THE ROLE OF COMPARATIVE ADVANTAGE IN TRADE WITHIN INDUSTRIES: A PANEL DATA APPROACH FOR THE EUROPEAN UNION

Abstract

A large share of EU Member States trade is intra-industry trade (IIT) in the period 1985-1996, specially IIT based on products differentiated in quality (vertical IIT). Moreover, exports from southern countries are located mainly at the lower end of the price-quality spectrum, whereas those countries with higher incomes per capita are located at the higher end. According to the vertical IIT models, we hypothesize that commercial specialization of Members States over the quality spectrum within industries is explained by differences in technological, physical and human capital. The results show that comparative advantage is an important driver of the pattern of European trade within industries.

Key words: Intra-industry trade, quality differences, commercial specialization, comparative advantage.

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1. INTRODUCTION

The purpose of this paper is to examine intra-industry trade (IIT) in the EU Member States and to study its determinants. We focus on vertical intra-industry trade in the period 1985-1996. In these years, European integration accelerated, reflecting a greater appreciation of its economic and political benefits. Nevertheless, there are few studies about the consequences of the Single Market on intra-industry trade of every EU Member State[1].

European integration has had liberalizing effects on the flows of goods and productive factors between participating economies. Integration involves an intensification of economic relationships, particularly trade relationships, in those countries which have decided to reduce or eliminate trade barriers. In this broader sense, the analysis of integration effects on the commercial specialization has been one of the main purposes of research during the last few decades. The earliest empirical studies (Balassa, 1966; Grubel and Lloyd, 1975) showed that tariff reductions had promoted intra-industry trade in the European Economic Community. However, Globerman and Dean (1990) and Greenaway and Hine (1991) noticed that the growth of the intra-industry trade in the first half of the eighties was less than in previous decades. This fact seemed to reflect a change in the trend and the possibility of a greater inter-industry specialization in accord with more advanced European integration. Nevertheless, recent analysis (Fontagné, Freudenberg, and Péridy, 1997; Brülhart and Hine, 1999) shows an intensification of intra-industry trade in the European Union.

Recent empirical work has focused on investigating the nature of IIT. IIT based on horizontally differentiated products (HIIT) is explained by the existence of scale economies and imperfectly competitive markets. The models of IIT based on vertically differentiated products (VIIT) introduce comparative advantage as an explanation of these flows. For example, Falvey (1981) and Falvey and Kierzkowski (1987) developed a model in which differential factor endowments between partner countries explain IIT. They supposed that the capital intensity needed in the production process is greater for higher qualities of the differentiated products. On the other hand, Greenaway and Milner (1986) noted the importance of the human capital in producing high quality varieties of differentiated products. Likewise, Flam and Helpman (1987) emphasized technological differences between countries as determinants of intra-industry flows.

[1] See Fontagné, Freudenberg, and Péridy (1997) for the period 1980-1994.

So, comparative advantages deriving from a combination of differences in physical capital, human capital and technology may explain VIIT.

The structure of the paper is as follows. The next section reviews the theoretical foundations of intra-industry trade models. The third section analyses the importance and nature of IIT over the period 1985-1996. In section four, we present an empirical model with high quality VIIT as the dependent variable. We test the hypothesis that specialization in high quality exports is explained by comparatives advantages based on differences in technological, physical and human capital endowments. The final section concludes.

2. THEORETICAL FOUNDATIONS

Attempts to explain IIT have followed a number of different approaches over the last few decades. There is first, a traditional approach to IIT, which considers that goods are horizontally differentiated. In these models (Krugman, 1979; Lancaster, 1980; Helpman, 1981), IIT opens up in monopolistically competitive markets, with increasing returns to scale on the supply side and diverse consumer preferences on the demand side. Helpman and Krugman (1985) add factor endowment differences in a model that explains the co-existence of intra and inter-industry trade. They consider two countries (A and B), two factors (labour and capital) and two goods: a homogeneous commodity which is relatively labour intensive and a differentiated product which is relatively capital intensive. If country A is relatively labour abundant and country B is relatively capital abundant, Helpman and Krugman show how the first country tends to export the homogeneous good and both of them import the differentiated good. This kind of model predicts that IIT will decline as countries' factor endowments diverge.

An alternative IIT analysis involves models with vertically differentiated products. An example is Falvey (1981), later developed by Falvey and Kierzkowski (1987). In their theory, IIT will take place in a perfectly competitive market, with two countries (A and B), two goods (a homogeneous product and a differentiated one) and two factors (capital and labour). To avoid that the pattern of trade would be undetermined, the authors introduce technological differences between countries but only in the homogeneous product sector. So, this is a sector of Ricardian kind whereas differentiated product sector is of Heckscher-Ohlin kind. Relating to the differentiated product sector, it is assumed that more capital is used in producing higher quality varieties of the differentiated good than in lower quality varieties. So, capital-abundant countries would specialize in exporting higher-quality varieties and labour-abundant countries in the lower-quality varieties. In this sense, it is an application of Heckscher-Ohlin paradigm for IIT[2]. Nevertheless, there are two principal differences: on the one hand, capital once created is a factor of production that is industry-specific and is mobile between firms within a given sector, but immobile between sectors. On the other hand, vertical product differentiation exists at least in one sector. Demand aspects are elaborated in Falvey and Kierzkowski (1987). It is considered that every consumer prefers high-quality varieties but they consume other varieties for the same reason that they consume different quantities of goods: because their incomes differ. In this way, as incomes increase, consumers switch from lower-quality varieties to higher-quality varieties. Furthermore, different income levels in each economy guarantee demand for every variety produced and IIT emerges.

A similar vertical IIT model is Flam and Helpman (1987), in which the North-South trade structure is determined by technological differences, income differences and income distribution differences between the North and the South. The source of quality differentiation is not the amount of capital used in producing the product, like in the Falvey and Kierzkowski (1987) model, but the technology used[3]. Labour input per unit output of the quality differentiated product differs between countries and the North has comparative advantage in high quality products. So, the North exports industrial products of high quality and imports industrial products of lower quality from the South. Given an overlap in income distribution, IIT emerges.

In addition, other authors try to explain IIT without changing traditional trade theory. An example is Davis (1995) who introduces technical differences between countries as a new element in a Heckcher-Ohlin-Ricardo model. He considers two countries, three goods, two of them belonging to the same industry and a third of another industry, and two factors (capital and labour). The two intra-industry goods are produced under identical factor intensity (both of them are capital-intensive relative to the third product), but the author assumes small cross-countries technological differences in the production of one of these goods. Due to this technical advantage, only one country can produce that product. As there is demand for the two goods of the same industry, IIT occurs and can be explained by comparative advantage. So, traditional Ricardian determinants of trade (technical differences between countries) induce to an intra-industry specialization and IIT.

