<u>Working Paper No 17/04</u>

**The Effects of International Fragmentation of
Production on Trade Patterns:
An Empirical Assessment**

**by
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SIØS - Centre for International Economics and Shipping

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The Effects of International Fragmentation of Production on Trade Patterns: an Empirical Assessment[*]

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April 2004

Abstract

Does fragmentation of production affect the trade patterns of different countries in similar ways? In contrast with current theories of vertical specialization, attempts to provide empirical evidence on this question have been based, in the vast majority of cases, only on a statistical analysis of trade flows. I propose a general equilibrium model of trade and fragmentation that allows me to capture the effects of vertical specialization on the export performances of different countries in individual sectors. It is a comprehensive framework, which combines comparative advantages (both of the Ricardian and Heckscher-Ohlin type) with other characteristics of the economies (sizes, market structure, investments in R&D) and takes into consideration the role of the employment of domestic and imported intermediates in the production of exported and non-exported final goods. The model is used to explain the differences in French and Japanese exports of manufactured goods (relative to US) toward other OECD countries over the period 1980-1994. In particular, the model highlights the propensity of France to vertically specialize its activities in order to fill possible gaps in terms of innovation and TFP, while the negative impact of fragmentation on Japanese exports shows a disinclination to use imported intermediates in the production of the exported goods.

Key words: Fragmentation of production; Vertical specialization; General equilibrium model of trade; Trade patterns

JEL classification: F10; F12; F14.

<< Figures at the end of the paper >>

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1   Introduction

In the last few decades a rapidly increasing integration of the global economy has been observed. A general increase of trade/GDP ratios has been experienced by all the OECD countries. The reasons for this are usually said to involve the higher and higher share of services traded, the decline of transport cost and tariffs (trade liberalization), the greater similarity of countries' sizes (in the economic sense), etc. But as Jones and Kierzkowski (2001) argue another reason is the fact that a larger part of production activity is now intensively affected by trade.

Increasing competition in the world economy has forced producers to look outside their own borders to reduce costs. As Feenstra (1998) claims «the rising integration of world markets has brought with it a disintegration of the production process, in which manufacturing or services activities done abroad are combined with those performed at home». The result of this process has been defined as fragmentation of production.

A production process is fragmented when it is split into two or more steps that can be undertaken in different locations but that lead to the same final product. The decision to locate phases of the production process abroad should be determined by the presence of some kind of comparative advantage offered by the country chosen. But a new meaning for comparative advantage is required in this context: when fragmentation takes place, delocalization of production segments is not necessarily induced by differences in technology or in factor endowments as in the orthodox frameworks, but it can occur because of differences in the absolute level of labor cost. In fact, when the role of intermediate goods is considered, a trade flow can be originated by the existence of an absolute cost advantage and by the specific combination of phases of production taking place in different countries.

The ways in which international fragmentation of production takes place are many and that is why the same phenomenon is described in many different ways in the literature: delocalization of production, vertical specialization, outsourcing, etc. But, as Hummels et al. (2001) state, the key idea behind fragmentation is that «countries increasingly link sequentially to produce goods». And following their contribution strictly it can be said that it occurs when:

a) a good is produced in two or more sequential stages;

b) two or more countries provide value-added during the production of goods;

c) at least one country must use imported inputs in its stage of the production process and some of the resulting output must be exported.

An import side and an export side are thus involved in the definition, as long as vertical specialization is more than the share of intermediate goods in general trade; it is the subset of imported intermediates that will be embodied in exported goods.

So internationalization of production has made the trade flows change not only quantitatively, but also qualitatively.

According to Yi (2002) vertical specialization is not merely one of the reasons for the increase in the volume of world trade observed in the past half-century, but it is the key-reason. In fact, fragmentation of production «can serve as a propagation mechanism magnifying tariff reductions into large increases of trade», allowing for an explanation of the puzzle of the non-linearity of trade growth with respect to the observed decrease in the level of tariffs.

Fragmentation may be considered as a manifestation of globalization and technology combined. In fact, in some industries the possibility of splitting the process of production and coordinating the resulting parts has been possible only thanks to advances in technology.

But the fragmentation of production does not only affect efficiency, leading to cost savings and increases in trade. It also has a strong impact on domestic employment which is significantly different for skilled and unskilled workers. The absolute cost advantage that delocalization offers to developed countries in terms of unskilled wages will cause a movement of activities that intensively use unskilled labor towards developing countries. The domestic relative demand for unskilled workers will then fall in a similar way as replacing these workers with automated production. So as Feenstra (1998) claims: «this means that outsourcing has a qualitatively similar effect on reducing the demand for unskilled relative to skilled labor within an industry as does skill-biased technological change».

In this contribution I strictly focus on the effects of fragmentation on trade patterns. I shall proceed by discussing the main contributions to the theoretical treatment of the phenomenon, and the reliability of the indices used so far to measure it. I shall then present a general equilibrium model of trade and fragmentation that allows me to simultaneously take into account all the main findings of the theory. This framework will be empirically applied to understand how vertical specialization may affect the relative export of different countries in different ways. Evidence will be provided for French and Japanese exports, relative to the US, to the rest of the OECD.

2   Fragmentation and trade patterns: theory and evidence

Deardorff (1998) tries to explain fragmentation's implications on the basis of the textbook Ricardian framework of comparative advantages. He provides a clear and systematic theoretical treatment of the phenomenon, but he seems to overlook many important aspects both in terms of the causes and effects of fragmentation. In fact, he finds that if the country is specialized in the production of a certain good, X, and there is the possibility for a costly fragmentation of the X industry, the price conditions under which the country moves from one specialization to another might change slightly, but with non-significant changes in trade patterns. Instead, if fragmentation became possible in the import good industry, Y, under special price conditions, a comparative advantage in this good may rise. There will then be room for a significant change in the patterns of trade. But what is missing in the analysis of Deardorff is a clear distinction between exported final goods fully produced domestically and exported final goods produced by a fragmented technology. As Baldone et al. (2001) explain, comparative advantages can be derived unambiguously only for the first type of good as long as it fully incorporates the country specific relative endowment, technology and characteristics. In fact, the second type sums up different countries' specific advantages, so it would be misleading to say that the country exporting it is the one with a comparative advantage. Other factors should be taken into account such as possible absolute cost advantages (for example, those deriving from a specific combination of phases of production) which makes its export profitable for the country in which it is completed. Thus, with the presence of fragmentation of production the directions of trade will not follow just the suggestions of the standard theory, and comparative advantages are not the only determinants of trade patterns.

In a subsequent paper Deardorff (2001), in a Heckscher-Ohlin framework, provides an analysis of the effect of trade barriers, such as transport costs and tariffs, on fragmentation and finds that it can be both encouraged and discouraged[1]. So the presence of obstacles to the transactions and other trade costs cannot be ignored when the phenomenon is studied.

As we depart from the assumptions of orthodox frameworks (perfect competition, homogeneous products, etc.) to encounter the more realistic ones of the new theories (non-competitive markets, differentiated products, etc.) we face a significantly different approach to the theoretical treatment of the phenomenon of outsourcing.

Grossman and Helpman (2002a, 2002b), firstly define a general equilibrium

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[1] Intuitively, it is not difficult to see that if there is not a barrier to trade in a good, X, but there is one to trade in any intermediate input, Z, coming from the fragmented production of X, then fragmentation may become unprofitable even if it would otherwise lower costs. This happens every time a not very large tariff is required to raise the cost above the one resulting from producing X with the old technology. So a tariff may prevent fragmentation from occurring. On the other hand, if there is a barrier to trade in X, but none to trade in Z, then even costly fragmentation can be profitable.

model of industrial structure in which outsourcing and vertical integration (all the activities undertaken within the same firm) are considered as possible outcomes of an organizational process endogenous to a single industry, and then they extend their methodology in order to analyze the possible effects in a global market. The focus is on the so-called "make-or-buy" decision[2]. They show that, in a multi-industry model with differentiated products of consumption, the size of the country matters as long as it affects the "thickness" of its market. Furthermore, innovation in technology plays a crucial role as long as it affects the willingness of a partner to tailor its intermediates to the final product and to undertake investments in a prototype. But there are also some country specific conditions to be taken into account: the effectiveness of the search technology is influenced by the availability of good infrastructures for communication and transportation, and different contracting environments imply different profitabilities of outsourcing in different countries. These findings define a set of conditions for fragmentation to occur that are strictly related to the economic structures of the countries involved in the outsourcing process. Thus they reveal the capability of a country to engage in the international fragmentation of its own production activities and this capability can be expected to be clearly reflected in trade patterns.

