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# TWO-WAY INTERNATIONAL TRADE AND PRODUCTION IN ITALY: A COUNTRY/INDUSTRY SPECIFIC ANALYSIS

*Filippo Reganati, Rosanna Pittiglio\**

## ABSTRACT

*Economic interactions among high-income developed countries are characterized by high degrees of both intra-industry trade and intra-industry affiliate production and sales. Similar high-income countries both heavily trade with and invest into each other. This paper examines the determinants of Italian intra-industry trade and intra-industry production with most European trading partners using a dataset where variables are different not only between countries but also between sectors of the same country. Using different econometric methods, the results obtained suggest that intra-industry trade and intra-industry production tend to share the same determinants; in particular they are higher as the two partner countries are more similar in relative factor endowments (physical and technological capital), in relative country size and are less geographically distant.*

**Keywords:** intra-industry trade, intra-industry foreign direct investment.

*JEL Classification:* F13, F23

## 1 – Introduction<sup>1</sup>

The increasing degree of economic integration and interdependence among countries has underscored the affinity between trade and international production. First, in the manufacturing sector the same firms are responsible for a substantial share of world trade and international production. Second, both trade and international production in manufacturing are predominantly taking place in the more technologically advanced industries in developed countries. Third, the phenomenon of intra-industry trade (IIT) in manufacturing, among industrial sectors of advanced market economies, has been paralleled by the emergence of intra-industry production (IIP) in the corresponding industries of the same countries.

The share of all foreign direct investment (FDI) outflows generated by the first six countries (Belgium-Luxembourg, France, Spain, the United Kingdom, United States, Canada) and absorbed by another six countries rose and amounted to 73,27% of total OECD FDI by 2000 (57% of total world FDI). At the sectorial level, intra-industry international production is more likely to occur in income-elastic and technology-intensive manufacturing industries such as electronics, pharmaceuticals, motor vehicles and computers.

In the last twenty years, many scholars (Helpman 1984; Brainard, 1993; Reganati, 1999; Markusen and Venables, 1998 and 2000) have tried to build a unified framework where international production and FDI have been integrated inside trade models. This literature has provided a better understanding of both observed multinational enterprises' (MNEs) behaviour and empirical trade-international production relationships. However, while the literature on IIT has been extensive both theoretically (Helpman and Krugman, 1985; Norman and Dixit, 1980) and empirically (Loertscher and Wolter, 1980; Helpman 1987; Hummels and Levinsohn 1995), there have been few studies measuring IIP.

Taking into consideration the bilateral exchange of goods and the FDI of

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<sup>1</sup> Although this paper has been jointly developed by the authors, it was written as follows: section 1, 2 and 3 F. Reganati; section 4,5 and 6 R. Pittiglio.

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Italy with ten European Union countries for the period 1996-1999, the purpose of this work is to empirically examine the determinants of IIP. In contrast to other empirical works (Di Mauro, 2001; Ekholm, 2002; Markusen and Maskus, 2002; Reganati, 2002) that have assumed homogeneity among countries in analyzing industry-specific factors and homogeneity among sectors in analyzing country-specific factors, in this work we use a multi-country and multi-industry approach; that is, we use a dataset where variables are different not only between countries but also between sectors of the same country.

This paper is organized as follows. Section 2 presents some figures of the bilateral share of IIT and IIP in the Italian manufacturing sector. Section 3 reviews the empirical literature on the determinants of IIP and on its relationship with IIT. Section 4 discusses the data and the empirical model, whereas section 5 presents our main results and the robustness check. Finally, section 6 provides some concluding remarks.

