{(1-\sigma_k)})^{1/(1-\sigma_k)} . \quad \text{(A2)}$$

Let us assume that monopolistically competitive firms supply differentiated goods and that each country is symmetric in the sense that each country produces the same number of goods and same types of goods. Then, the firm producing the industry k goods in country j sets the price of the goods, $p_{j,k}$, equal to marginal cost by the markup ratio $(\sigma_k /[\sigma_k - 1])$.[52] We assume that all additional costs associated with trade (trade costs) are passed on in the import price, and we denote theses costs by $\tau_{ij,k}$. Then, when the goods are exported from country j to country i, $p_{ij,k}=p_{j,k}\ \tau_{ij,k}$ holds.

Letting Y_i and $c_{ij,k}$ be the income of a representative consumer in country i and the

factors model can also lead to the conclusion that international factor movement and trade are substitutes with each other.

[52] For simplification, the foreign exchange rate of country i to country j is assumed to be one.

consumption of industry k goods exported by country j to country i respectively, $c_{ij,k}$ can be expressed as follows based on utility maximization,

$$c_{ij,k} = \frac{\eta_k Y_i (p_{ij,k})^{-\sigma_k}}{(G_{i,k})^{1-\sigma_k}}. \tag{A3}$$

Assuming that $M_{ij,k}$ and $n_{j,k}$ represent the nominal value of imports of industry k goods by country i from country j, and the types of industry k goods produced by country j, then the following relationship holds.

$$M_{ij,k}=n_{j,k} p_{j,k} c_{ij,k}, \tag{A4}$$

Substituting equation (A3) into equation (A4) yields the following.

$$M_{ij,k} = \frac{n_{j,k}(p_{j,k})^{1-\sigma_k} \cdot \eta_k Y_i \cdot \tau_{ij,k}{}^{-\sigma_k}}{(G_{i,k})^{1-\sigma_k}}. \tag{A5}$$

Let us also assume that trade cost is expressed as a function f^k of distance D_{ij}, and that it is different for each good. It is further assumed that trade cost increases exponentially in relation to distance. Thus trade cost can be expressed as follows (A6).

$$\tau_{ij,k} = f^k(D_{ij}) = (D_{ij})^{\delta_k}, \tag{A6}$$

where δ_k is the elasticity of trading cost with respect to distance. In this case, import demand can be expressed with the following equation.

$$M_{ij,k} = \frac{n_{j,k}(p_{j,k})^{1-\sigma_k} \cdot \eta_k Y_i \cdot D_{ij}{}^{-\delta_k \sigma_k}}{(G_{i,k})^{1-\sigma_k}}. \tag{A7}$$

Equation (A7) indicates that a one percent increase in trade causes a $\delta_k\sigma_k$ percent decrease in country i's demand for the country j goods, holding the other factors (like income) constant. Note that $\delta_k\sigma_k$ percent is the sum of the effect on demand in country i of an increase in transportation cost passed on in the import price and the substitution effect caused by an increase in the sales price of the country j good.

The gravity equation (1) can be derived from equation (A7) by approximating $n_{j,k}(p_{j,k})^{1-\sigma_k}$, the information on the exporting country, and $Y_i/(G_{i,k})^{1-\sigma_k}$, the information on the importing country, by each country's GDP.

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Table 1

Product characteristics and aggregation of electrical machinery, textiles and transportation machinery

	Item code	Name	Item characteristics	Notes (products included, etc.)
Electrical Machinery	6973	Household cooking equipment	Plus other	Including electric ranges
	716A	Motors & generators	Plus other (including motors and condensers)	Including components
	7243	Sewing machines	Plus other (household appliances & their components)	
	7511	Typewriters		
	7512	**Calculating machines**	**IT-related goods**	Including ATMs
	752A	**Personal computers, etc.**	**IT-related goods**	PCs (7522), CPUs (7523), memory (7524), Peripherals (7525), Hard drives (7528)
	7591	**Parts & accessories for calculators and computers**	**IT-related goods**	
	761A	**TVs**	**Final products (household appliances)**	
	762A	**Wireless communications equip.**	**IT-related goods**	
	7641	**Fixed-line communications equip.**	**IT-related goods**	
	7642	**Speakers & microphones**	**Generic intermediates**	
	7649	**Parts for PCs and communications equip.**	**Generic intermediates**	
	771A	**Transformers**	**Generic intermediates**	Including converters and rectifiers
	772A	**Switches, etc.**	**Generic intermediates**	Including fuses and printed circuit boards
	7742	X-ray-related equip.	Plus other	
	7751	**Washing machines**	**Final products (household appliances)**	
	7752	**Refrigerators**	**Final products (household appliances)**	
	7754	Electric razors & their components	Plus other (household appliances & their components)	
	7757	Other household appliances & their components	Plus other (household appliances & their components)	Vacuum cleaners (77571), etc.
	7758	Electric heaters & their components	Plus other (household appliances & their components)	
	776A	**Semiconductors & liquid crystal related**	**IT-related goods**	CRTs (7761), electronic tubes (7762) semiconductors (7763), integrated circuits (7764), liquid crystals (7768)
	7781	**Batteries, etc.**	**Generic intermediates**	
	7782	**Electronic tubes**	**Generic intermediates**	Fluorescent tubes, EDTs, infrared & ultraviolet lamps
	7788	Other electrical machinery	Plus other (including motors & capacitors)	Including capacitors (77844), also electro-magnets, signalers, alarms, particle accelerators, & carbon brushes
	8124	Lighting fixtures	Plus other	Dry-cell batteries
	8983	Records & CDs	Plus other	
T	2686	Waste of sheeps/lambs wool	Plus other (except apparel)	
	2690	Used fabric	Plus other (except apparel)	
	6512	**Wool yarn**	**Intermediates**	
	6514	**Cotton yarn**	**Intermediates**	
	6517	**Synthetic yarn**	**Intermediates**	
	6519	**Other yarn**	**Intermediates**	
	6521	**Unfinished cotton**	**Intermediates**	
	6522	**Finished cotton**	**Intermediates**	
	6531	**Synthetic fabric**	**Intermediates**	
	6539	**Fabric for carpets**	**Intermediates**	
	6542	**Wool fabric**	**Intermediates**	
	6549	**Other wool fabric**	**Intermediates**	
	655A	**Knit fabrics**	**Intermediates**	
	6560	**Lace & embroidery**	**Intermediates**	
	6571	**Felt**	**Intermediates**	
	6573	**Flame resistant fabric**	**Intermediates**	
	6575	Twine, rope, etc.	Plus other (except apparel)	