Notwithstanding the early stages of the theoretical treatment of the phenomenon, an increasing amount of evidence about the increasing importance of the phenomenon has been provided. Unfortunately, the empirical work has so far been almost entirely based on a strict statistical analysis of trade flows and no relevant attempts to incorporate fragmentation in an empirical general equilibrium model of trade have been made.

Among the others, the contribution of Baldone-Sdogati-Tajoli (2001) seems to be particularly interesting. In order to observe the trends of the fragmentation of production within EU, they refer to the general concept of Processing Trade (PT)[3]. The advantage of these kind of measures is represented by the availability of data at high level of merchandise disaggregation allowing for a deep sectoral analysis, but there are two major drawbacks: they tend to underestimate the level of fragmentation that has actually occurred[4], and data are available just

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[2] The dilemma is about incurring the high cost of production faced by a vertically integrated firm, basically due to the large number of divisions to be managed and to the absence of the learning spillovers deriving from specialization, or to face the costs of outsourcing, represented by the possible frictions in the search for a partner and by the imperfect contracting due to the impossibility for a third part to verify the presence in the provided inputs of all the required attributes.

[3] PT is a particular EU trade regime which consist in a separate registration of flows concerning final goods with respect to those concerning intermediate goods exported (imported) temporarily in order to be processed and then re-imported (re-exported) by the country of origin. It can be broken into two specific components, Inward Processing Trade (IPT) and Outward Processing Trade (OPT), by means of which it can be stated if a country is either a destination of fragmented production activities or an origin of fragmentation activities.

[4] Fabbris and Malanchini (2000) point out that only the firms endowed with a licence and respecting some requirements (among the others, goods exported for processing should originate in the EU) can temporarily send Community goods outside the EU customs territory under this special trade regime.

for EU countries because of the juridical status granted to OPT within the EU trade legislation. Thus, measures like the ones discussed above cannot be used for a more general analysis that takes into account Non-EU countries as principals.

A different measure is proposed by Hummels et al. (2001). Their index allows the researcher to capture the amount of vertical specialization for a country that uses imported inputs to produce exported goods. The VS index for a country k in the sector (good) i is defined as the imported input content of exports ("share of imported inputs into gross production - IIGP" multiplied by "exports") or as the foreign value-added embodied in exports:

$$VS_{ki} = \frac{\text{imported intermediates}_{ki}}{\text{gross output}_{ki}} \text{ exports}_{ki} = \frac{\text{exports}_{ki}}{\text{gross output}_{ki}} \text{ imported intermediates}_{ki}.$$

The availability of data, provided by the OECD's Input-Output tables for a large number of countries, is certainly the main advantage offered by the VS measure, but there are at least three more technical advantages of the I-O tables that are worth considering: a) arbitrariness of classification schemes (what is "intermediate"? what is "final"?) is avoided, b) data are available for disaggregated sectors, c) imported inputs used "indirectly" in the production of exported goods are taken into account. The latter feature is very useful as long as it allows us to consider the case in which imported inputs «circulate through several stages of the domestic economy before "exiting" as an export».

On the other hand, it should be noticed that if there is a positive or negative correlation between the two components of the VS (IIGP and exports) within a sector, a computation that involves I-O sector-level data will be respectively downward or upward biased. So the VS measure must be handled carefully. However, this kind of measure tends to consider a large number of the many possible cases of fragmentation (one, two or more border crossings) while the OPT considers just a special case of transactions for processing purpose[5].

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[5]Fabbris and Malanchini (2000) underline that OPT is only a subset of vertical specialization defined in this far more general sense.

3 A general equilibrium model of trade and fragmentation

From the proposed theoretical and empirical survey I can round up the elements that seem to play the key-roles in the explanation of the effects of international fragmentation of production on trade patterns. Comparative advantages (differences in endowments and technologies) seem to act differently than usual with respect to the determination of trade patterns in a world with fragmentation of production, but they are still effective. So Ricardian and Heckscher-Ohlin theories should not be dismissed. On the other hand, the more realistic frameworks defined in the New Theories approach provide the instruments to catch significant features of the exchanges: differentiation of products and intra-industry trade, the role of the economies' sizes, the role of innovation in technology. Furthermore, trade barriers can both encourage and discourage fragmentation of production so they should be taken into account and possible country-specific effects cannot be ignored. Finally, in order to measure and evaluate the effect of the phenomenon it is necessary to consider the intermediate goods content of trade, but this should be achieved by means of an index that minimizes the possible measurement biases.

It seems clear that in order to consider such a wide range of elements, a very comprehensive framework is required. I believe this can be accomplished through the extension of the model proposed by Chaudhri and Hakura (2000). It is a framework set up on the basis of an integrated Ricardo-Heckscher-Ohlin-New Theories approach, which defines a general equilibrium model of trade with monopolistic competition.

3.1 The Model

Let I be the number of monopolistic-competitive industries in the J countries considered. It is possible to define the consumer demand for each variety produced in every single industry on the basis of a Dixit and Stiglitz (1977) utility function. Thus, assuming that the demand for final products and the demand for intermediates have the same form, country m demand for a variety produced in the sector i of a country j can be written as

$$d_i^{jm} = \frac{E_i^m \left(P_i^j B_i^{jm} \right)^{-\sigma}}{\sum_{k \epsilon J} n_i^k \left(P_i^k B_i^{km} \right)^{1-\sigma}}, \qquad (1)$$

where $i = 1, ...I$ indexes sectors, E_i^m is the total expenditure in country m on domestic and foreign varieties produced in the considered sector, $P_i^j B_i^{jm}$ is the price on country m's market of the variety produced in country j's industry ("home price for a foreign variety" multiplied by an "industry trade barriers index"), n_i^j is the number of firms (each producing one variety) in the sector i and σ is the elasticity of substitution that is assumed identical across industries.

The industry i export from country j to country m is defined as
$$X_i^{jm} \equiv n_i^j P_i^j d_i^{jm},$$

thus the relative export of a pair of countries $(j,\ k)$ to a third country's market (m) can be defined as

$$\frac{X_i^{jm}}{X_i^{km}} \equiv \left(\frac{n_i^j}{n_i^k}\right)\left(\frac{B_i^{jm}}{B_i^{km}}\right)^{-\sigma}\left(\frac{P_i^j}{P_i^k}\right)^{1-\sigma}. \qquad (2)$$

Assuming that each variety is produced in a plant with CRS and requires a certain fixed amount of headquarter services, it is possible to define the production function for every firm in the plant as

$$q_i^j = \alpha_i^j f_i^j, \qquad (3)$$

where q_i^j is the output of the firm, α_i^j is the technical coefficient (productivity) and f_i^j is the quantity of the composite factor employed in the firm.

f_i^j is a function of the vectors of primary factors, $\underline{v}_i^{pj}$, and intermediate goods, $\underline{z}_i^{pj}$, employed in the plant; it follows that $f_i^j \equiv \phi_i(\underline{v}_i^{pj}, \underline{z}_i^{pj})$, where the function $\phi_i(.)$ is homogeneous of degree 1 and identical across countries. Then equation (3) allows for technology differences among countries only of the Hicks-neutral type.