## 2 - The pattern of intra-industry trade and foreign production in the Italian manufacturing sector

The share of Italian IIP and IIT was measured using the “unadjusted” Grubel-Lloyd (GL) index:

$$IIP_{ijkt} = 1 - \frac{\sum_j |O_{ijkt} - I_{ijkt}|}{\sum_j (O_{ijkt} + I_{ijkt})} \quad (1)$$

$$IIT_{ijkt} = 1 - \frac{\sum_j |X_{ijkt} - M_{ijkt}|}{\sum_j (X_{ijkt} + M_{ijkt})} \quad (2)$$

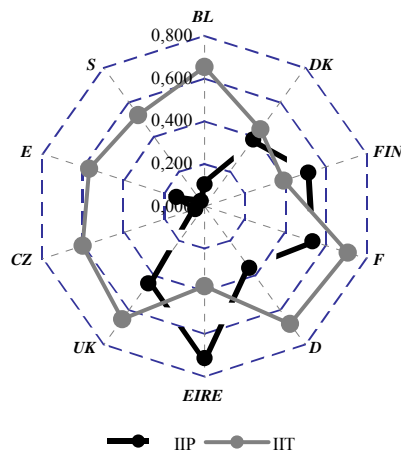
where  $O_{ijkt}$  and  $I_{jkt}$  are outward and inward FDI from the home country  $i$  (Italy) to host country  $k$  in sector  $j$  in year  $t$ ; while  $X_{ijkt}$  and  $M_{jkt}$  are exports and imports from Italy to partner country  $k$  in sector  $j$  in year  $t$ . Both GL indices assume values that vary between 0 and 1.

In particular, when the index is equal to zero, it means that there is no intra-industry trade (or international production), while when it is equal to one it

means that all trade (or international production) is of an intra-industry type.

To make comparable IIT and IIP, we have chosen a level of industry aggregation corresponding to the two-digit level of ISIC2 which in our sample includes 22 manufacturing industries. The countries considered in the analysis are Belgium-Luxembourg, Denmark, Finland, France, Germany, Ireland, the United Kingdom, Czech Republic, Spain and Sweden<sup>3</sup>.

**Figure 1** - Intra-industry Foreign Direct Investment and Intra-industry Trade (average: 1996-1999)



Source: IIT - author's calculations on EUROSTAT data; IIP - author's calculations on AIDA and AMADEUS data

Figure 1 reports the bilateral GL indices of IIT and IIP for Italy in manufactured products. It can be easily seen that, on average, Italy achieves higher indexes of intra-industry trade than intra-industry production. It is true for every country except Finland and Ireland, for which our country has reported the lowest intra-industry trade index. Besides, Italy achieves the highest IIP with Ireland, France, Finland and the UK. We might interpret this situation in two different ways. In fact, the higher intra-industry production indexes with Ireland and Finland might be a consequence of a higher concentration inside the manufacturing industry between attractive and unattractive locations; the higher IIP with France and the UK seem to supply