	6577	Industrial textiles	Plus other (except apparel)	
	6581	Sacks & bags	Plus other (except apparel)	
	6583	Blankets	Plus other (except apparel)	
	6584	Bed and table linen	Plus other (except apparel)	
	6589	Other textile products	Plus other (except apparel)	Including Tents (6582), etc.
	6592	Carpets & rugs	Plus other (except apparel)	
	8421	**Men's coats**	**Final products (apparel)**	
	8422	**Men's suits**	**Final products (apparel)**	
	8423	**Trousers**	**Final products (apparel)**	
	8429	**Other men's outerwear**	**Final products (apparel)**	
	8431	**Women's coats**	**Final products (apparel)**	
	8432	**Women's suits**	**Final products (apparel)**	
	8433	**Women's dresses**	**Final products (apparel)**	
	8434	**Women's skirts**	**Final products (apparel)**	
	8441	**Men's woven shirts**	**Final products (apparel)**	
	8442	**Woven undergarments excl. tops**	**Final products (apparel)**	
	8451	**Knit shirts**	**Final products (apparel)**	
	8452	**Knit dresses & skirts**	**Final products (apparel)**	
	8459	**Other knit outerwear**	**Final products (apparel)**	
	8461	**Knit undergarments**	**Final products (apparel)**	
	8465	Corsets, bras, etc.	Final products (non-apparel)	
	8471	Other woven accessories	Final products (non-apparel)	
	8472	Other knit accessories	Final products (non-apparel)	
	8481	Leather goods	Final products (non-apparel)	
	8483	Fur goods	Final products (non-apparel)	
	8484	Headgear	Final products (non-apparel)	
Transportation machinery	7133	Marine engines	Plus other (except motor vehicles)	
	7139	**Engine components**	**Intermediates**	Including engines for motor vehicles
	7783	**Electrical components of engines**	**Intermediates**	
	7810	**Passenger motorcars**	**Final product (motor vehicles)**	
	7821	**Trucks**	**Final product (motor vehicles)**	
	7822	**Cranes, etc.**	**Final product (motor vehicles)**	
	7831	**Buses**	**Final product (motor vehicles)**	
	7849	**Motor vehicle parts**	**Intermediates**	Chassis, body, etc.
	7852	**Bicycles**	**Plus other (except motor vehicles)**	
	786A	**Trailers & their parts**	**Plus other (except motor vehicles)**	Not motorized
	791A	**Railway vehicles & associated equip. & parts**	**Plus other (except motor vehicles)**	
	792A	**Aircraft & associated equip. & parts**	**Plus other (except motor vehicles)**	
	793A	**Ships, boats, & associated equip. & parts**	**Plus other (except motor vehicles)**	Including floating structures

Note: The items in bold letters and highlighted are those items used by the author in aggregation.

Table 2

Estimation results for pooled OLS regression using industry-specific data

	Electrical machinery		General and precision machinery		Textiles		Transportation machinery		Chemicals		Metal and related products	
	1982–89	1990–97	1982–89	1990–97	1982–89	90–97	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97
YiYj	0.512	0.433	0.645	0.513	0.887	0.617	0.531	0.577	0.674	0.597	0.678	0.692
(β_1)	(0.14)	(0.06)	(0.11)	(0.08)	(0.12)	(0.08)	(0.14)	(0.10)	(0.07)	(0.05)	(0.09)	(0.06)
	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉
$phY_i phY_i$	1.900	1.719	1.393	1.164	1.545	1.071	1.459	0.959	0.942	0.879	1.126	0.983
(β_2)	(0.19)	(0.10)	(0.15)	(0.12)	(0.14)	(0.12)	(0.20)	(0.15)	(0.10)	(0.06)	(0.12)	(0.07)
	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉
$JFDI_i$	−0.009	0.421	0.078	0.244	−0.014	0.149	0.016	0.021	0.119	0.067	0.022	0.004
(η_1)	(0.07)	(0.08)	(0.05)	(0.11)	(0.05)	(0.05)	(0.07)	(0.03)	(0.05)	(0.05)	(0.06)	(0.07)
	〈0.90〉	〈0.00〉	〈0.15〉	〈0.04〉	〈0.79〉	〈0.00〉	〈0.82〉	〈0.53〉	〈0.01〉	〈0.22〉	〈0.72〉	〈0.96〉
$JFDI_i$	0.047	0.420	0.051	0.180	0.199	0.219	−0.093	−0.083	0.145	0.103	0.011	0.027
$+JFDI_j$	(0.05)	(0.07)	(0.05)	(0.10)	(0.06)	(0.04)	(0.06)	(0.03)	(0.04)	(0.05)	(0.05)	(0.06)
(η_2)	〈0.39〉	〈0.00〉	〈0.28〉	〈0.08〉	〈0.00〉	〈0.00〉	〈0.14〉	〈0.01〉	〈0.00〉	〈0.04〉	〈0.81〉	〈0.66〉
dist	−0.165	−0.194	−0.143	−0.124	−0.172	−0.681	0.528	0.162	−0.271	−0.326	−0.057	−0.209
(γ)	(0.17)	(0.12)	(0.21)	(0.14)	(0.20)	(0.18)	(0.26)	(0.19)	(0.12)	(0.09)	(0.21)	(0.11)
	〈0.34〉	〈0.12〉	〈0.51〉	〈0.39〉	〈0.41〉	〈0.00〉	〈0.051〉	〈0.39〉	〈0.03〉	〈0.00〉	〈0.78〉	〈0.06〉
lang	0.380	0.459	0.850	0.866	1.098	0.609	0.330	0.949	0.703	0.550	0.166	0.251
(ϕ_1)	(0.25)	(0.22)	(0.34)	(0.33)	(0.30)	(0.34)	(0.53)	(0.34)	(0.20)	(0.23)	(0.38)	(0.27)
	〈0.13〉	〈0.04〉	〈0.02〉	〈0.01〉	〈0.00〉	〈0.08〉	〈0.54〉	〈0.01〉	〈0.00〉	〈0.02〉	〈0.67〉	〈0.36〉
cntg	1.905	1.524	1.215	1.067	1.037	0.643	2.470	1.450	0.752	0.821	1.291	1.209
(ϕ_2)	(0.51)	(0.43)	(0.73)	(0.62)	(0.65)	(0.80)	(0.95)	(0.66)	(0.41)	(0.51)	(0.71)	(0.56)
	〈0.00〉	〈0.00〉	〈0.11〉	〈0.09〉	〈0.12〉	〈0.43〉	〈0.01〉	〈0.03〉	〈0.08〉	〈0.12〉	〈0.08〉	〈0.04〉
n_obs	322	359	322	359	319	359	315	357	322	359	322	359
adjR^2	0.843	0.897	0.808	0.855	0.737	0.767	0.708	0.737	0.833	0.870	0.797	0.866
F test $JFDI_i$	18.44	〈0.00〉	2.24	〈0.14〉	4.35	〈0.04〉	0.01	〈0.94〉	0.96	〈0.33〉	0.05	〈0.83〉
F test $JFDI_i + JFDI_j$	22.54	〈0.00〉	1.74	〈0.19〉	0.12	〈0.73〉	0.03	〈0.87〉	0.59	〈0.45〉	0.05	〈0.83〉

Note: Heteroskedasticity-adjusted standard deviations are in parentheses ( ), and P values are within inequality signs < >. Shadow indicates a P value of 0.05 or less. The F test indicates the F value and P value under the null hypothesis that each coefficient was the same for the 1980s as for the 1990s.