A unit of the composite factor can be employed incurring in the cost

$$C_i^j = \kappa_i(\underline{W}^j, \underline{P}_i^{zj}),$$

where $\underline{W}^j$ is the price vector for primary factors and $\underline{P}_i^{zj}$ is the price vector for intermediate inputs. The unit variable cost can be easily obtained from (3), $\dfrac{C_i^j}{\alpha_i^j}$, and from the profit maximization process we have

$$\frac{C_i^j}{\alpha_i^j} = \left(\frac{\sigma - 1}{\sigma}\right) P_i^j. \qquad (4)$$

The production of headquarter services requires a fixed amount of composite factor defined as a function of the primary factors $(\underline{v}_i^{hj})$ and intermediate inputs $(\underline{z}_i^{hj})$ employed

$$\overline{h}_i \equiv \phi_i(\underline{v}_i^{hj}, \underline{z}_i^{hj}).$$

The initial assumption of monopolistic-competitive market implies the following definition of the zero-profit condition

$$\frac{\overline{h}_i C_i^j}{q_i^j} + \frac{C_i^j}{\alpha_i^j} = P_i^j,$$

where $\overline{h}_i C_i^j / q_i^j$ is the unit fixed headquarter cost. Using the equations (3) and (4) we obtain

$$f_i^j = (\sigma - 1)\overline{h}_i. \qquad (5)$$

Let A_i^j represent the Total Factor Productivity of the industry i in the country j, defined as $A_i^j = \dfrac{Q_i^j}{F_i^j}$, where $Q_i^j \equiv n_i^j q_i^j$ is the industry output and $F_i^j \equiv n_i^j\left(f_i^j + \overline{h}_i\right)$ represents the total amount of composite factor employed in the industry. By (3) and (5) we can obtain the relation existing between the coefficient α_i^j (technology) and the TFP

$$\alpha_i^j = A_i^j \frac{\sigma}{\sigma - 1}. \qquad (6)$$

From equation (5) we can derive the number of firms in the industry i of the country j as a function of the total amount of the composite factor employed in the industry. From the definition of F_i^j we have

$$n_i^j = \frac{F_i^j}{\sigma \bar{h}_i}. \qquad (7)$$

Now it is possible to go back to equation (2) in order to enrich the export relation by incorporating the assumption and the results of the production side of the model. Using equations (4), (6) and (7) we can write

$$\frac{X_i^{jm}}{X_i^{km}} \equiv \left(\frac{F_i^j}{F_i^k}\right) \left(\frac{B_i^{jm}}{B_i^{km}}\right)^{-\sigma} \left(\frac{C_i^j}{C_i^k}\right)^{1-\sigma} \left(\frac{A_i^j}{A_i^k}\right)^{-(1-\sigma)}. \qquad (8)$$

The first component on the right-hand side (relative employment of the composite factor, F_i^j/F_i^k) proxies for the ratio of the number of firms in the industry, or the relative size of the two countries. The second component on the right-hand side, B_i^{jm}/B_i^{km}, accounts for trade barriers and trade costs. The relative cost of the composite factor, C_i^j/C_i^k, represents the Heckscher-Ohlin part of the model, accounting for endowments. The relative productivity term, A_i^j/A_i^k, takes into account possible Ricardian explanations in terms of Hick-neutral technical differences across industries and countries.

Further characteristics, such as innovation in technology and country-specific effects, can be introduced in the model's econometric implementation.

3.2 The econometric implementation

The model allows one to estimate the relative export, $\left(\dfrac{X_{it}^{jm}}{X_{it}^{km}}\right)$, of two countries (j,k) to a third one, of the goods produced in the sector i at time t, on the basis of the log-linear form of the equation (8),

$$\ln\left(\frac{X_{it}^{jm}}{X_{it}^{km}}\right) \equiv a_0 \ln\left(\frac{B_{it}^{jm}}{B_{it}^{km}}\right) + a_1 \ln\left(\frac{F_{it}^j}{F_{it}^k}\right) + a_2 \ln\left(\frac{A_{it}^j}{A_{it}^k}\right) + a_3 \ln\left(\frac{C_{it}^j}{C_{it}^k}\right) + e_{it}^m,$$
(9)

where $a_0 = -\sigma$, $a_1 = 1$, $a_2 = \sigma - 1$, $a_3 = 1 - \sigma$, e_{it}^m is a stochastic residual.

This kind of specification does not consider explicitly the effects of trade in intermediates as long as they are incorporated in the definition of the composite factor, F_i. In the equation, the intermediate inputs variable is isolated by the assumption that the industry total use of the composite factor in country j is defined by a Cobb-Douglas function

$$\ln F_{it}^j = k_i \ln K_{it}^j + w_i \ln L_{it}^j + \sum_r \theta_i^{zr} \ln Z_{it}^{jr}, \qquad (10)$$

where K_{it}^j is the quantity of capital used, L_{it}^j is the amount of labour employed, Z_{it}^{jr} is an aggregate measure of the intermediate inputs produced in sector r and employed in sector i; w_i, k_i and θ_i^{zr} are the shares of the three factors used to form one unit of the output[6].

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[6] Of course, the sum of the three coefficients will equal 1.

The intermediates component of the composite factor can be approximated by the following expression

$$\ln Z_{it}^j = \sum_r \theta_i^{zr} \ln Z_{it}^{jr} \cup \theta_i \ln \mathcal{Z}_{it}^j = \theta_i \left(\ln \mathcal{P}_{it}^j + \ln \mathcal{VS}_{it}^j \right), \qquad (11)$$

where θ_i is the overall share of intermediates in the formation of the composite factor, $\mathcal{Z}_{it}^j$ is an aggregate measure of the employment of intermediate inputs that can be decomposed into two parts: $\mathcal{P}_{it}^j$ represents the amount of domestic and imported intermediates employed in the production of goods sold on the domestic market, $\mathcal{VS}_{it}^j$ represents the imported intermediates content of export (vertical specialization).

Therefore, by means of (11) I can write equation (10) as

$$\ln F_{it}^j = \ln PF_{it}^j + \ln Z_{it}^j = \ln PF_{it}^j + \ln I_{it}^j + \ln VS_{it}^j, \qquad (12)$$

where the contributions of the primary factors, $\ln PF_{it}^j = k_i \ln K_{it}^j + w_i \ln L_{it}^j$, and the role of intermediates in the formation of the composite factor, $\ln I_{it}^j = \theta_i \ln \mathcal{P}_{it}^j$ and $\ln VS_{it}^j = \theta_i \ln \mathcal{VS}_{it}^j$, are considered separately.

In order to take into account the possible effects of technological innovation, I provide the equation with a new variable able to act as measure of the R&D effect. The assumption to make is about the form of the value-added function that is supposed to be a Cobb-Douglas of the following type

$$\ln Y_{it}^j = \ln \mathcal{A}_{it}^j + (1 - \varpi_i) \ln K_{it}^j + \varpi_i \ln L_{it}^j, \qquad (13)$$

where Y represents the output in the sector i, K is the capital employed, L is the labor employed, ϖ_i and $(1 - \varpi_i)$ are the proportions in which the two factors contribute to the formation of the value-added. Considering a shift of the curve due to the R&D, I can simply define a new function

$$\ln Y_{it}^j = \left(\ln \mathcal{TFP}_{it}^j + \ln \hat{R\&D}_{it}^j \right) + (1 - \varpi_i) \ln K_{it}^j + \varpi_i \ln L_{it}^j, \qquad (14)$$

where I assume the Solow residual to consist of two components, $\ln \mathcal{A}_{it}^j = \ln \mathcal{TFP}_{it}^j + \ln \hat{R\&D}_{it}^j$, the first accounting for total factor productivity and the second for the effects of investments in research and development activities.