[2] These models are named neo-Heckscher-Ohlin models (Greenaway and Milner, 1986).

[3] A third model based on vertical differentiated products is Shacked and Sutton (1984), in which technology investments determine quality differences but in an imperfectly competitive market setting.

The introduction of technological differences among countries as a source of comparative advantage[4] invalids the H-O hypothesis that the international dissemination of technology is a smooth and cost-free process. This is not a realistic hypothesis, because numerous imperfections in the international technology market exist. So, if we consider that vertical differentiation of products depends on the existence of gaps in the technological capacity of the countries, the most technological advanced countries will be specialized in high qualities products relative to competitors.

Thus, the theoretical literature argues that VIIT determinants and HIIT determinants differ. This may explain why those econometric analysis which have total IIT (vertical and horizontal) as their dependent variable may be misspecified. It is necessary to investigate determinants of HIIT and VIIT separately.

In this paper, our purpose is to estimate determinants of commercial specialization by product quality among EU-12 Member States, according to VIIT models. In these models, VIIT occurs as a consequence of comparative advantage which is based on technological differences and on factor endowment differences. So both Ricardian and Heckscher-Ohlin influences would matter in the specialization along quality ranges in the intra-EU trade. When a country is more capital-abundant (technological, physical and human capital), its exports of vertically differentiated goods will be of a higher quality.

3. INTENSITY AND NATURE OF INTRA-INDUSTRY TRADE AMONG EU MEMBER STATES

In this section, we analyse the extent, nature and dynamics of IIT in intra-EU exchanges from 1985 to 1996. To measure IIT, we use Grubel and Lloyd's (1975) index: it reflects the proportion of balanced trade of the country *j* (overlap between exports *X* and imports *M*) in intra-EU trade in a given industry *i* in the year *t*[5]:

[4] See Dollar (1993) and Harrigan (1997) who defend that technology differences are a source of comparative advantage and an important determinant of specialization.

[5] These indices are calculated from aggregate flows between each Member State and its fellow EU Members. In this way, the indices obtained can be overestimated due to geographical aggregation.

$$IIT_{itj} = \left[\frac{X_{itj} + M_{itj} - | X_{itj} - M_{itj} |}{X_{itj} + M_{itj}} \right] \cdot 100 = \left[1 - \frac{| X_{itj} - M_{itj} |}{X_{itj} + M_{itj}} \right] \cdot 100$$

The index is equal to 100 if all intra-EU trade of the country *j* is IIT and it is equal to 0 if all trade is inter-industry trade. As Fontagné, Freudenberg and Péridy (1997) do, a threshold of 10% for trade overlap is introduced, i.e., only when the minority flow represents at least 10% of majority flow, that overlap is considered IIT. Below that threshold, the trade overlap cannot be considered significant and we define these flows as inter-industry exchanges.

In this work, the indices have been calculated at the 6-digit level of Nimexe and Combined Nomenclature[6] in order to avoid statistical aggregation (about 5,500 items). Later, we aggregate them to 13 manufacturing sectors which distinguish the NACE-CLIO R25, linking trade data supplied by Eurostat to a production nomenclature.

We can aggregate these 13 manufacturing sectors into three groups, according to their technological intensity and demand dynamism[7]. Advanced manufactures or manufactures with high technological intensity and high demand growth include two sectors: office and data processing machines; and electrical goods. Intermediate manufactures or manufactures with medium technological intensity and medium demand growth include four branches: chemical products; rubber and plastic products; agricultural and industrial machinery; and transport equipment. Traditional manufactures or manufactures with low technological intensity and low demand growth include seven industries: basic metals; metal products; non-metallic minerals and mineral products; food, beverages and tobacco; paper and printing products; textiles and clothing; and other manufacturing products.

The examination of the IIT significance among EU Member States (Table 1) suggests the following conclusions. Firstly, for the EU average, IIT increased over the period analysed, from 45% to 57% of the intra-EU trade. Nevertheless, important differences between the European countries can be observed. This diversity is shown in the vertical dimension of Chart 1. In 1985 only two countries, Germany and France, were characterized by a high share of IIT in their trade

[6] See Díaz Mora (2001).
[7] This classification is proposed by Myro and Gandoy (1999). It joins offer aspects (using a classification of technological content from OECD) and demand aspects (following the Commission of European Communities).

with other Member States. In 1996, in most cases IIT dominates. Every European country increased its IIT, but the shift is greater in those economies which have joined to the EU recently (Greece, Spain and Portugal), bringing them closer to EU average. Thereby, progress in European integration has promoted an intra-industry commercial specialization, as other authors found in previous decades.

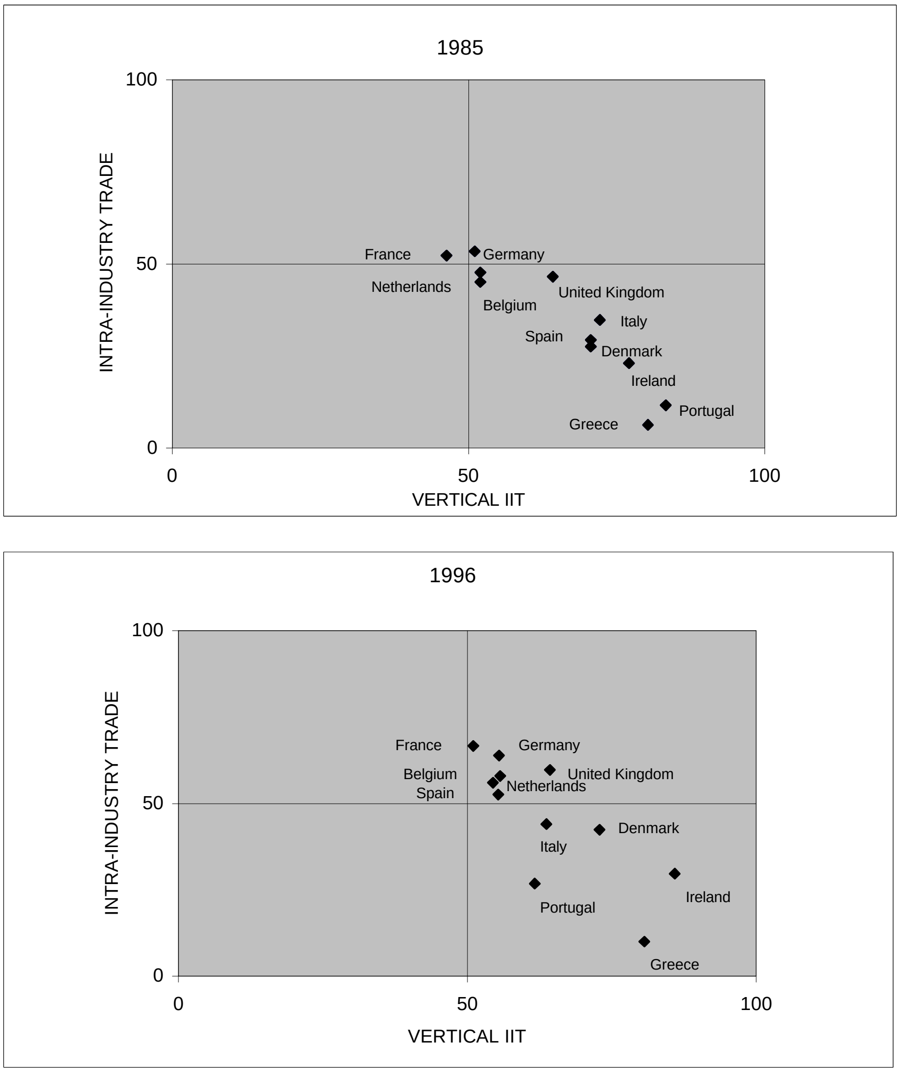
TABLE 1: NATURE OF INTRA-INDUSTRY TRADE[1] WITHIN THE EU BY COUNTRY (1985-1996)