Table 3

Estimation results for pooled OLS regression using goods-specific data

	Electrical Machinery						Textiles				Transportation Machinery			
	IT-related goods		Generic intermediates		Household electrical appliances		Apparel		Intermediates		Vehicles		Intemediates	
	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97	1982–89	1990–97
YiYj	0.459	0.389	0.490	0.462	1.325	0.490	0.730	0.699	0.915	0.622	0.628	0.613	0.335	0.532
(β_1)	(0.18)	(0.08)	(0.14)	(0.07)	(0.19)	(0.11)	(0.25)	(0.16)	(0.12)	(0.09)	(0.17)	(0.17)	(0.18)	(0.11)
	〈0.02〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.01〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.07〉	〈0.00〉
$phY_i phY_i$	2.349	2.041	1.862	1.515	2.435	1.705	1.477	1.341	1.611	1.069	1.433	1.191	1.016	0.709
(β_2)	(0.25)	(0.16)	(0.16)	(0.11)	(0.17)	(0.17)	(0.24)	(0.16)	(0.15)	(0.13)	(0.25)	(0.20)	(0.21)	(0.15)
	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉
$JFDI_i$	−0.052	0.595	−0.081	0.298	−0.285	0.105	0.098	0.452	−0.043	0.074	−0.010	0.045	0.081	0.053
(η_1)	(0.09)	(0.10)	(0.06)	(0.09)	(0.09)	(0.12)	(0.08)	(0.15)	(0.05)	(0.05)	(0.07)	(0.07)	(0.06)	(0.04)
	〈0.55〉	〈0.00〉	〈0.15〉	〈0.00〉	〈0.00〉	〈0.41〉	〈0.21〉	〈0.01〉	〈0.43〉	〈0.14〉	〈0.88〉	〈0.51〉	〈0.18〉	〈0.16〉
$JFDI_i$ $+JFDI_j$	0.037	0.604	−0.075	0.271	0.041	0.094	0.072	0.363	0.220	0.215	−0.261	−0.138	−0.177	−0.148
	(0.05)	(0.10)	(0.05)	(0.08)	(0.09)	(0.11)	(0.10)	(0.11)	(0.06)	(0.04)	(0.07)	(0.05)	(0.06)	(0.04)
(η_2)	〈0.49〉	〈0.00〉	〈0.12〉	〈0.00〉	〈0.64〉	〈0.41〉	〈0.48〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.01〉	〈0.01〉	〈0.00〉
dist	−0.316	−0.189	0.052	−0.252	0.644	0.158	−1.079	−0.825	0.041	−0.647	−0.100	−0.080	0.363	0.107
(γ)	(0.20)	(0.18)	(0.25)	(0.12)	(0.35)	(0.21)	(0.52)	(0.27)	(0.21)	(0.19)	(0.44)	(0.40)	(0.27)	(0.19)
	〈0.12〉	〈0.29〉	〈0.83〉	〈0.04〉	〈0.08〉	〈0.47〉	〈0.045〉	〈0.00〉	〈0.85〉	〈0.00〉	〈0.82〉	〈0.84〉	〈0.19〉	〈0.57〉
lang	0.152	0.276	0.555	0.855	1.204	0.647	1.323	1.325	1.155	0.449	0.138	0.954	0.819	1.235
(ϕ_1)	(0.32)	(0.29)	(0.30)	(0.22)	(0.49)	(0.35)	(0.65)	(0.36)	(0.35)	(0.41)	(0.56)	(0.57)	(0.43)	(0.28)
	〈0.64〉	〈0.35〉	〈0.07〉	〈0.00〉	〈0.02〉	〈0.07〉	〈0.048〉	〈0.00〉	〈0.00〉	〈0.28〉	〈0.81〉	〈0.10〉	〈0.06〉	〈0.00〉
cntg	1.772	1.461	2.548	1.525	2.257	2.325	1.428	1.202	1.164	0.625	2.961	1.678	2.224	1.530
(ϕ_2)	(0.70)	(0.43)	(0.54)	(0.49)	(0.85)	(0.70)	(1.06)	(0.90)	(0.64)	(0.77)	(0.99)	(0.90)	(0.76)	(0.60)
	〈0.02〉	〈0.00〉	〈0.00〉	〈0.00〉	〈0.01〉	〈0.00〉	〈0.18〉	〈0.19〉	〈0.07〉	〈0.42〉	〈0.01〉	〈0.06〉	〈0.01〉	〈0.01〉
n_obs	310	359	316	359	298	357	305	359	319	359	273	349	315	357
adjR^2	0.796	0.838	0.803	0.891	0.690	0.749	0.531	0.734	0.713	0.718	0.702	0.598	0.745	0.751
F test $JFDI_i$	26.07	〈0.00〉	18.06	〈0.00〉	7.26	〈0.01〉	3.85	〈0.06〉	3.10	〈0.09〉	0.57	〈0.46〉	0.28	〈0.60〉
F test $JFDI_i$+$JFDI_j$	24.78	〈0.00〉	15.18	〈0.00〉	0.16	〈0.69〉	3.81	〈0.06〉	0.01	〈0.94〉	2.55	〈0.12〉	0.21	〈0.65〉

Note: Heteroskedasticity-adjusted standard deviations are in parentheses ( ), and P values are within inequality signs < >. Shadow indicates a P value of 0.05 or less. The F test indicates the F value and P value under the null hypothesis that each coefficient was the same for the 1980s as for the 1990s.