The total use of the composite factor and the Solow residual are linked by the following output relation

$$\ln Q_{it}^j = \ln A_{it}^j + \ln F_{it}^j, \qquad (15)$$

where $\ln A_{it}^j = y_i \ln \mathcal{A}_{it}^j$, y_i being the share of value added in the value of output[7]. It follows that

$$\ln A_{it}^j = y_i \ln \mathcal{A}_{it}^j = y_i \left(\ln \mathcal{TFP}_{it}^j + \ln \hat{R\&D}_{it}^j \right) = y_i \ln \mathcal{TFP}_{it}^j + y_i \ln \hat{R\&D}_{it}^j = \ln TFP_{it}^j + \ln R\&D_{it}^j. \qquad (16)$$

I can compute the unit cost for the employment of the composite factor by the relation

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[7]Of course, we can write $k_i = y_i(1 - \varpi_i)$, $w_i = y_i \varpi_i$.

Thus, $\ln Q_{it}^j = \ln A_{it}^j + \ln F_{it}^j = y_i \ln \mathcal{A}_{it}^j + \ln F_{it}^j = $
$y_i \left(lnY_{it}^j - (1 - \varpi_i)K_{it}^j - \varpi_i L_{it}^j \right) + k_i \ln K_{it}^j + w_i \ln L_{it}^j + \sum_r \theta_i^{zr} \ln Z_{it}^{jr} = $
$y_i lnY_{it}^j - y_i(1 - \varpi_i)K_{it}^j - y_i \varpi_i L_{it}^j + k_i \ln K_{it}^j + w_i \ln L_{it}^j + \sum_r \theta_i^{zr} \ln Z_{it}^{jr} = $
$y_i lnY_{it}^j + \sum_r \theta_i^{zr} \ln Z_{it}^{jr}.$

$$\ln C_{it}^j = k_i \ln R_t^j + w_i \ln W_t^j + \sum_r \theta_i^{zr} \ln P_{it}^{jr},$$

where R_t^j is the rental rate in the country j, W_t^j is the wage rate in the same country[8], P_{it}^{jr} is the price index for the intermediates. This index is affected by the number of varieties produced in the industry and by their domestic and foreign prices. Anyway, if inter-country differences in prices are assumed to be small, the computation of the unit cost of the composite factor can be simplified by considering the intermediates' prices equal in all the countries ($P_{it}^{jr} = P_{it}^{kr}$) and the inputs traded and produced in monopolistic-competitive sectors. Thus I have

$$\ln \mathcal{C}_{it}^j = (1 - \mathbf{e}_i) \ln R_t^j + \mathbf{e}_i \ln W_t^j, \qquad (17)$$

and $\ln C_{it}^j = y_i \ln \mathcal{C}_{it}^j.$

The variable accounting for trade barriers should take into consideration all the possible ways in which the obstructions to trade could rise: tariffs, non-tariff barriers, transport cost. Such a composite index cannot be computed because of the extreme variability of trade barriers across country pairs and time. I can then decompose the variable into two elements accounting respectively for specific time and country pair effects in a given market m,

$$\ln \frac{B_{it}^{jm}}{B_{it}^{km}} = \beta^{jkm} + \beta_t^m. \qquad (18)$$

Through (12), (16) and (18), I can finally restate the export relation as

$$\ln \frac{X_{it}^{jm}}{X_{it}^{km}} \equiv \beta^{jkm} + \beta_t^m + a_1 \ln \frac{PF_{it}^j}{PF_{it}^k} \frac{I_{it}^j}{I_{it}^k} + a_2 \ln \frac{VS_{it}^j}{VS_{it}^k} + a_3 \ln \frac{TFP_{it}^j}{TFP_{it}^k} +$$

$$a_4 \ln \frac{R\&D_{it}^j}{R\&D_{it}^k} + a_5 \ln \frac{C_{it}^j}{C_{it}^k} + e_{it}^m.$$

This is the equation[9] that will be tested empirically.

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[8] The assumption of free mobility of factors ensures that both the rental and wage rates are equal in all sectors.

[9] I consider jointly the role of primary factors (PF_i) and that of domestic and imported intermediates employed in the production of goods sold on the domestic market (I_i). The reason for this is that only VS_i can be considered as a clear manifestation of international fragmentation of production. In the data in my possession, imported intermediates due to fragmentation incorporated in I_i cannot be clearly distinguished from the intermediates share of general trade.

4 A Case Study: The Effects of Fragmentation on the Trade Patterns of France, Japan and US

In order to estimate the general equilibrium model presented in the previous chapter, I have to create a database containing six variables (one dependent, five independent) for the manufacturing sectors of the different economies. The indeces are built on the basis of data available for most of the OECD's members[10]. This gives me the opportunity to focus on the possible different effects of fragmentation of production on the trade patterns of three developed economies that are structurally different: France, Japan, US.

In fact, dissimilarities in endowments, technologies, sizes, innovation as well as different geographical characteristics may raise different opportunities to fragment the production processes and thus affect the exports in a different way. As we shall see below, countries like France and Japan present both a strongly different economic structure and a very different attitude torward fragmentation of production. To stress this difference I choose US as the benchmark and estimate two relations: the relative export of France with respect to US and the relative export of Japan with respect to US, both toward the rest of the OECD countries.

Some general idea about the ways in which fragmentation of production has been affecting the production process in the three countries over time and whether they present sensible discrepancies regarding their attitude to vertically specializing can be drawn through a closer look at trends in the employment of domestic and foreign intermediates[11]. A disaggregated manufacturing sector (11 industries) is considered[12].

4.1 United States

According to Hummels et al. (2001), the US is one of the countries that presents an increase in the overall VS share from 5% to 10% in the three decades that lie between 1970 and 1990. Feenstra (1998) points out that the US's preferred regions for outsourcing activities are Eastern Asia and Central America with Mexico playing a major role in the latter area.

For the manufacturing sectors I observe that the employment of domestic intermediates has been increasing in the early 1970s and has then remained constant (Fig. 1) while the shares of imported intermediate inputs over gross output present an upward trend for most of the industries (Fig. 2).

In Figure 3, the trends of the Vertical Specialization index (imported intermediates content of export) for the manufacturing sectors depict a significant

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[10] See Appendix B for the construction of the series.

[11] Drawing out the data from the OECD's Input-Output Tables, one can compute the sectoral "Domestic Intermediates/Gross Output" and "Imported Intermediates/Gross Output" ratios. The sectoral Vertical Specialization index as defined in Hummels et al. (2001) can be computed as well.

[12] See Appendix A for a detailed list of the sectors considered.

increase over the whole period with the Machinery, Transport equipments and Chemicals sectors providing a major contribution.

4.2 France

The structures of production and export of France present the typical key features of the developed European economies. Similarly to Germany, Italy and UK, about 70% of the export is toward the rest of the EU. For what concerns fragmentation of production, a common feature for the majority of EU members is the growing share of intermediate goods in total trade flows. This is pointed out by Fabbris and Malanchini (2000) who underline the increasing importance of Outward Processing Trade with respect to total trade. France together with Germany, Italy, the Netherlands and Austria, account for about 90% of total flows generated by European member states toward the Central Eastern Europe Countries (CEECs). Because of historical and economic connections, France was among the first to outsource activities to firms located in the Mediterranean basin (Northern Africa Countries) over the last few decades. But its dominance in this region seems to be progressively lost in favor of the upward involvement of Germany. On the other hand, the weight of France's activities in the CEECs has been significantly growing over the 1990s despite the first mover advantage enjoyed by Germany for proximity reasons both in geographical, economic and political terms. Baldone, Sdogati and Tajoli (2001) observe that France displays «a high propensity to international fragmentation of production both in terms of IPT and OPT».

Figures 4 and 5 show that, in the three decades (1970-1990), France experienced a considerable increase in the employment of imported intermediates as opposed to the negative trend in the domestic intermediates/gross output ratio with no significant differences across the manufacturing sectors. As a consequence, in the same time period, a remarkable rise in the VS index can be observed for the whole manufacturing sector with a primary role played by the Chemicals, Machinery and Basic Metal sectors (Fig.6).