	Intra-Industry trade (% of intra-EU trade)		Vertical IIT (% of IIT)		High-quality VIIT (% of VIIT)	
	1985	1996	1985	1996	1985	1996
France	**52,3**	**66,6**	46,3	51,0	**62,8**	**61,4**
Belgium	45,1	**58,0**	52,0	55,6	**51,2**	**61,2**
Netherlands	47,7	**55,9**	51,7	54,4	**60,3**	**63,5**
Germany	**53,4**	**63,9**	51,0	55,5	**68,6**	**68,9**
Italy	34,8	44,0	**72,2**	63,4	21,6	38,3
United Kingdom	46,5	**59,7**	64,2	64,3	**55,4**	**56,5**
Ireland	23,1	29,6	**77,1**	**85,9**	**59,4**	**67,3**
Denmark	27,6	42,4	**70,6**	**72,9**	**58,1**	**69,7**
Greece	6,2	11,2	**80,3**	**80,6**	24,4	48,6
Portugal	11,7	26,7	**83,6**	61,7	45,8	29,7
Spain	29,4	**52,5**	**70,6**	55,4	43,4	37,7
EU-12[2]	45,5	**56,7**	55,2	57,2	**56,0**	**59,0**

(1) Unadjusted Grubel-Lloyd indices calculated from Nimexe and CN 6-digit statistics from COMEXT database, for manufactured products.
(2) Average of 11 countries, weighted by values of intra-EU manufactured imports and exports.

These results are similar to those obtained in recent studies which measure IIT for each Member State of the European Union (Table 2). For example, Brülhart and Hine (1999) provide a descriptive survey of IIT among 12 EU countries in the 1961-1992 period. Their analysis indicate that, after an IIT stagnation for the 1980s, there has been an increase in IIT in the run-up to the implementation of European Single Market. Even so, in some Member States like Greece, Portugal, Ireland and Italy inter-industry trade is predominant. Their IIT indices are lightly above ours, but the tendency is similar, with the higher rates of IIT growth in Spain and Portugal. Although being based on a different methodology, Fontagné, Freudenberg and Péridy (1997) results are compatible with ours: between 1980 and 1994 IIT increased for most European countries, while the rise most important is for Portugal and Spain again. Only for Ireland, Denmark, Greece and Portugal IIT represents less than half of all intra-EU trade. So, according with the most recent research, the Single Market did not promote an increase in inter-industry specialization, against certain predictions[8].

CHART 1: TRADE TYPES IN INTRA- EU FLOWS BY COUNTRY (1985-1996)



[8] See Motta (1990) and Krugman (1991), who warned about the probable increase of inter-industry specialization faced the removed of trade barriers due to the implementation of the Single Market.

TABLE 2: MAIN RESULTS OF EMPIRICAL STUDIES WITH REFERENCE TO IIT AND ITS NATURE IN INTRA-EU TRADE

	Fontagné, Freudenberg, and Péridy (1997)			**Brülhart and Hine (1999)**			**Diaz Mora (2000)**		
	Period	Two-way Trade[1]	Vertical T-W trade	Period	IIT[2]	Vertical IIT	Period	IIT	Vertical IIT
France	1980	**60**	63	1985	**68**		1985	**52**	46
	1994	**68**	65	1992	**72**		1996	**67**	51
Belgium	1980	**59**	59	1985	**56**		1985	**45**	52
	1994	**64**	64	1992	**60**		1996	**58**	56
Netherlands	1980	**55**	64	1985	**60**		1985	**48**	52
	1994	**61**	69	1992	**67**	53[3][4]	1996	**56**	54
Germany	1980	**59**	66	1985	**60**		1985	**53**	51
	1994	**67**	69	1992	**68**		1996	**64**	55
Italy	1980	**47**	75	1985	**52**		1985	35	72
	1994	**53**	68	1992	**51**		1996	44	63
United Kingdom	1980	**53**	70	1985	**62**	67[5]	1985	**46**	64
	1994	**64**	73	1992	**68**		1996	**60**	64
Ireland	1980	44	68	1985	40	70[6]	1985	23	77
	1994	42	81	1992	41		1996	30	86
Denmark	1980	32	78	1985	42		1985	28	71
	1994	40	80	1992	47		1996	42	73
Greece	1980	14	86	1985	15	79	1985	6	80
	1994	15	80	1992	15	80[4]	1996	11	81
Portugal	1980	10	90	1985	24	84[6]	1985	11	84
	1994	30	80	1992	31	73[4]	1996	27	62
Spain	1980	**30**	83	1985	**47**		1985	**29**	71
	1994	**54**	65	1992	**60**		1996	**52**	55
EU-12	1980	**53**	66	1985	**58**		1985	45	55
	1994	**61**	69	1992	**64**		1996	57	57

Note: IIT is expressed as percentage of intra-EU trade, whereas Vertical and Horizontal IIT is expressed as percentage of IIT.