Table 4

Share of sales and purchases by Japan's foreign affiliates in East Asia

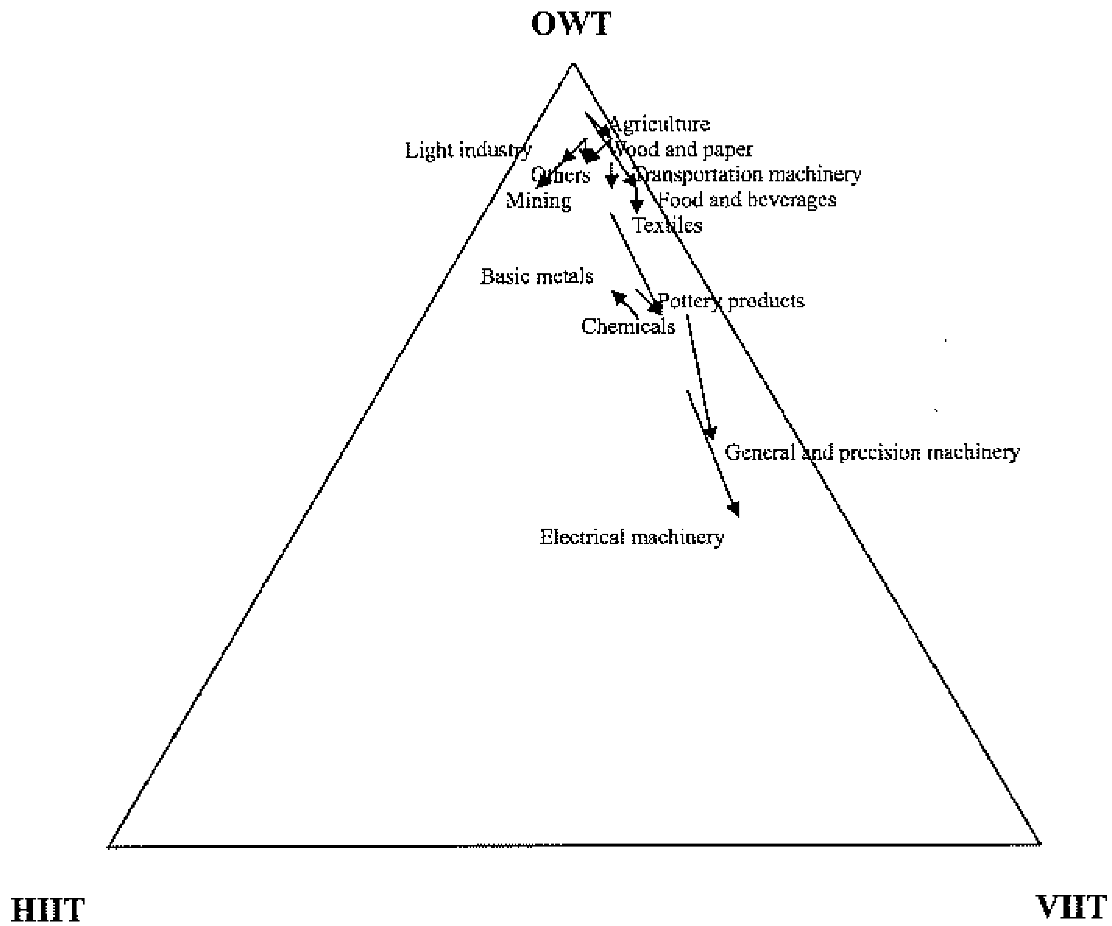
(FY1998, %)

	Share of sales				Share of purchases			
	Domestic sales	Exports to Japan	Export to East Asia	Other exports	Domestic	Imports from Japan	Imports from East Asia	Other imports
Electric	32.3	33.0	24.8	9.9	35.7	37.0	26.4	0.9
General & precision	30.4	42.6	18.0	9.0	50.2	36.0	11.2	2.5
Textiles	47.7	22.2	12.0	18.1	52.9	26.1	11.2	9.8
Transportation	81.1	11.0	2.2	5.7	53.7	37.0	6.0	3.3
Chemicals	72.4	7.6	16.6	3.4	54.4	18.6	14.8	12.3
Metal and its products	73.7	7.9	14.3	4.1	27.9	56.5	13.4	2.1

Notes: Author's calculation using the Survey of Overseas Business Activities (METI).

Figure 1

Changes in trade structure by sector within East Asia



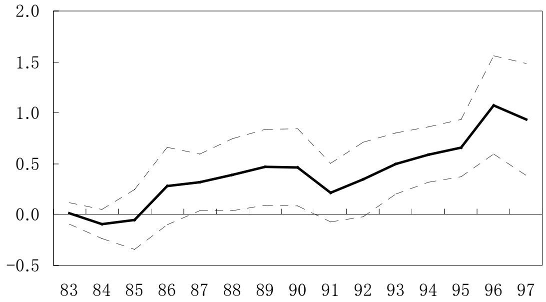
Note: OWT is one-way trade, HIIT is horizontal intra-industry trade, and VIIT is vertical intra-industry trade.
Source: Fukao *et al.* [2003]

Figure 2

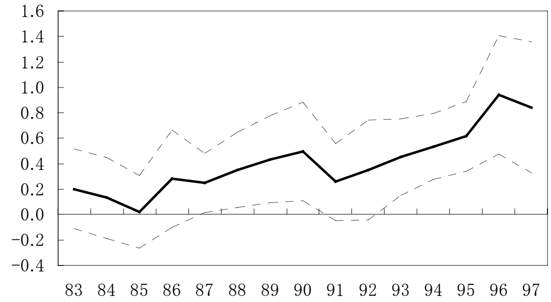
Estimation results for cross-section analysis using industry-specific data

Electrical machinery

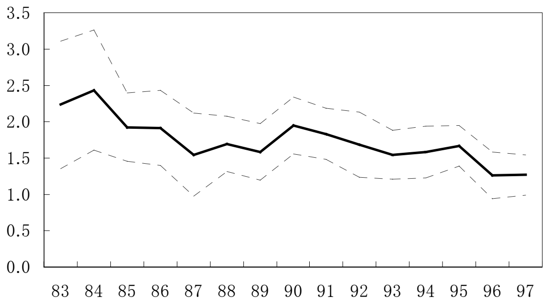
η_1 $(JFDI_j)$



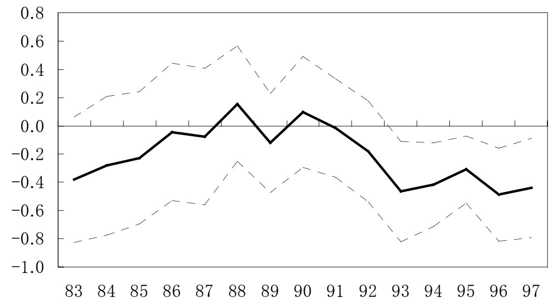
η_2 $(JFDI_i + JFDI_j)$



β_2 $(phY_i\, phY_j)$

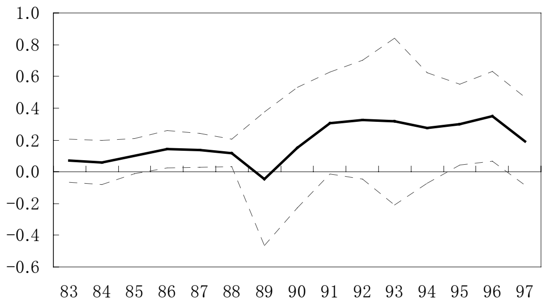


γ (Dst_{ij})