4.3 Japan

Japan represents a notable exception to the general trend. As Hummels et al. (2001) notice «for every country but Japan, the VS share grew between the initial and final year of the sample». In particular, there is a drop in the overall VS share from 7.3% to 6.6%. But for the manufacturing sectors I find a slightly different reality. If the employment of domestic intermediates is generally constant over the whole period (Fig.7), the employment of imported intermediates shows an upward trend even if substantial differences can be observed across the industries (Fig. 8). However, the VS index is clearly increasing for the Manufacturing Sector considered as a whole, with sectors like Chemicals, Basic Metal, Food and Machinery being the more vertically specialized (Fig. 9).

On the basis of this first-sight comparison evidence it is clear that these

three countries present very dissimilar profiles, with the production structure of France being the most affected by the phenomenon of the international fragmentation as opposed to Japan that seems not to consider very attractive the perspective of vertically specializing its activities.

The US presents a profile located somewhere in the middle of the first two: it is not as "closed" as Japan, but it is not as "open" as France either. This is an ideal feature with respect to my intention to use this country as a benchmark case in estimating the model. In fact, I would expect fragmentation of production to have a more substantial effect on the relative export of the French compared to the one it has in the case of Japan.

4.4 Estimation of Relative Exports and Results

In order to cope more effectively with possible individual-specific effects, I define a fixed-effects model following the least-squares dummy-variable approach as it is described in Hsiao (1990). This is what is also called the "covariance model" and should help to take into account both quantitative and qualitative factors that could vary from sector to sector being specific to individuals.

In Table 1, I present the results obtained for France applying a panel data analysis to the data collected for 10 manufacturing sectors over a 15 year period.[13]

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[13] The variables are renamed as follows

$$\text{EXPORT} = \ln\left(\frac{X_{it}^{jm}}{X_{it}^{km}}\right), \quad \text{FACTOR} = \ln\left(\frac{PF_{it}^j}{PF_{it}^k} + \frac{I_{it}^j}{I_{it}^k}\right), \quad \text{VS} = \ln\left(\frac{VS_{it}^j}{VS_{it}^k}\right), \quad \text{TFP} =$$

$$\ln\left(\frac{TFP_{it}^j}{TFP_{it}^k}\right),$$

$$\text{R\&D} = \ln\left(\frac{R\&D_{it}^j}{R\&D_{it}^k}\right), \quad \text{COST} = \ln\left(\frac{C_{it}^j}{C_{it}^k}\right). \text{ Where significant, a time-trend is indicated}$$

with T.

In the model with Vertical Specialization, the dependent variable EXPORT is regressed over all the other variables, while, in the model without Vertical Specialization the variables incorporating intermediates (VS and I) are not considered.

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Table 1. Estimates FRANCE/US toward OECD 1980-1994

Dependent Variable: EXPORT

Panel of Annual Data from 1980 to 1994

10 manufacturing sectors out of 11 (missing Other Manufacturing)

Estimation Technique:	Model with VS	Model without VS
	Fixed Effects with Specific Individual Effects	Fixed Effects with Specific Individual Effects
FACTOR	0.29**	0.46**
	(7.02)	(4.42)
VS	0.87**	
	(9.19)	
TFP	0.03	0.88**
	(0.42)	(5.43)
R&D	0.62*	1.72**
	(2.53)	(8.84)
COST	-0.22**	-0.16
	(-2.98)	(-1.73)
Usable Observations	150	150
Degrees of Freedom	145	146
R-squared	0.56	0.39

NOTE: t-statistics in parenthesis. * = Signif. 5%; ** = Signif. 1%. See Appendixes A and B for the list of sectors considered and the construction of the series.

Under Fixed Effects the coefficients obtained are consistent with the predictions of the model[14]. Differences in sizes, the vertical specialization index, relative productivity and differences in R&D expenditures have a positive effect on relative exports while differences in endowments affect them negatively. The coefficients are highly significant (all null hypotheses rejected at 1% level, with the exception of TFP and RD) and the fit is acceptable. Specific time effects were found not to be significant. The inclusion of the intermediate inputs role and the isolation of the VS component of trade do improve considerably the fit of the model (ΔR-squared = 17%). Indeed, the model with vertical specialization seems to provide further information with respect to the simpler one. While in the latter the key-roles are played by the gap in the investment in Research & Development activities and differences in productivity, when fragmentation of production is taken into account, the absolute value of the R&D coefficient

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[14] The choice of the level of aggregation of factors and sectors and the interpolation of data for the VS variable could introduce an error in the measures of productivity and cost variables. Different results obtained under Random Effects could be credited to this. (See Appendix C for further results).

is significantly reduced and the Ricardian component loses its importance. A decrease in the value of the coefficient reporting the role of difference in sizes is observed as well. On the contrary, a slightly larger importance is gained by the Heckscher-Ohlin component. These findings suggest that fragmentation of production could have allowed France to cope with the possible gap in productivity, innovation and market size. The Vertical Specialization variable shows, in fact, a positive impact on relative export and seems to play the major role in these estimates. This result is not surprising if we consider that in the time period investigated France showed, as stated above, a strong attitude to vertically specializing its production activities, acting as a pioneer in the fragmentation of production. In the model with VS, comparative advantages seem not to play a major role in the explanation of French relative export: differences in technology are not significant, differences in endowments are highly significant but have just a slight impact.

As concerns Japan, the estimation of the model in the same time period and for the same number of sectors led to the results presented in Table 2.

Table 2. Estimates JAPAN/US toward OECD 1980-1994

Dependent Variable: EXPORT		
Panel of Annual Data from 1980 to 1994		
10 manufacturing sectors out of 11 (missing Wood)		
	Model with VS	Model without VS
Estimation Technique:	Fixed Effects	Fixed Effects
	with	with
	Specific Individual Effects	Specific Individual Effects
T	-0.84**	-2.15**
	(-3.27)	(-7.80)
FACTOR	0.64**	0.78**
	(11.61)	(3.74)
VS	-0.29**	
	(-3.90)	
TFP	1.13**	2.82**
	(3.15)	(6.57)
R&D	1.06*	2.61**
	(2.53)	(5.19)
COST	-1.18**	-2.11**
	(-3.79)	(-5.11)
Usable Observations	150	150
Degrees of Freedom	144	145
R-squared	0.74	0.54
NOTE:	t-statistics in parenthesis. * = Signif. 5%; ** = Signif. 1%.	
	See Appendixes A and B for the list of sectors	
	considered and the construction of the series.	

Under Fixed Effects I have highly significant coefficients (5% for R&D, 1% for all the other variables). In this case, an important role is played by the time-trend that in our model stands as a component of the trade barriers index. Since its impact is negative, we would say that an increasing integration (less trade barriers) between Japan and the other OECD countries has brought with it an increase in the relative export. This is true for both specifications. As in the French case, I observe a strong improvement in the empirical performance of the model passing from the case with no intermediates and VS to the one with intermediates and a specific consideration of the VS impact (ΔR-squared = 20%). What is found to be different here is that all variables exept VS seem to play a rather important role and the fragmentation of production has a negative impact on Japanese relative export. Furthermore, comparative advantages (both Ricardian and Heckscher-Ohlin components) have a rather strong impact on Japanese relative export. These results are very representative of both structural differences between the two economies when compared to the US and different attitudes toward the fragmentation of production.

As regards the different value of coefficients representing the impact of the Heckscher-Ohlin component, it should be considered that Japan is among the most disadvantaged countries with respect to endowments of raw materials. Krugman (1991) claims that «Japan must pay for its raw materials by running a trade surplus in manufactures, presumably by importing less. European countries do more then half their manufactures trade with each other; Japan has no neighboring advanced nation». This was especially true in the period considered in our analysis and should help us to understand why the negative sign for coefficient of the Vertical Specialization variable is not surprising at all.