(1) Calculated from 8-digit Combined Nomenclature and bilateral intra-EU flows from Eurostat, for total goods. With a trade overlap above 10%, trade in an item is considered to be two-way trade.
(2) Grubel-Lloyd indices calculated from SITC 5-digit statistics and aggregate flows from OECD, for manufacturing goods. EU-12 is an average of 11 countries, weighted by values of intra-EU imports and exports.
(3) Vertical and horizontal nature of IIT for all commodities.
(4) Data for 1990; (5) Data for 1988; (6) Data for 1987.

If we introduce the sectoral dimension, advanced manufacturing sectors show the highest IIT levels, followed by the intermediate ones and then, the traditional ones (Table 3) throughout the whole period. The high share of IIT in the advanced manufacturing sectors may be related to their greater degree of differentiation by kinds, quality and characteristics of goods and their greater external competition. Nevertheless, the sectoral order is different in those economies with a lower share of IIT (Ireland, Greece and Portugal), with a higher IIT index for the advanced and traditional industries in Ireland and Greece and the opposite behaviour in Portugal. It is notable that in the Spanish case the share of IIT in intermediate and traditional manufactures was similar to the average European levels in 1996, but remained lower in the advanced ones. This feature can be explained by the weaker development of these industries in Spain.

The methodology to measure the nature of IIT was proposed first by Abd-el-Rahman (1991) and also adopted by Greenaway, Hine and Milner (1994). It is assumed that differences in prices reflect quality differences and prices can be proxied by unit values which are been calculated per tonne. These unit values of exports and imports are calculated at the same level of statistical aggregation (6-digit) for the trade of each Member State with the whole EU. Therefore, products whose unit values are close in a year t are considered as similar. Trade products are considered to be similar (horizontal differentiated) if the export and import unit values differ less than ±15%, i.e., if the next condition is satisfied:

$$0.85 \leq UV\ (X_{ij})\ /\ UV\ (M_{ij}) \leq 1.15$$

where *UV* refers to unit value, *X* and *M* refer to exports and imports, *i* refers to the 6-digit Nimexe and CN products in the country *j*. When this is not the case, goods are considered to be vertically differentiated. So, IIT can be divided into IIT with horizontally differentiated products and IIT with vertically differentiated products:

$$IIT_{ij} = HIIT_{ij} + VIIT_{ij}$$

Moreover, VIIT is assumed to have two components, high quality (HQVIIT) and low quality (LQVIIT). A high share of LQVIIT means that a country is specializing into relatively low-price export goods in the vertically differentiated sectors. A high share of HQVIIT implies that VIIT takes the form of high-valued exports. If the relative unit value of a good is below (over) the limit of 0.85 (1.15), it is considered as a low (high) quality export.

Using the methodology described, this study shows that VIIT is the more important form of IIT in intra-EU trade (Table 1). High shares of VIIT in total IIT are associated with a high proportion of inter-industry trade in flows between Member States. Chart 1 illustrates this relationship. A country in the right quadrants has IIT of a preponderantly vertical nature, whereas it is of a horizontal nature if the country is in the left quadrant. The results distinguish two groups of economies. The first one, formed by countries which are situated in the top right quadrant, is characterized by an intra-industry commercial specialization. This group includes France, the Netherlands, Germany, Belgium, United Kingdom and Spain. For these economies, IIT is based on vertically differentiated products (64% in UK and about 55% in the rest). In the second group, economies in the bottom right quadrant, intra-EU trade is mainly inter-industry trade, and IIT is based on products with different qualities[9].

Although more than half of IIT comprises flows of vertically differentiated products, HIIT has growth more than VIIT in countries whose IIT is mostly of the vertical kind, especially Italy, Portugal and Spain. In the case of Portugal and Spain, however, the greater growth of horizontal IIT can be affected by changes in the tariff system of these countries. Some studies in Spain have pointed that dismantling of tariff barriers associated with Spain's membership in the EU seems to have led changes in export and import prices. In one hand, the removal of tariff barriers supposed a reduction of prices of imports from EU countries. In the other hand, the exports subsidies, widely used in some Spanish sectors, had to be eliminated. So, the trend towards horizontal IIT can be a result of these price changes.

If these results are compared with the quoted recent studies, many coincidences are found. According with Fontagné, Freudenberg and Péridy (1997) results, intra-EU two-way trade is more important for vertically differentiated products than for similar products for each Member State between 1980 and 1994. The evolution is also similar; those countries with higher shares of two-way trade in goods differing by quality in 1980 (Greece, Italy, Portugal and Spain) experienced a greater increase in horizontally differentiated products, while the rest of countries experienced a greater specialization over the quality spectrum. Brülhart and

[9] However these results vary when a threshold of 25% is used to measure HIIT and VIIT and only three Member States in 1996 has IIT of vertical nature mainly: Ireland, Denmark and Greece. In Italy, United Kingdom and Portugal, IIT is 50% horizontal and 50% vertical and in the rest of countries HIIT is the most important for of IIT.

Hine (1999) also offer information about the nature of IIT in some countries for the last years of 1980s. Like this, IIT is mainly of vertical nature in all countries considered: Netherlands, the United Kingdom, Ireland, Greece and Portugal.

By sectors, intra-EU IIT is mainly vertically differentiated in industries where the demand and technology content is classified as high, together with machinery and metal products. The majority of Member States show these sectoral characteristics. However, there are some exceptions. So, France is the only country with a similar share of vertical and horizontally differentiation in advanced manufactures. On the other hand, IIT is mainly of a vertical nature in all three types of industries in Ireland, Denmark and Greece (Table 3).

For each country, VIIT can be considered as high or low quality according to the relative unit values of imports and exports. The average European share of high-quality VIIT is about 60% of VIIT in 1985-1996 period (Table 1). The results suggest a clear specialization into relatively high-price export goods in the vertically differentiated sector in Denmark (69.7% of vertical manufacturing IIT are high-quality products), Germany (68.9%), Ireland[10] (67.3%), Netherlands (63.5%) and France (61.4%) and it is extended to all manufacturing industries, with very few exceptions. Belgium (61.2%) and the United Kingdom (56.5%) are on a second level due to certain traditional branches (and intermediate ones in the case of United Kingdom) with a preponderant of low-quality products in their vertical IIT. However, these countries can be considered specialized into relative high-quality export in intra-EU flows[11]. In fact, about 20% of intra-EU trade in these countries is based on high-quality products. In 1996, only the southern countries (Portugal, Spain, Italy and Greece) were specialized into low-quality exportation goods in vertical manufacturing IIT. Although there are some manufacturing industries which achieve to overcome initial comparative disadvantages and export relative high-quality products, mainly in advanced manufactures and traditional like food, beverages and tobacco and textiles and clothing (Table 3).