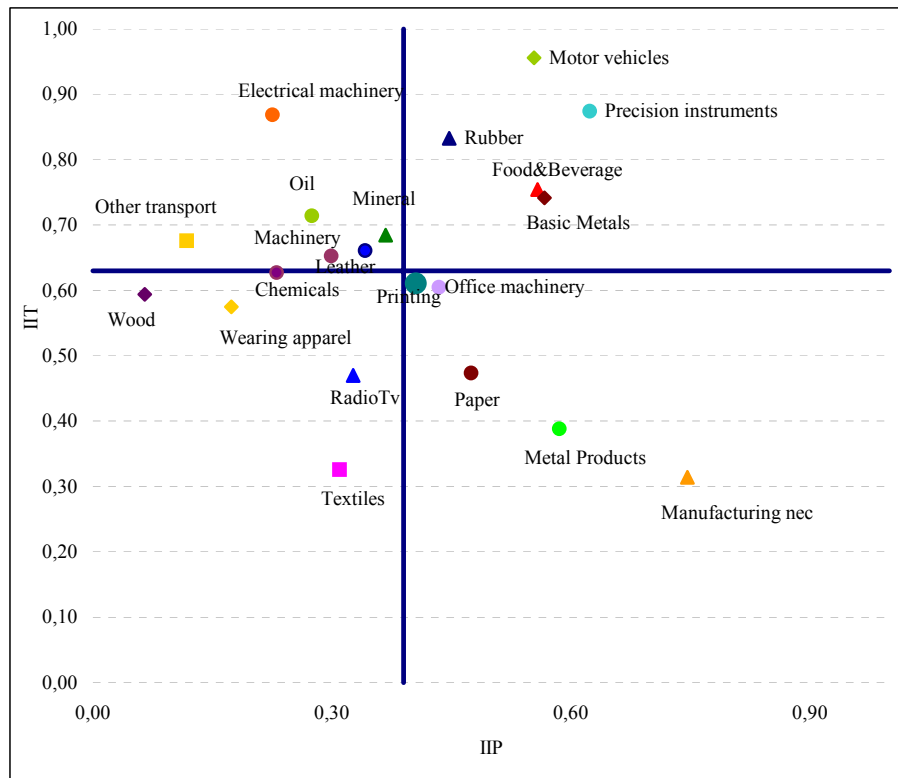
<sup>2</sup> Being conscious that the Grubel-Lloyd index reduces its value when the level of sectorial aggregation increases, we were obliged to choose a two-digit level because it was not possible to get data on FDI at a deeper level of aggregation.

<sup>3</sup> Selected countries are the most representative ones in terms of volume of trade and international production. In particular, they account for about 60 percent of the total volume of Italian FDI and about 40 percent of the total volume of Italian trade.

empirical evidence at the theoretical hypothesis of Markusen and Venables (2000), who maintain that the share of two-way international production is expected to be greater between countries which are similar in terms of absolute and relative factor endowments.

In order to explore, in greater detail, the relationship which links IIT and IIP, in figure 2 the IIP and IIT ratios have been combined in a double-entry matrix. At the top right-hand side of the matrix, we find those sectors which have above-average values of both IIP and IIT. *Precision Instruments, Motor Vehicles, Rubber, Food and Beverages, Basic Metals*, are all sectors where the high values of the IIP index are a consequence of large shares of both inward and outward international production in the Italian manufacturing sector.

**Figure 2 - Sectorial distribution of the Italian IIP and IIT (average 1996-1999)**



Source: IIT - author's calculations on EUROSTAT data; IIP - author's calculations on AIDA and AMADEUS data

This suggests that at a global level Italy and its firms are involved in these

sectors in a strong process of competition. For example, *Precision instruments* is a sector where Italian firms have always had a strong position in domestic production and in the export performance. Also, Italy itself has some location-specific advantages related to local technological conditions. Therefore, it could be argued that in this sector competition is moving away from market to technological rivalry.

At the bottom right-hand side of the matrix we find sectors which show a high degree of IIP associated with a low degree of IIT. Among these sectors, *Metal Products* and *Office Machinery* present above-average shares of both outward and inward international production which are associated with a marginal share of both imports and exports. In this sector, the existence of differences in national consumer preferences could suggest that international production is mainly of a local-market oriented type.

At the top left-hand side of the matrix, there are sectors which register below-average values of IIP associated with above-average values of IIT. In this box we find both sectors (i.e., *Machinery*) which present a high percent share of outward international production and sectors where foreign firms account for a high proportion of inward international production. High shares of inward international production associated with above-average values of intra-industry trade are recorded in some specialistic sectors such as *Electrical Machinery*. These are sectors where Italian firms are not traditionally strong enough to invest abroad and where well-established multinational enterprises, which operate in a large number of countries, are likely to engage in both vertical and horizontal integration processes.

Finally, at the bottom left-hand side of the matrix, we find those sectors which have below-average values of both IIP and IIT. Once again some sectors (i.e., *Textiles and Wearing Apparel*) are characterised by a stronger share of outward international production, while others (i.e., *Chemicals and Radio-TV*) account for a strong share of inward international production. In the *Textile and Wearing Apparel*, large segments of the productive phases are more and more rapidly relocated in low labour cost countries, including China and some Eastern European countries, such as Romania; international production is likely to be vertical of an export-platform type since we see the combination of high shares of outward international production with high shares of imports.