For a long period of time Japan has been acting as an importer of raw materials more than of intermediate goods. If we focus on the Eastern Asian region we can see that, during the 1980s, Japan was actually exporting intermediate goods (mainly components for high-tech industries) and selling final products through domestic companies' affiliates. Furthermore, Park and Park (1991) argue that, in the very same region, the U.S. has been playing an opposite role: «The East Asian NICs depend on the U.S. market for their exports of manufactured products and rely heavily on Japan as a major supply source of capital goods, intermediate inputs, technology, and management know-how. As a group, the four economies have also accumulated a growing trade surplus from their trade with the United States while running a large and persistent deficit with Japan since around the early 1970s». On the basis of these considerations the negative impact of Vertical Specialization on Japanese exports in the 15 years considered in our analysis is amply justified. It is noteworthy that the negativity of the sign is driven by the major impact in the Japanese export performance of the sectors in which Japan suffers a gap in Vertical Specialization with respect to US. In fact, if we drop the Transport Equipment sector, the VS coefficient decreases dramatically and ceases to be significant[15].

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[15]Result of the regression mentioned can be found in the Appendix C. A regression was also run that considered just the sectors in which Japan tends to fragment its production

However, we would hardly expect this negative sign to be persistent. In fact, as Ernst and Guerrieri (1998) point out, since the early 1990s Japanese firms have «begun gradually to open their International Production Networks» showing an increasing localization of component sourcing in Asia as well as a rapid growth of the imports of electronics products after 1992. By consequence, considering that the high-tech industries account for the largest part of Japanese selling abroad, the imported intermediates content of exports is extensively growing. It is likely that if we could rely on a larger database, this trend would already be highlighted.

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activities more than US and another one that took into account just the sectors in which the US propensity to vertically specialize was prevailing. As expected, the sign for VS was positive in the first case and negative in the second. It should be noticed that the sectors considered in the latter case included Fabricated Metal Products, Machinery and Transport Equipment, which are the most important Japanese exporting sectors. I believe this finding supports the robustness of the negative sign obtained for VS in the general estimation.

5   Concluding Remarks

According to the theory there can be different reasons for a country to vertically specialize its production activities: for example, the existence of a comparative advantage in a phase of the production process or the exploitation of an absolute cost advantage. But when international fragmentation of production becomes possible, new comparative advantages may arise and new patterns of trade can be shaped: the decomposition of the value added chain may give a country a comparative advantage in a good where it had no advantages before. Furthermore, having a comparative advantage in a single part of the production process may allow a country to branch into international markets with no need to be an efficient producer of an entire good. In addition, countries engage in the formation of international production networks in order to combine possible scale economies with the flexibility of decentralization.

Thus, vertical specialization can affect the direction of trade of each country in different ways depending on factors like differences in economic structures (size, competitiveness of markets, innovation content of production), differences in the endowments of factors and differences in productivity.

The comprehensive general equilibrium model of trade and fragmentation of production presented in this paper tries to explain the trends in the relative export of different countries considering simultaneously these elements. The econometric implementation and its application to a case study show that the framework is able to highlight the possible dissimilarity in the impact of vertical specialization on the relative exports of different countries. In particular, I compared the French and Japanese export relative to the US toward OECD members for different manufacturing sectors.In the 15 years from 1980 to 1994 I found that, through its positive effects, fragmentation seems to have allowed France to reduce the gap in terms of productivity and innovation with respect to United States. Comparative advantages instead have not much explanatory power. As regards Japan, I observed a significantly different picture: fragmentation of production played a very singular role with its impact being negative in the sectors in which the country enjoyed a better export performance. This is explained by the Japanese propensity to provide intermediate inputs, technology and capital in those sectors to its commercial partners (especially East Asian developing countries) in the period considered. Furthermore, Japanese relative export seems to follow the prediction of the standard theory of comparative advantages.

The bottom line is that the impact of fragmentation of production on trade patterns is not one-way and, as expected, depends strictly on the structural characteristics of the participants in the formation of international value chains.

These results are consistent with what has been found in the past through the statistical analysis of trade flows. But for the first time they come out from an all-inclusive theoretical and empirical framework. This allows us to know more about the ways in which the international fragmentation of production affects trade patterns.

A The Manufacturing Sectors Taken into Account

In bold the sectors considered:

Total Manufactoring
  Food Products, Beverages and Tobacco
    Food Products and Beverages
    Tobacco Products
  Texitiles, Textiles Products, Leather and Footwear
    Textiles and Texitile Products
      Textiles
      Wearing Apparel, Dressing and Dying of Fur
    Leather, Leather Products and Footwear
  Wood and Products of wood and cork
  Pulp, Paper, Paper products, Printing and Publishing
    Pulp, Paper and Paper Products
    Printing and Publishing
  Chemical, Rubber, Plastic and Fuel Products
    Coke, Refined Petroleum Products and Nuclear Fuel
    Chemicals and Chemical Products
    Rubber and Plastic Products
  Other Non-Metallic Mineral Products
  Basic Metals
      Iron and Steel
      Non-ferrous Metals
  Fabricated Metal Products
  Machinery and Equipment
    Machinery and Equipment
    Electrical and Optical Equipment
      Office, Accounting and Computing Machinery
      Electrical Machinery and Apparatus
  Transport Equipment
    Motor Vehicles, Trailers and Semi-Trailers
    Other Transport Equipment
      Building and Repairing of Ships and Boats
      Aircraft and Spacecraft
      Railroad Equipment and Transport Equipment
  Other Manufacturing

B The Database

1. X_{it}^{jm} represents the value of country j's export toward country m of goods produced in sector i in thousands of US dollars. We draw out the series from OECD's Bilateral Trade Database.

2. Y_{it}^{j} is the added value at 1990 prices and purchasing power parity [PPP 1990, US$]. It can be draw out from ISDB where it is named GDPD.

3. K_{it}^{j} is the gross capital stock at 1990 prices and purchasing power parity [PPP 1990, US$]. It can be taken from ISDB where it is named KTVD.

4. L_{it}^{j} is the total employment in the sector i of country j and it can be taken from ISDB where it is named ET.

5. α_i is the coefficient of the labor contribution to the formation of the added value in the sector i. It can be computed as the average value in the considered period:

$$\alpha_{it} = \left(\frac{WSSS * ET}{EE} \right) / GDP$$

where WSSS is the compensation per worker at current prices in national currency, ET is the total employment, EE is the number of employees, GDP is added value at current prices in national currency. All series are available on the ISDB.

6. $(1 - \alpha_i)$ is the coefficient of the capital contribution to the formation of the added value in the sector i and can be computed as a difference with respect to the α_i series.

7. y_i is the coefficient of the added value contribution to the formation of the output at current prices in the sector i. Thus it is a mean of the values computed for the considered period as a ratio of the following type

$$y_{it} = \frac{VALU}{PROD},$$

both the series are available on the STAN.

8. $k_i = y_i(1 - \alpha_i)$, $w_i = y_i \alpha_i$ and $\theta_i = 1 - k_i - w_i$.

9. $\hat{R\&D}_{it}^{j}$ is the Research & Development intensity (value added) for the sector i in country j as measured in the OECD's Main Industrial Indicators database. Thus $\ln \hat{TFP}_{it}^{j} = \ln \hat{A}_{it}^{j} - \ln \hat{R\&D}_{it}^{j}$.

10. VS_{it}^{j} is computed as in Hummels et al. (2001),

$$VS_i^j = \left(\frac{\text{imported intermediates}_i^j}{\text{gross output}_i^j} \right) \text{exports}_i^j, \text{ drawing the series out from}$$

the OECD's Input-Output Tables. $\hat{P}_{it}^{j}$ is obtained as the difference between

the total amount of intermediates (domestic and imported) employed in the sector i of country j and $\emptyset S_{it}^{j}$.

11. W_{it}^{j} is the wage rate computed as

$$W_{it}^{j} = \frac{WSSS}{EE},$$

both the series can be taken from ISDB.