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[10] The Irish specialization in relative high-quality exports seems to be associated with foreign affiliates which play a leading part in using Ireland as a location of assembly lines devoted to furnishing the European market. This explains the high import content of high-quality exports (Fontagné, Freudenberg and Péridy, 1997).

[11] The shares of high-quality vertical IIT in these countries are even higher if a wedge of 25% is used.

TABLE 3: IIT TYPES IN THE EUROPEAN UNION BY INDUSTRY, 1996[1]

NACE-CLIO R-25	France			Belgium			Netherlands			Germany			Italy			United Kingdom			Ireland			Denmark			Greece			Portugal			Spain		
	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT	IIT	VIIT	HQ VIIT
Advanced	74.3	50.9	70.7	67.1	68.9	66.1	62.9	68.6	66.0	70.2	61.5	74.0	57.0	81.3	45.0	73.1	76.3	64.0	33.6	89.6	78.3	53.7	70.4	71.6	13.2	89.7	74.4	21.7	88.6	26.6	47.2	70.6	55.4
Office & data processing machines	75.9	35.3	76.5	73.1	60.6	60.9	67.6	73.6	64.8	73.2	55.5	45.8	68.6	83.8	64.4	78.8	69.7	75.0	31.0	86.1	96.0	53.3	72.5	92.9	5.4	89.3	48.4	22.6	93.5	62.4	40.7	55.5	70.1
Electrical goods	73.2	61.4	68.4	63.8	74.3	68.8	57.2	61.3	67.9	68.6	64.9	87.9	50.1	79.3	28.4	68.7	82.2	55.8	36.8	93.2	61.3	53.9	69.2	58.6	16.9	89.8	78.3	21.4	87.1	14.5	50.1	76.2	51.5
Intermediate	70.1	48.4	49.1	59.1	53.0	69.3	56.8	44.0	64.2	65.3	50.7	68.1	53.9	53.8	27.1	59.9	52.0	52.0	23.2	88.2	55.0	41.1	81.0	64.0	4.2	69.1	48.3	33.1	43.3	26.1	57.9	47.5	30.3
Chemical products	58.0	62.1	53.2	58.3	59.6	72.5	48.8	52.2	56.7	58.9	63.7	62.6	47.5	56.0	43.4	51.9	62.1	60.7	18.7	95.9	47.3	37.7	83.2	62.4	3.9	66.2	56.4	18.2	59.5	48.3	46.2	69.3	24.6
Rubber & plastic products	65.8	49.1	86.0	65.1	57.1	67.0	65.4	31.9	74.0	69.7	54.4	90.6	53.5	52.1	14.0	69.4	57.2	74.3	49.9	76.4	78.0	54.6	85.2	86.2	14.8	68.2	53.3	48.1	79.3	19.7	67.5	30.7	40.3
Agricultural & industrial machinery	71.6	67.2	53.3	63.9	90.5	56.8	66.7	58.6	75.7	59.8	79.9	82.5	55.3	82.0	19.5	57.7	78.7	42.6	36.7	94.4	55.3	55.0	76.2	65.7	4.2	73.0	27.8	19.4	87.5	22.0	62.3	80.7	18.6
Transport equipment	79.9	30.6	27.7	56.0	24.7	85.7	60.8	25.1	60.2	72.0	29.0	47.6	58.8	28.5	29.1	66.6	26.0	40.2	11.8	36.0	69.2	18.9	84.8	23.0	0.3	99.2	78.2	43.9	23.4	21.4	59.9	27.0	50.1
Traditional	58.7	55.1	72.8	54.2	54.5	49.2	51.0	55.1	60.8	58.6	59.0	66.7	29.7	67.2	48.2	49.8	70.6	52.9	31.1	79.0	60.8	38.8	68.2	73.6	15.0	81.0	43.6	23.4	74.2	33.1	46.6	63.7	39.3
Basic metals	60.9	31.3	64.0	45.3	27.6	39.3	47.0	50.7	66.9	62.9	34.5	77.7	38.6	44.8	42.3	52.6	49.3	27.0	15.8	82.9	45.0	38.7	47.1	71.7	25.5	40.7	10.1	13.3	48.3	44.3	42.5	45.1	21.5
Metal products	69.5	78.2	75.9	61.2	61.6	52.7	64.7	60.1	60.4	68.1	75.3	85.1	32.8	83.1	22.6	66.6	75.4	67.1	43.3	91.9	78.2	57.0	86.7	79.2	9.9	80.8	38.5	40.6	75.1	45.7	65.7	74.4	47.3
Non-metallic min. & min. products	55.8	58.0	71.6	49.0	71.6	61.9	52.5	55.6	63.3	52.1	60.8	81.9	30.1	67.2	37.6	50.6	75.3	57.2	32.1	94.7	67.2	38.9	57.1	62.0	6.6	98.8	29.9	26.6	45.0	29.6	43.5	66.4	38.5
Food, beverages & tobacco	46.5	44.8	70.9	52.2	55.9	43.8	37.0	56.3	71.6	50.7	55.7	31.3	24.0	76.6	64.3	38.8	68.9	48.0	25.2	64.8	58.5	28.0	55.0	72.3	9.1	91.9	14.5	20.2	62.5	64.3	35.6	55.4	36.2
Paper & printing products	71.3	48.3	60.2	70.6	45.2	39.4	70.4	37.0	63.3	60.4	41.7	72.3	40.1	56.2	32.6	42.5	65.5	82.9	37.9	94.6	83.7	45.7	70.1	57.6	3.2	93.2	27.1	12.5	71.8	28.4	47.4	76.3	14.9
Textiles & clothing	61.2	70.7	83.7	53.6	60.3	30.6	62.7	62.0	33.4	56.6	77.0	73.2	26.9	68.5	66.0	56.6	75.1	51.9	39.0	79.9	49.4	54.5	77.7	79.4	23.4	90.1	61.5	24.4	80.9	25.0	49.4	65.5	55.7
Other manufacturing products	61.1	69.7	64.2	60.0	73.2	79.5	56.6	69.9	81.6	62.1	77.7	50.5	22.4	84.2	50.6	50.3	90.7	45.3	43.7	92.2	46.8	25.4	67.1	70.2	11.2	77.0	82.4	25.6	93.5	23.1	54.5	75.2	42.7
Total manufacturing	66.6	51.0	61.4	58.0	55.6	61.2	55.9	54.4	63.5	63.9	55.5	68.9	44.0	63.4	38.3	59.7	64.3	56.5	29.6	85.9	67.3	42.4	72.9	69.7	11.2	80.6	48.6	26.7	61.7	29.7	52.5	55.4	37.7

[1] IIT as percentage of intra-EU flows. Vertical IIT as percentage of IIT. High-quality vertical IIT as percentage of vertical IIT.