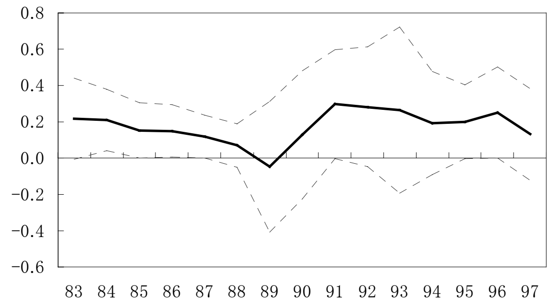


General and precision machinery

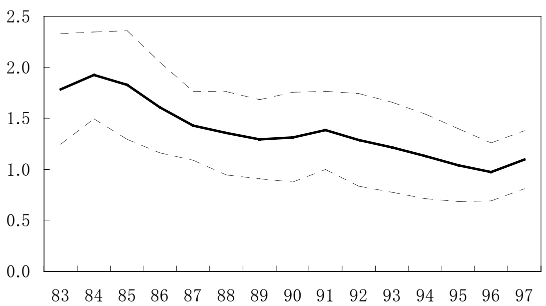
η_1 $(JFDI_j)$



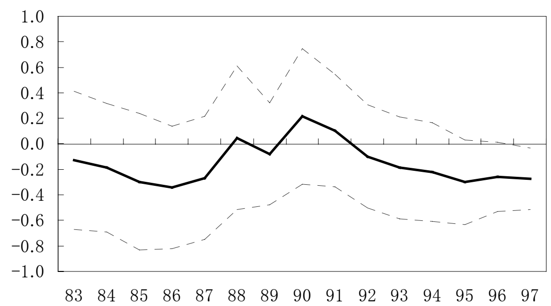
η_2 $(JFDI_i + JFDI_j)$



β_2 $(phY_i\, phY_j)$



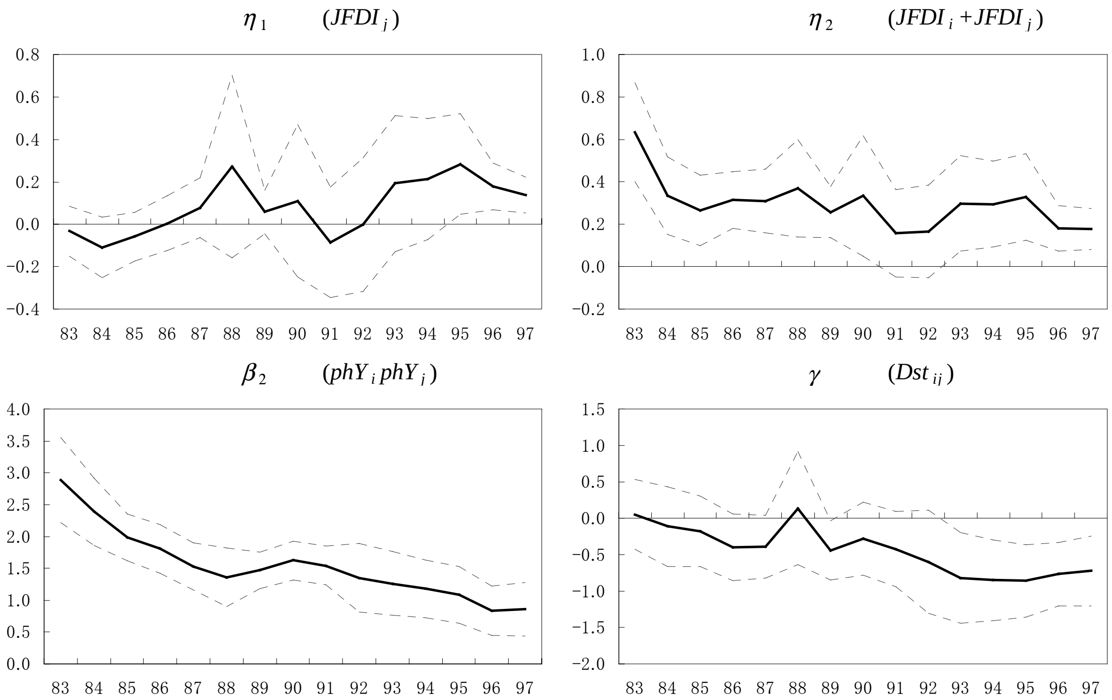
γ (Dst_{ij})



Note: Straight line is estimated value, dotted line shows confidence interval for each year (5% significance level, and heteroskedasticity is adjusted). The same holds true for Figures 3-5.

Figure 2 (continued)