12. R_{it}^{j} is the return on capital in US$. We can follow Chaudhri and Hakura (2000) computing it as

$$R_{it}^{j} = (r + \delta)P_I$$

where r is the real interest rate (difference between the nominal long-term interest rate on treasure bills and the consumer price index). Both the series are available on the IMF's IFS; δ is the depreciation rate conventionally considered equal to 10%; P_I is the price of the investment good in US$ that can be computed as

$$P_I = \frac{ITD}{ITV * ER},$$

where ITD is the gross fixed capital formation at 1990 prices and 1990 PPPs (US$), ITV is the gross fixed capital formation at 1990 prices in the national currency, both the series are available in the ISDB. ER is the exchange rate (national currency per US$) and it is taken from the IMF's IFS.

The lack of the ITD, ITV series for Japan has been overcome computing the prices of the investment goods by the proxy

$$P_I = \frac{GDPD}{GDPV * ER},$$

where $GDPD$ is the added value at 1990 prices and 1990 PPPs (US$); $GDPV$ is the added value at 1990 prices in national currency. These series are available in the ISDB, as well.

C Other results

Table 3. Estimates FRANCE/US toward OECD 1980-1994 (Random Effects)

Dependent Variable: EXPORT		
Panel of Annual Data from 1980 to 1994		
10 manufacturing sectors out of 11 (missing Other Manufacturing)		
	Model with VS	Model without VS
Estimation Technique:	Random Effects	Random Effects
	with	with
	Specific Time Effects	Specific Time Effects
FACTOR	0.43**	0.51**
	(3.59)	(5.20)
VS	0.21**	
	(5.27)	
TFP	0.18*	0.96**
	(2.26)	(6.39)
R&D	1.61**	1.84**
	(7.68)	(10.30)
COST	-0.27**	-0.16*
	(-3.62)	(-1.99)
Usable observations	150	150
Degree of freedom	145	146
R-squared	0.42	0.44
NOTE:	t-statistics in parenthesis. * = Signif. 5%; ** = Signif. 1%.	

Table 4. Estimates JAPAN/US toward OECD 1980-1994 (Random Effects)

Dependent Variable: EXPORT		
10 manufacturing sectors out of 11 (missing Wood)		
	Model with VS	Model without VS
Estimation Technique:	Random Effects with Specific Time Effects	Random Effects with Specific Time Effects
INTERCEPT		-2.15**
		(-7.97)
FACTOR	0.65**	0.77**
	(18.31)	(3.74)
VS	-0.28**	
	(-4.20)	
TFP	0.58**	2.82**
	(4.82)	(6.67)
R&D	0.63*	2.61**
	(2.48)	(5.22)
COST	-0.53**	-2.11**
	(-4.24)	(-5.19)
Usable observations	150	150
Degree of freedom	145	145
R-squared	0.76	0.52
NOTE:	t-statistics in parenthesis. * = Signif. 5%; ** = Signif. 1%. See Appendixes A and B for the list of sectors considered and the construction of the series.	

Table 5. Estimates JAPAN/US toward OECD 1980-1994
(without Transport Equipment)

	Model with VS	Model With VS
Dependent Variable: EXPORT		
Panel of Annual Data from 1980 to 1994		
9 manufacturing sectors out of 11 (missing Wood and Transport Equipment)		
	Model with VS	Model With VS
Estimation Technique:	Fixed Effects with Specific Time Effects	Random Effects with Specific Time Effects
FACTOR	0.61**	0.66**
	(7.74)	(18.05)
VS	-0.13	-0.12
	(-1.11)	(-1.41)
TFP	0.98	0.49**
	(1.66)	(4.17)
R&D	1.42*	0.76**
	(2.03)	(2.86)
COST	-0.94	-0.52**
	(-1.77)	(-4.34)
R-squared	0.76	0.74
NOTE:	t-statistics in parenthesis. * = Signif. 5%; ** = Signif. 1%. See Appendixes A and B for the list of sectors considered and the construction of the series.	

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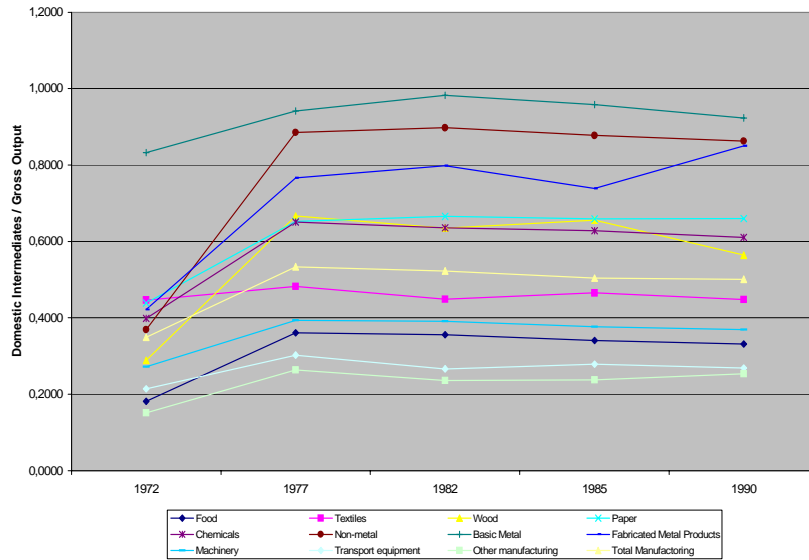
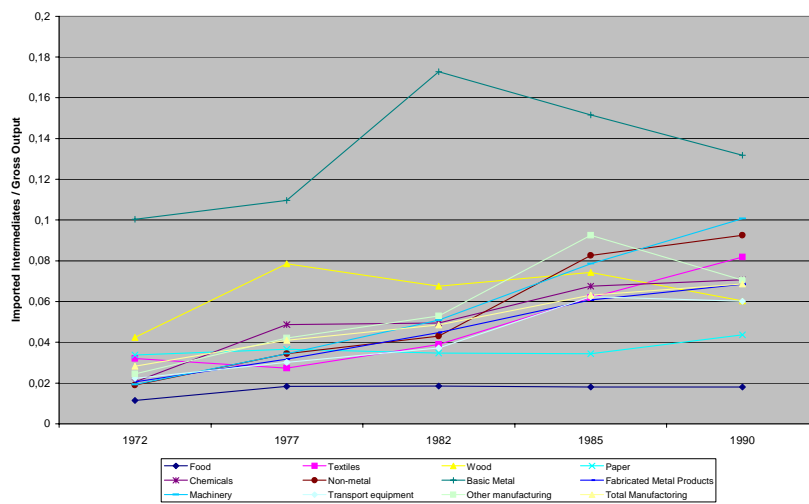Figure 1: US employment of domestic intermediates
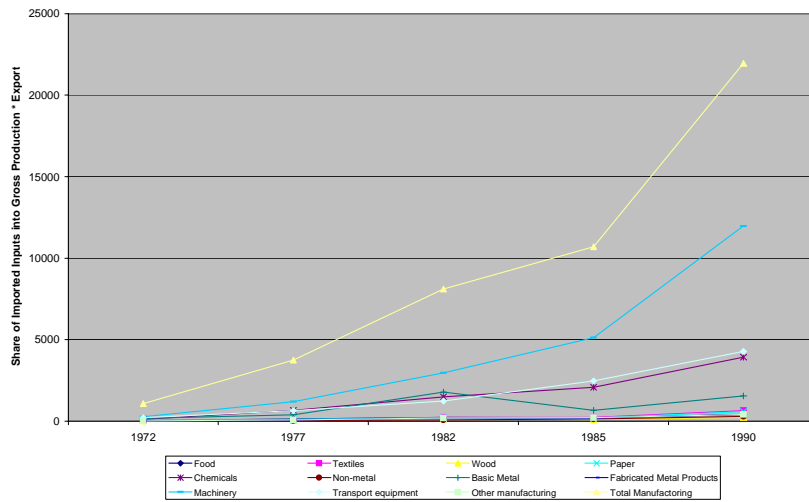