So, the empirical evidence supports VIIT models. Member States with higher relative level of incomes (the North) exports appear to be predominantly of a higher quality than imports and the opposite behaviour is observed in Member States with lower relative level of incomes (the South). In addition, the share of high quality component of the VIIT is declining in southern countries like Spain and Portugal. In contrast, such a tendency is not apparent in Italy and Greece.

4. DETERMINANTS OF HIGH-QUALITY VERTICAL INTRA-INDUSTRY TRADE IN THE EU-12

The neo-H-O and neo-Ricardian models of IIT suggest that VIIT will occur between countries with differences in technology, income and income distribution and reflect production specialization along the quality spectrum. Capital-abundant and technologically advanced economies will be specialized in high-quality goods whilst those that are (unskilled) labour-abundant and less advanced technologically will be specialized in low-quality goods.

The purpose of this section is to explore the association between the pattern of comparative advantages among EU-12 and the intra-EU commercial specialization of countries in quality ranges[12] within industries. It is hypothesized that those Member countries with higher capital endowments (technological, physical and human capital) relative to the EU average will be specialized in high-quality varieties in vertical IIT in intra-EU flows, whereas countries with comparative disadvantages will be specialized in low-qualities varieties. The conclusions of our empirical analysis suggest that relationship pointed out by the neo-H-O and neo-Ricardian models of IIT.

We estimate a model with the following form:

$$\text{Ln HQVIIT}_{jt} = \alpha_j + \beta_1 \ln \text{RTK}_{jt} + \beta_2 \ln \text{RPK}_{jt} + \beta_3 \ln \text{RHK}_{jt} + v_{jt}$$

where *j* refers to the country (*j*=1...11 Member States), *t* is the year (*t*= 1985...1996), *HQVIIT* denotes the share of high-quality vertical IIT in the vertical intra-sectoral trade within the EU

[12] We know that the analysis with aggregate flows hides the different specialization patterns of a Member State with other individual Member States. But it gives an idea of the country's intra-EU commercial specialization.

and *RTK*, *RPK* and *RHK* denote the technological, physical and human capital in each Member State relative to the EU average.

We use a panel data model to estimate determinants for each manufacturing industry and for the whole manufacturing sector. The expected signs of the three parameters are positive. Thus, comparative advantage promotes a specialization of countries in quality ranges within industries.

The variable *RTK* refers to the level of technological capital in each Member country relative to the EU average. We use an indicator of technological capital per worker, calculated using the perpetual inventory method:

$$TK_t = (1-\delta)TK_{t-1} + RDE_{t-1}$$

where TK_t is the technological capital for the year t, d is the depreciation or obsolescence rate which was assumed to be 15%[13] and *RDE* are the R&D expenditures in every Member State based on data from the OECD. The initial (1975) technological capital stock, TK_0, is calculated as:

$$TK_0 = RDE_0 / (I+\delta)$$

where RDE_0 is R&D expenditure in the first year for which the data were available and *I* is the average annual logarithmic growth rate of R&D expenditures over the period for which published R&D data were available (1975-1996).

The technological capital stock for each year is divided by the level of employment to obtain the technological capital stock per worker. As we want to express the technological advantage or disadvantage of each economy relative to the EU average, the variable RTK_{jt} is calculated by dividing the technological capital stock per worker for each Member State and by the same variable for the EU-12. Hence, a ratio above unity will indicate the existence of a technological advantage of that Member State in the EU and a ratio below unity a technological disadvantage.

[13] See Coe and Helpman (1995). Alternative measures of technological capital were also calculates assuming d = 5% and d = 10% with similar results.

As in Leamer (1984), we measure the endowment of physical capital by the depreciated sum of cumulated gross domestic investment, which is adjusted according to purchasing power parities (PPP). The data used is taken from the capital stock per worker series in the Penn World Tables (PWT), Summer and Heston (1991) database. This gives a proxy for the relative endowment of physical capital for the period from 1985 until 1992. The physical capital stock after 1992 is calculated using the perpetual inventory method with gross fixed capital formation data from Eurostat. We use data since 1975, a depreciation rate of 7% (Benhabib and Spiegel, 1994) and PPP to convert to a common currency. The endowment of physical capital obtained is divided by the employment. Its growth rates are applied to the PWT data. It would have been preferable to use gross fixed capital formation data for the manufacturing sector alone and not for the whole economy, but this data is not readily available. As in the case of technological capital, an indicator of differences in endowment of physical capital is calculated between each Member State and the EU average to reflect comparative advantages and disadvantages.

To construct a measure of human capital endowment is more difficult. Two proxies of human capital stock are used mainly:

1. The average years of schooling, calculated basically from the formula:

   $$\text{Average years of schooling} = \sum_j YR_j \cdot HS_j$$

   where j is the schooling level, YR_j is the number of years of schooling represented by level j and HS_j is the fraction of the population for which the jth level is the highest value attained[14].

2. The educational attainment, i.e. the fraction of the population that has attained a specific level of education. This is a worse indicator than the previous one because it doesn't consider the fraction of population which has attained each education level or the differences in the number of years of schooling in each level between countries.

[14] This measure of average years of schooling elaborated by Barro and Lee (1993) is the most commonly used in empirical studies.

As information of average years of schooling for the 12 Member States of the EU-12 and for 1985-1996 period is lacking, human capital endowment is proxied by the percentage of the population that has attained a specific level of education. Specifically, we choose the fraction of the population 25 to 64 years of age that has attained at least upper secondary education. As the definition of the labour force varies across countries, the population aged 25 is used rather than the whole labour force[15]. The widest differences between the EU economies are found in the percentage of the population which has attained upper secondary education which includes vocational training and training programmes in companies. The data is from OECD, which offers information for every Member State until 1996.