### **3 – The empirical evidence on intra-industry foreign production**

A number of researchers have noted the existence of some important

similarities between patterns of trade and patterns of FDI. In particular, Dunning (1981) argued that the structure of international production has followed an evolution similar to that of trade, even if with a time lag. As a result, just as trade was “originally mainly inter-industry but now is intra-industry, so international production seems to be following a similar sequence” (p. 431).

Very few empirical studies have explored the determinants of IIP and its relationship with IIT. By considering a sample of 56 US industries in 1980, Dunning and Norman (1985) found a positive but not significant correlation between the IIT and IIP indices. Cantwell (1989) looked at the four largest European countries (Germany, Italy, France and the UK) together with the US and Japan in 1982 and found that IIP and IIT were positively and significantly correlated only in the case of Italy. Weng (1998) analysed the determinants of IIP between the US and the rest of the world in 19 manufacturing industries from 1983 to 1990. Using panel data analysis with random effects, he found that trade barriers, market size and labour unions in the US, and trade barriers in the rest of the world, have significant effects on IIP; however, market size in the rest of the world, US productivity (to the rest of the world), product differentiation, and foreign multinational firm-specific advantages seem to have insignificant effects on IIP. Using a gravity type model, Di Mauro (2001) tested the determinants of IIP in three countries (US, D, UK) for three years, 1990 - 1994 - 1998. Her empirical model considered the following variables: relative factor endowments, an index of countries' similarity in size, geographic distance between the partner countries and a measure of the 'economic space' between the two countries. The estimations are consistent with the theoretical hypotheses, but some differences stand out between the considered sectors. By testing the relationship between IIT and IIP in Germany, Di Mauro also found that three sectors out of four showed a sign of complementarity (positive and significant coefficients). Markusen and Maskus (2002) analysed the bilateral U.S. intra-industry trade and affiliate sales with ten countries or regions for the years 1988, 1991 and 1994. Using a standard logit approach, they regressed the IIT index, the IIP index, and the ratio IIP / IIT with respect to some country-specific characteristics such as market size, country similarity in size, differences in skill endowments and trade barriers. The authors found that theory was fitting quite well; both indices of IIT and IIP were higher as the two countries were richer and more similar in size and in relative endowments. Also, the ratio IIP /IIT was encouraged by higher incomes and country similarity in terms of size and labour-force composition. Using Swedish data on affiliate activities in the OECD countries for four years (1986, 1990, 1994 and 1998), and two different econometric techniques (a logistic function estimated with OLS and



panel data analysis with random effects), Ekholm (2002) found that the degree of similarity in relative factor endowments was well explaining both IIT and IIP. Also this author found that both indices of IIT and IIP were lower as the two countries were less similar in relative endowments. Moreover, there is evidence of the differences in human capital endowments which produce a negative impact on both dependent variables. Finally, the coefficients estimate of variable “difference in physical capital” is positive but in no way significant. Using data of Italian bilateral trade and affiliate production with OECD countries, Reganati (2002) found that dissimilarity in relative endowments affects both IIT and IIP negatively. Also, he found that IIT and IIP were highly correlated. In particular, the correlation coefficient was positive and significant both when he considered the set of world countries (0,73 percent) and when he took into consideration only the EEC countries (0,89). However, it became negative but not significant (-0,21) when we considered only the less developed countries. At a sectorial level, a positive but not significant correlation was found between intra-industry trade and intra-industry production (the correlation coefficient was 0,39). The relationship between intra-industry trade and intra-industry production for Korea was investigated by Jung-Soo et al. (2002). In their empirical analysis covering ten manufacturing sectors for the period 1989-1999, they found a positive but not significant relationship between IIP and IIT. At a sectorial level, a substitutability relationship was found only in three sectors out of ten.