Figure 2: US employment of imported intermediates
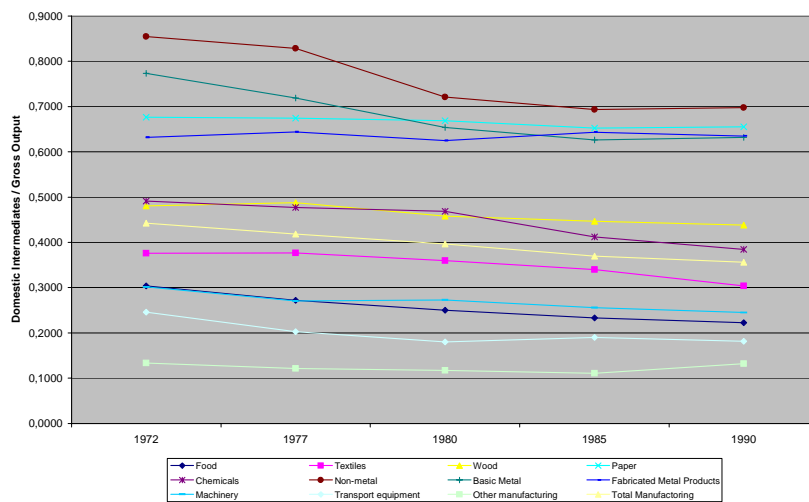
Figure 3: US Vertical Specialization

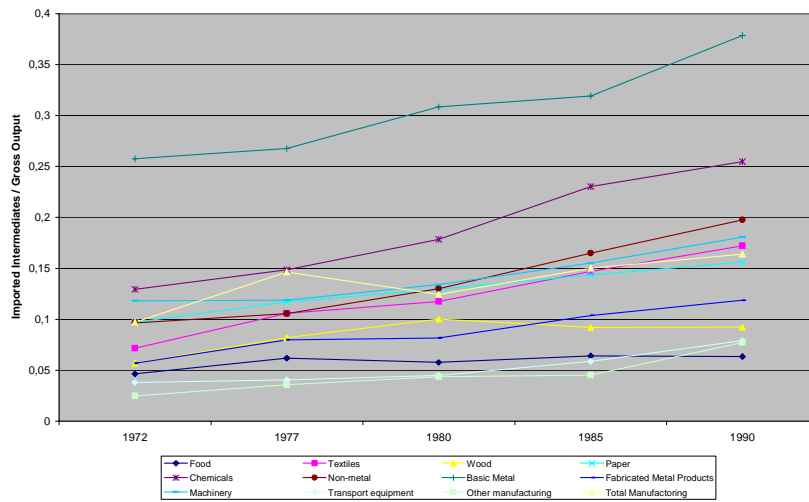Figure 4: FRANCE employment of domestic intermediates

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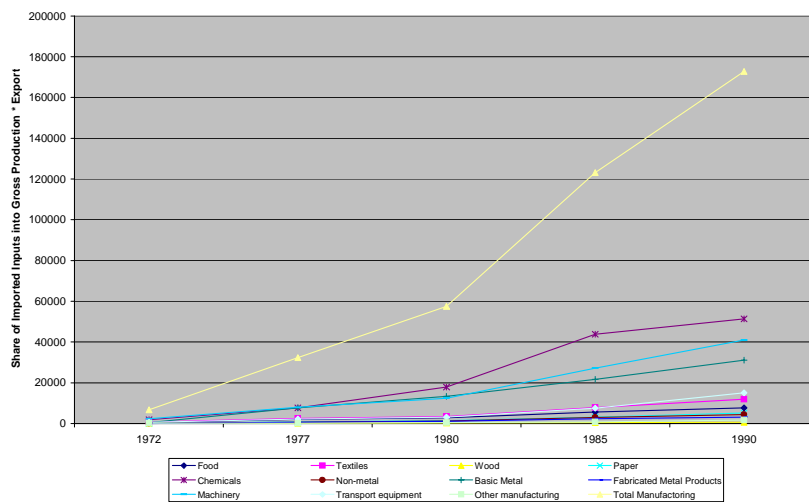Figure 5: FRANCE employment of imported intermediates
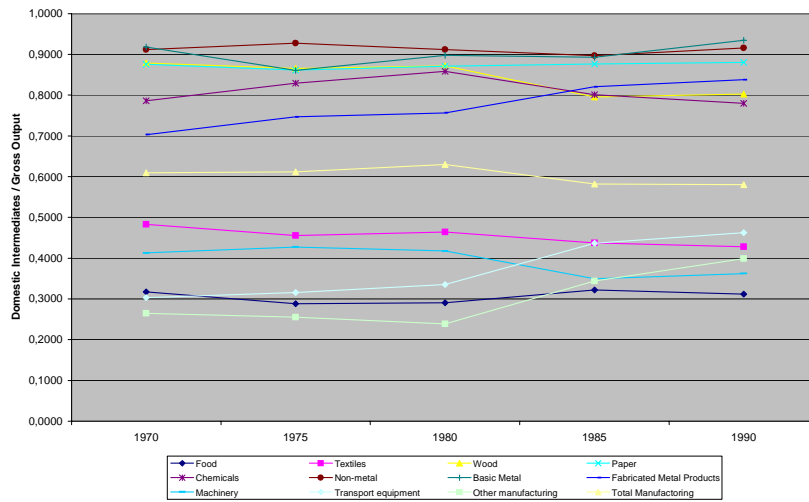

Figure 6: FRANCE Vertical Specialization

29

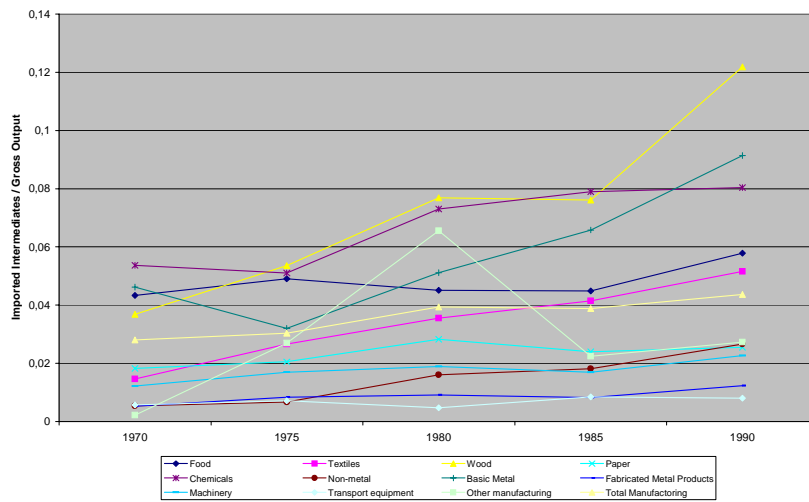Figure 7: JAPAN employment of domestic intermediates
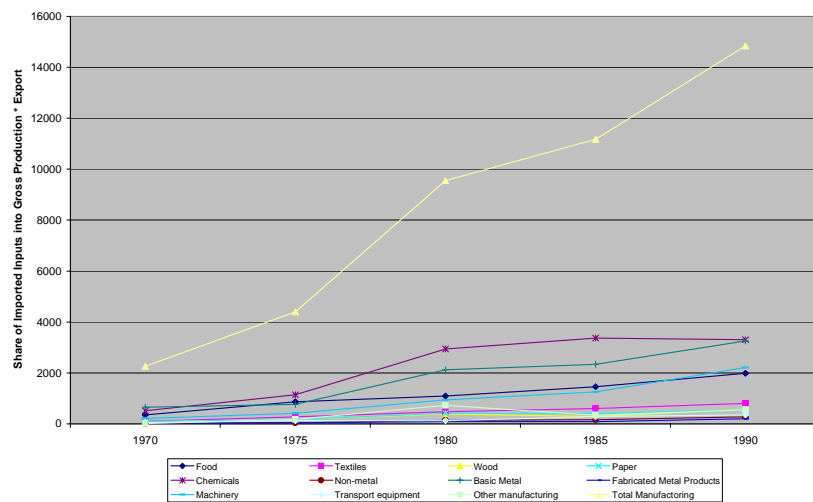

Figure 8: JAPAN employment of imported intermediates

Figure 9: JAPAN Vertical Specialization