The dependent variable (high-quality vertical intra-industry trade as a percentage of IIT in quality differentiated products within the EU) takes values within a limited range (0 to 100). However, there is no guarantee that the predicted values of the regression equation will fall within this range when a linear estimation is used. Following Balassa (1986) and Balassa and Bauwens (1987), a logistic function (1) or its logit transformation (2) are more appropriate.

$$HQIIT_{jt} = 1\ (1 + \exp - \beta' Z_{jt}) + \varepsilon_{jt} \qquad (1)$$

$$\ln\ (HQIIT_{jt}\ /\ 1 - HQIIT_{jt}) = \beta' Z_{jt} + u_{jt} \qquad (2)$$

The second function cannot handle extreme values but in our database we do not observe values of 0 (indicating that all vertical IIT is low-quality intra-industry trade) and 100 (indicating that all vertical IIT is high-quality intra-industry trade). So, (2) can be estimated using ordinary least-squares without other specification problems[16].

Determinants of high-quality vertical intra-industry trade between countries: Panel regression results.

For the econometric estimation, the standard panel technique was used. First at all, we test the significance of the group effects with a F test. In our model, $F(10,118) = 38.43$, so the

[15] See Barro and Lee (1993, p. 370).
[16] We estimate using ordinary least-squares but we correct for hereroscedasticity following White (1980).

hypothesis that the country effects are the same is rejected[17]. Secondly, we can use the fixed effects approach or the random effects approach. The Hausman test value shows that the first one should be used. In this way, the bias derived from the existence of country effects correlated with the explanatory variables is avoided and the within-group estimator is the only consistent estimator.

The results of the estimation are given in Table 4. For the whole manufacturing sector, the coefficients of relative endowments of technological and physical are significant at the 1% level, but only the first shows the expected signs and affects the quality of exported products positively[18]. The negative coefficient of physical capital is also obtained in Torstensson (1996) and Greenaway and Torstensson (1998) for the Swedish case[19]. A possible explanation of this sign is the heterogeneity of industries included in the manufacturing sector as a whole. As Greenaway and Hine (1986) showed, it is easy to find examples of industries where higher physical capital-intensity does not have to increase the quality of exports (hand-made clothing or footwear, other custom-built motor cars). On the other hand, as Flam and Helpman (1987) suggested, differences in technology are also important in explaining trade flows between industries. Technological differentiation is associated with the introduction of certain characteristics that result in new, technically improved products which are considered better than existing products in all quality ranges[20]. In this study we find evidence that an abundant technological capital endowment does increase the quality of intra-EU manufacturing exports.

A potential econometric problem is the non-normality of the error terms. Then, OLS may be less efficient than other estimates. As a check, we used the Jarque-Bera test which is a joint test for skewness and kurtosis. The hypothesis of normality can be accepted at the 5% level for the whole manufacturing sector and for each industry.

The value for the Wald test allows us to accept the hypothesis of joint significance for all the variables included in the regression, and we can accept the hypothesis of lack of first-order and second-order serial correlation in the residuals for the most part of manufacturing industries. Finally, we confirmed the exogeneity of all the explanatory variables by a

[17] The F test takes values between 6.77 in basic metals and 29.36 in rubber and plastics.

[18] Although the two measures of human capital are similar, we have obtained the most significant coefficient with the percentage of population that have reached the upper secondary education level.

[19] An alternative measure of physical capital stock has been introduced in the model but its sign is still negative. In this case, the value of capital stock in 1996 is calculated using the perpetual inventory method. Previous values are obtained applying the growth rates of the capital stock from OECD (see Myro, 2000).

Hausman test, so it was not necessary to use instrumental variables.

The conclusions to be drawn from the estimations vary between manufacturing branches. In five branches (office and data processing machines; electrical goods; basic metals; food, beverages and tobacco; and textiles and clothing), only the technological capital has a positive and significant coefficient. On the one hand, in advanced manufactures, specialization in high-quality products seems to depend mainly on abundant technological endowment, allowing the incorporation of technological advances before competitors. Country-specific technological knowledge appears to play an important role in the relative quality of exports, especially in these research-intensive activities. On the other hand, in three traditional manufacturing branches (basic metals; food, beverages and tobacco and textiles and clothing) with a high level of product standardization, strategies of technological differentiation like improvements in the design and quality of the product have been used, according with the econometric results.

The relative human capital endowment seems to affect the quality of exported products positively and significantly in several manufacturing industries. This positive and significant relationship also has been found in Torstensson (1996) and Greenaway and Torstensson (1998). In the case of branches like rubber and plastic products and metal products, relative human and technological capital show expected and significant signs. In the case of agricultural and industrial machinery and paper and printing products, relative human capital stock is the only variable that determines the pattern of quality specialization within industries in the EU. And in chemical products, among the factors which define comparative advantage, both relative abundance of human capital and physical capital have significant and positive coefficients.

Thus, we can see that the effects of technological capital, human capital and physical capital are different across manufacturing industries. And technological and human capital do seem to have a large effect on trade patterns within industries.

However, there are three manufacturing industries for which the results of the empirical analysis are unusual: non-metallic mineral products, other manufacturing products and transport equipment. In the two first cases, none of the variables are significant probably

[20] See Greenaway (1984).

due to the heterogeneity of productions considered in these branches. But the case of transport equipment is more complicated because relative factor endowment does not affect the results in a consistent manner. Only the coefficient for human capital stock is significant but it is negative. In one hand, it necessary to take into account that transport equipment is a sector heterogeneous, which includes motor vehicles, aircraft and ships. So we would need a more detailed analysis. On the other hand, the unexpected sign could be related with problems with data information. Sometimes, there isn't information of export and import quantities. In those cases, so we can't calculate values unit per tonne as an approximation of prices and quality and we can't determine the nature of IIT[21]. This feature explains that it is the branch with the highest variation coefficient. So, the results obtained must be interpreted carefully and even this branch could be removed from econometric analysis. In fact, if we do the regression for the manufacturing sector excluding the transport equipment, the positive coefficient of human capital becomes significant like the technological capital.

If we use as dependant variable the high quality vertical IIT over the total IIT, the results are very similar (Table 5). A relatively greater technological capital in advanced and some traditional manufacturing industries explain the specialization in high-quality products within the EU. The importance of human capital endowments seems to be linked to the exports of relative high quality products in intermediate industries and again some traditional ones. According to this broad measure of high quality vertical IIT, there is also evidence that technological and human capital endowments increase the quality of manufacturing exports.

[21] The percentage of missing data varies depending on the year, the country and the type of industry included in this sector and it can be up until the 45% of trade.