Textiles



Transportation machinery

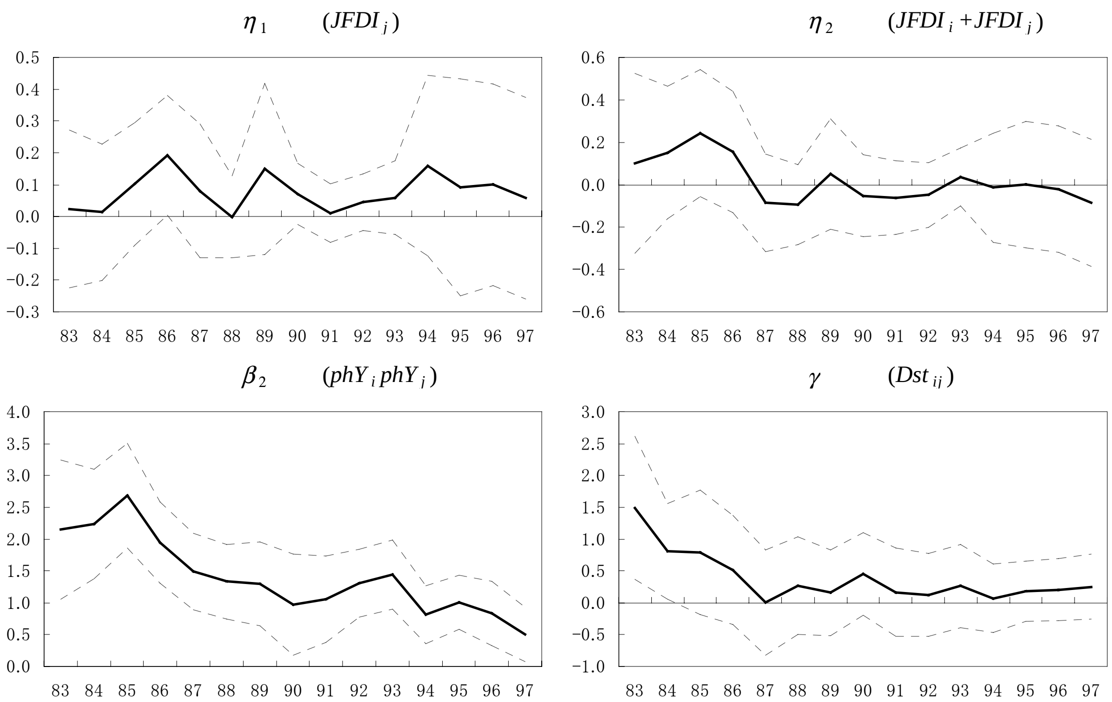
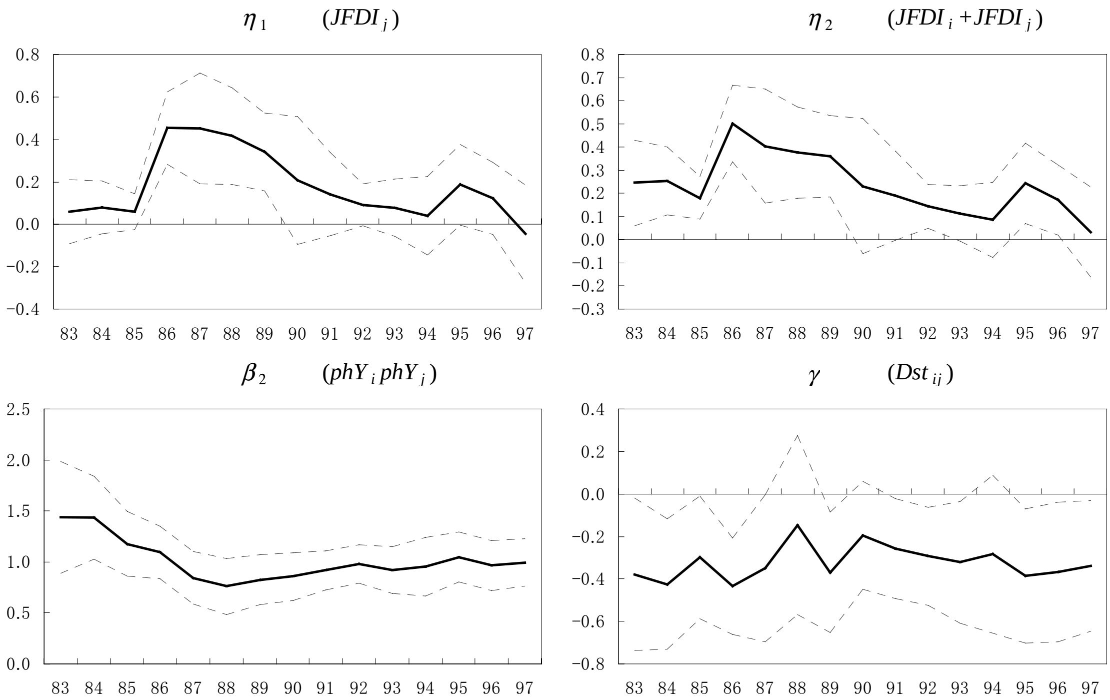


Figure 2 (continued)

Chemicals



Metal and related products

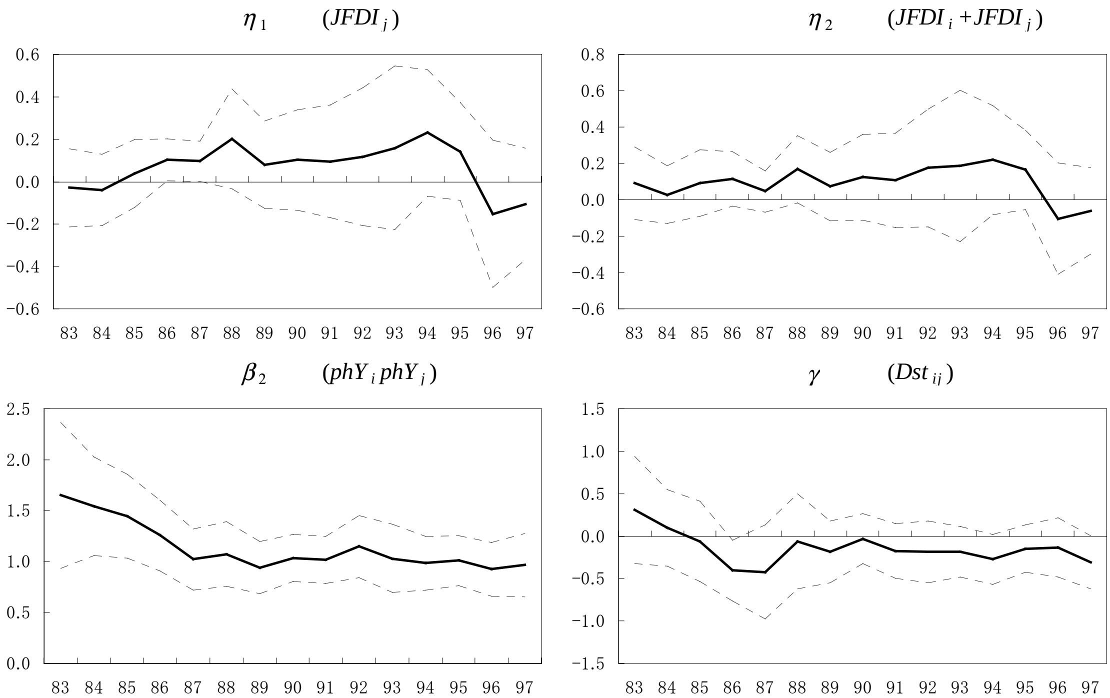
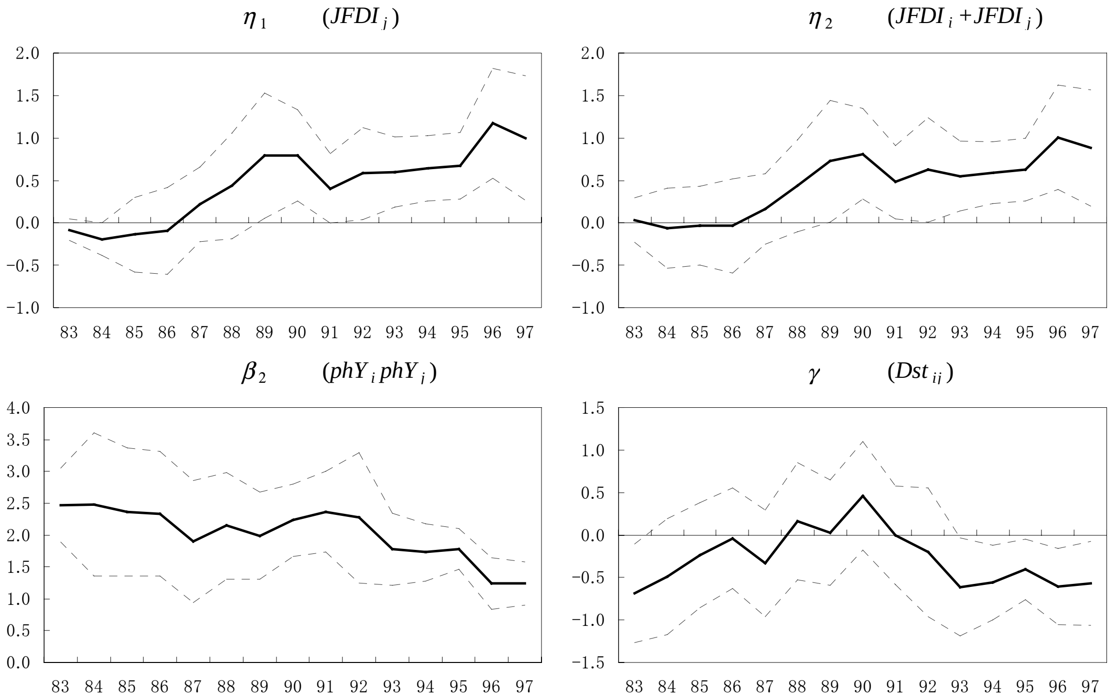


Figure 3

Estimation results for cross-section analysis using goods-specific data

in the electrical machinery sector

IT-related goods



Generic intermediates

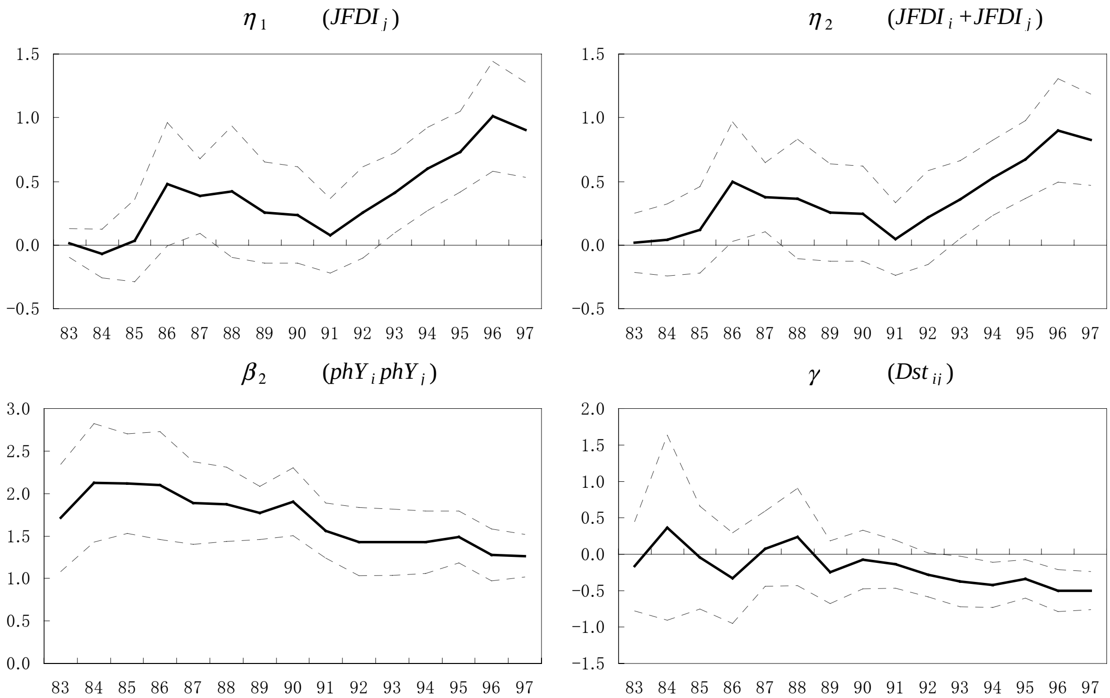


Figure 3 (continued)

Household electrical appliances

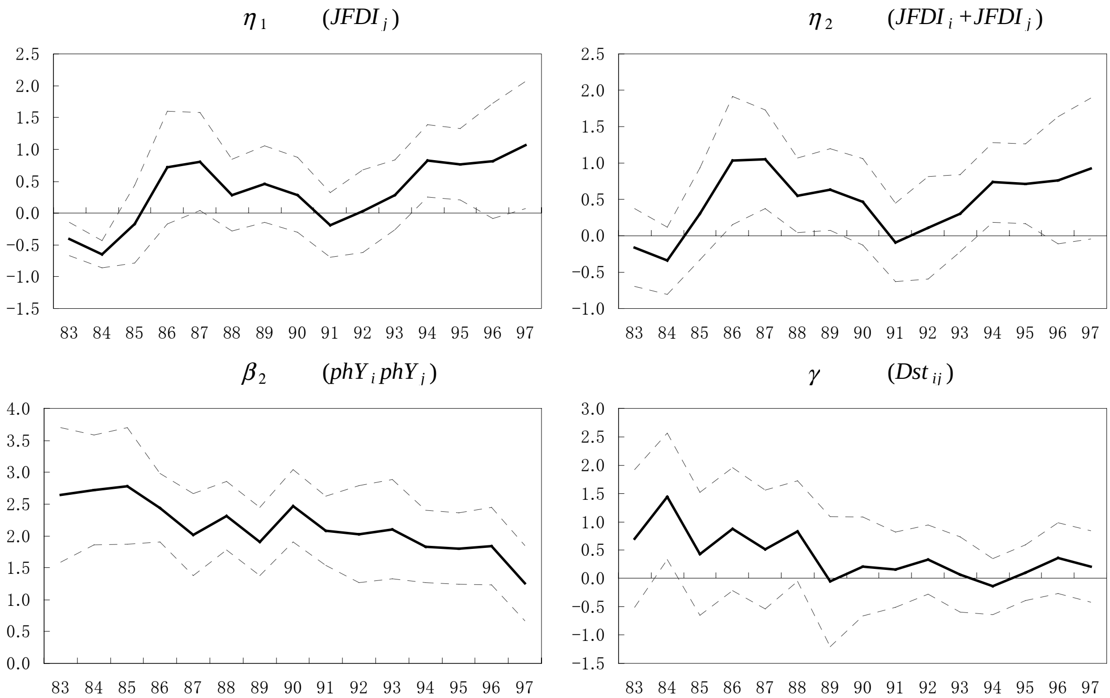
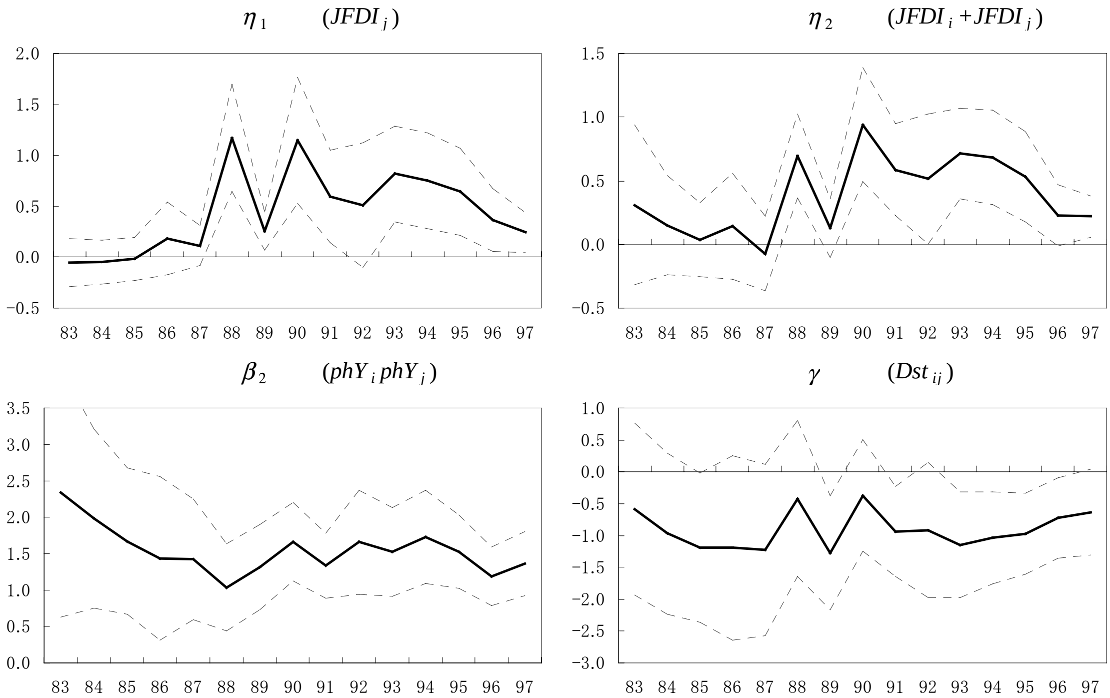