TABLE 4: HIGH QUALITY VERTICAL IIT AND COMPARATIVE ADVANTAGE REGRESSION RESULTS; PANEL DATA (EU-12, 1985-1996, 132 observations)

(Dependant variable: High quality vertical II / Vertical IIT)

	VARIABLES INDUSTRIES	RTK (a)	RPK (a)	RHK (a)	Adjusted R^2 (b)
Advanced manufactures: High demand growth and technology intensity	Office & data processing machines	**2.95** **(5.30)*****	-3.05 (-2.31)**	0.53 (0.67)	0.51
	Electrical goods	**0.84** **(2.03)*****	-2.09 (-2.25)**	0.01 (0.01)	0.63
Intermediate manufactures: Medium demand growth and technology intensity	Chemical products	-0.61 (-2.24)**	**1.07** **(2.32)****	**0.95** **(4.17)*****	0.84
	Rubber & plastic products	**1.09** **(2.22)****	-0.5 (-0.40)	**1.37** **(1.81)***	0.85
	Agricultural & industrial machinery	-0.07 (-0.19)	-0.35 (-0.35)	**0.92** **(2.11)****	0.77
	Transport equipment	1.09 -1.32	-1.09 (-0.10)	**-2.32** **(-2.90)*****	0.45
Traditional manufactures: Low demand growth and technology intensity	Basic metals	**1.06** **(2.36)****	0.41 (0.40)	0.68 (0.88)	0.78
	Metal products	**0.49** **(1.67)***	0.78 (1.16)	**0.96** **(2.76)*****	0.89
	Non-metallic minerals & mineral products	0.01 (0.05)	0.39 (0.45)	0.40 (0.79)	0.74
	Food, beverages & tobacco	**0.93** **(2.36)****	-3.44 (-4.29)***	0.14 (0.36)	0.74
	Paper & printing products	-0.16 (-0.50)	0.51 (0.58)	**0.91** **(2.28)****	0.84
	Textiles & clothing	**1.65** **(5.42)*****	-1.64 (-2.13)**	0.36 (0.89)	0.84
	Other manufacturing products	0.28 (0.64)	0.29 (0.34)	-0.92 (-1.37)	0.48
	Total manufacturing sector	**0.88** **(4.71)*****	-1.76 (-4.54)***	0.24 (1.02)	0.89

(a) Heteroscedastic-consistent t-values in parenthesis: *** 1% level of significance, **5%, *10%.
(b) Adjusted R^2 from WITHIN estimation.

TABLE 5: HIGH QUALITY VERTICAL IIT AND COMPARATIVE ADVANTAGE REGRESSION RESULTS; PANEL DATA (EU-12, 1985-1996, 132 observations)

(Dependant variable: High quality vertical II / Total IIT)

	VARIABLES INDUSTRIES	RTK (a)	RPK (a)	RHK (a)	Adjusted R^2 (b)
Advanced manufactures: High demand growth and technology intensity	Office & data processing machines	**2.47** **(4.17)*****	-2.11 (-1.45)	0.21 (0.27)	0.38
	Electrical goods	**0.71** **(1.70)***	-2.04 (-2.01)**	0.21 (0.34)	0.46
Intermediate manufactures: Medium demand growth and technology intensity	Chemical products	-0.23 (-1.06)	**0.99** **(2.06)****	**0.79** **(2.98)*****	0.85
	Rubber & plastic products	0.54 (1.07)	-2.12 (-1.52)	**1.78** **(2.25)****	0.77
	Agricultural & industrial machinery	-0.06 (-0.13)	0.70 (0.67)	**0.71** **(1.69)***	0.67
	Transport equipment	0.83 (1.23)	-1.80 (-1.09)	-2.48 (-3.26)***	0.52
Traditional manufactures: Low demand growth and technology intensity	Basic metals	**0.98** **(1.66)***	-0.96 (-1.23)	**0.54** **(1.82)***	0.62
	Metal products	**0.64** **(2.64)*****	0.72 (1.24)	**0.60** **(2.06)****	0.86
	Non-metallic minerals & mineral products	0.12 (0.45)	-0.84 (1.20)	0.43 (1.03)	0.68
	Food, beverages & tobacco	0.83 (0.07)	-3.22 (-3.09)***	**0.05** **(2.49)****	0.56
	Paper & printing products	-0.22 (-0.63)	0.99 (1.05)	0.56 (1.42)	0.79
	Textiles & clothing	**1.51** **(4.89)*****	-1.50 (-1.88)*	0.43 (1.02)	0.77
	Other manufacturing products	-0.05 (-0.11)	0.21 (0.25)	-0.70 (-1.26)	0.39
	Total manufacturing sector	**0.06** **(3.95)*****	-1.75 (-3.96)***	0.12 (0.44)	0.80

(a) Heteroscedastic-consistent t-values in parenthesis: *** 1% level of significance, **5%, *10%.
(b) Adjusted R^2 from WITHIN estimation.

5. CONCLUSIONS

In this paper we have investigated the nature of trade in intra-EU trade. This was the first aim of the present study. We find that the share of IIT, calculated at a very disaggregated level, has increased considerably between 1985 and 1996 in each Member State. More than half of all intra-EU IIT is in vertically differentiated products. By contrast, a greater increase in IIT based on horizontal product differentiation is observed over the time period considered in the Mediterranean countries where vertical IIT was the most important IIT type in the mid 1980s. This change towards IIT in horizontal differentiation may reflect the efforts to upgrade the quality of Mediterranean exports with strong competition from other European countries.

The results suggest an important degree of specialization of countries by quality within industries in intra-EU trade. Exports from southern countries seem to be located mainly at the lower end of the price-quality spectrum, whereas those countries with higher incomes per capita are located at the higher end, according to the vertical IIT models. Furthermore, two countries specialized in low-quality exports in their vertical IIT (Spain and Portugal) have increased the relative quality of products over time.

The second aim of the paper was to examine how comparative advantage affects the trade specialization of countries in quality ranges within industries. Differences in human and physical capital endowments and technological levels between countries, which are the traditional determinants of inter-industry trade, were considered as possible driver of high quality vertical IIT. According to the findings of our econometric analysis, differences in technological capital endowment and human capital endowment are important determinants of specialization of countries over the quality spectrum within industries in intra-EU trade. In particular, there is support for the influence of technological capital in advanced manufacturing industries, rubber and plastic products and the majority of traditional manufacturing branches. In manufacturing industries with demand growth and technological content classified like medium and some traditional like metal products and paper and printing products, an abundant endowment of human capital is associated with an increase in the quality of exports. These results support, therefore, the hypothesis that comparative advantage (mainly, based on differences in human and technological capital endowments between countries) is an important determinant of the pattern of European trade within industries.

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