Figure 4

Estimation results for cross-section analysis using goods-specific data in the textile sector

Apparel



Intermediates

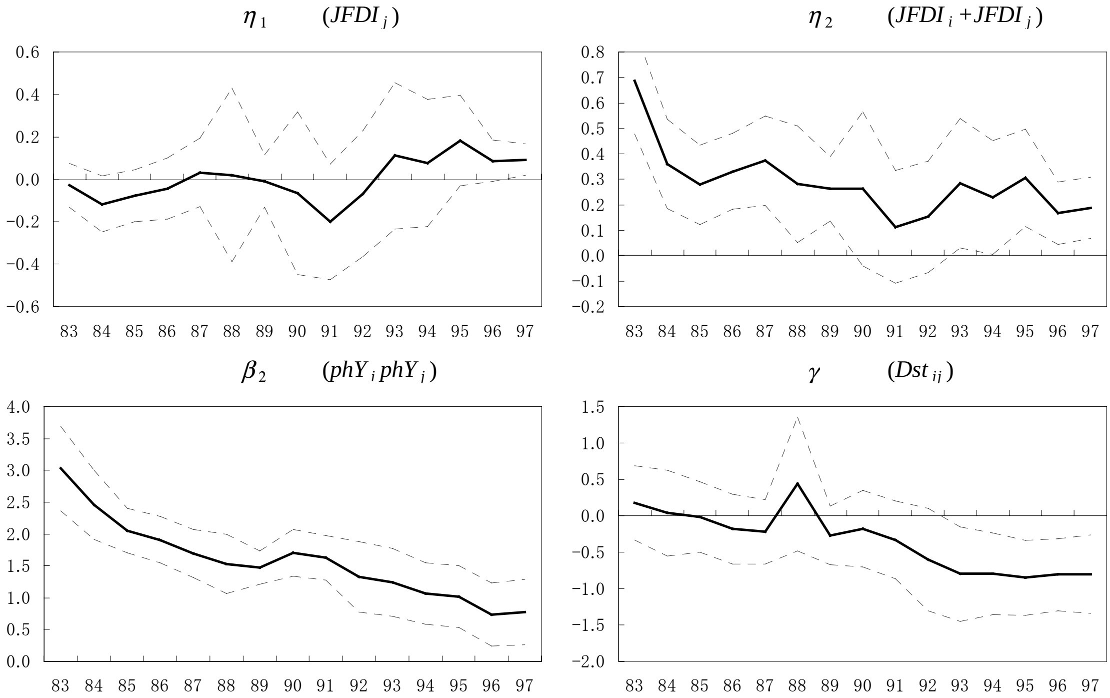
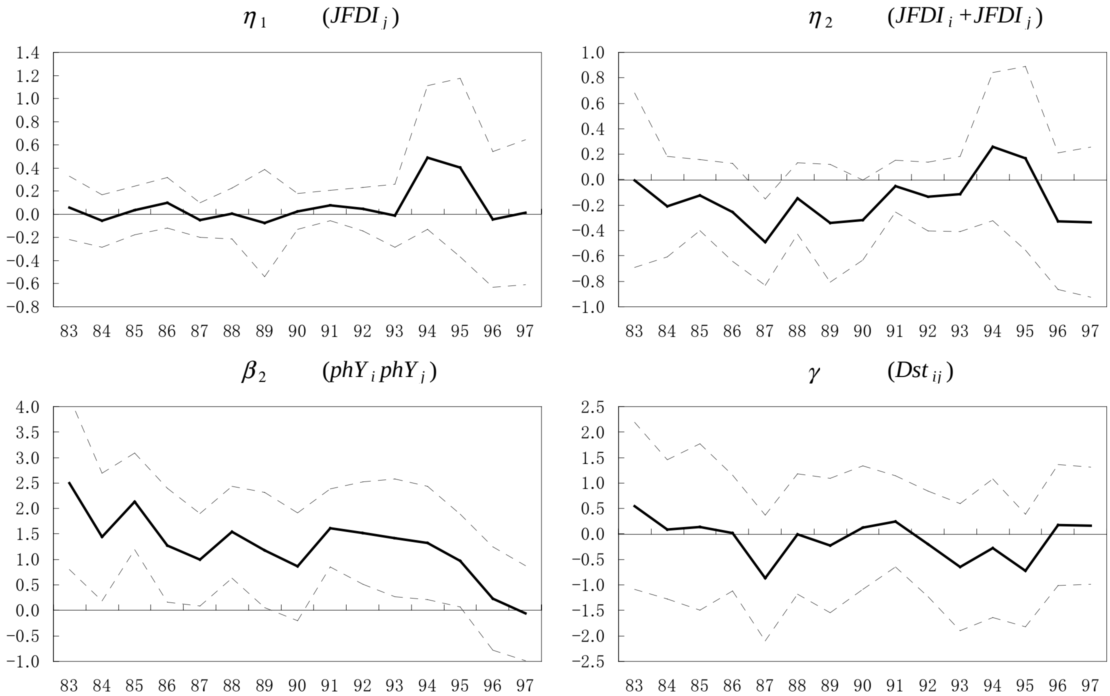


Figure 5

Estimation results for cross-section analysis using goods-specific data in the transportation machinery sector

Vehicles



Intermediates