#### **4 – The econometric model**

Let us present some hypotheses relating to country specific factors and IIT in bilateral trade and IIP, the econometric methods used and the results of the regression analysis. Our empirical analysis will follow an eclectic approach because instead of testing a specific theoretical model we pick hypotheses from various models.

##### *4.1. Hypotheses and Variables*

- (i) *Physical capital difference (DIFPC)*: The share of both IIT and IIP are positively correlated with the differences in physical capital between the two trading partner countries (Falvey, 1981; Falvey and Kierzkowski,

- 1987; Brainard, 1993; Markusen e Venables, 1995);
- (ii) *Technological capital difference (DIFRS)*: The share of both IIT and IIP are positively correlated with the differences in the level of technology between the two trading partner countries (Flam and Helpman, 1987; Shaked and Sutton, 1984; Brainard, 1997; Markusen and Venables, 1998);
  - (iii) *Market Size Difference (DIFY)*: The share of both IIT and IIP are negatively correlated with the differences in market size between the two trading partner countries (Lancaster, 1980; Krugman, 1979; Helpman, 1981; Brainard, 1997; Markusen e Venables, 1998);
  - (iv) *Market Size (SIZE)*: The share of both IIT and IIP are positively correlated with the market size of two trading partner countries (Falvey and Kierzkowski, 1987; Markusen e Venables, 2000);
  - (v) *Distance (DIST)*: The share of both IIT and IIP are negatively correlated with distance between the two partner countries.

Following Ekholm (2002) the variables measuring the degree of dissimilarity between countries are equal to:

$$DIS_{jkt} = \left| \frac{X_{kt} - X_{jt}}{X_{kt}} \right| \quad (3)$$

where variable X is the difference either in physical capital, in technological capital or total GDP (current US dollar).

It is worth noting that the majority of empirical studies on IIT and IIP assume homogeneity between countries in analyzing industry-specific factors and homogeneity between sectors in analyzing country-specific factors. In so doing, in these works the differences in terms of factorial endowments among industries are overlooked. To solve this problem, we suggest following a multi-country and multi-industry approach; that is, we use a dataset with *country/industry specific* variables where factorial endowments are different not only between countries but also between sectors of the same country.

As a result, *DIFPC* represents the difference in physical capital between Italy and the partner k in industry j; *DIFRS* is the difference in absolute value in R&D per worker between Italy and the partner k in industry j; *DIFY*; is the absolute difference of total GNP (current US dollar) between Italy and her trading partner k in industry j; *SIZE* represents the average size of the markets and is given by the average GDP (current US dollar) of Italy and her trading partner k in industry j. Finally, *DIST* is the geographical distance calculated as a number of Km between Rome and each of the capital cities of partner

country  $k$ .

International production has been measured by MNE employment; in other words, outward affiliate production is equal to the number of employees in Italian firms' foreign affiliates, and inward affiliate production is equal to the number of employees in foreign firms' Italian affiliates. Data on international production were drawn by the AMADEUS database which provides information on the number of firms, employment and sales on both Italian firms which operate abroad and on foreign firms operating in Italy. Data on bilateral imports and exports were obtained by EUROSTAT, Comext database. Data on GDP, number of workers, stock of physical capital, R&D in industry  $j$  of country  $k$  were obtained from OECD-STAN database, while data on wages in industry  $j$  of country  $k$  were obtained from OECD-SSIS database. Finally, data on geographical distance between capital cities were obtained from John Haveman's International Trade Data.

#### *4.2. Specification of the Model*

To estimate the determinants of intra-industry trade and international production, previous studies have used a variety of different methods such as linear or log linear functions estimated using the ordinary least squares (OLS), the OLS on the logit transformation of the logistic model, and non-linear least squares of the logit function. It has been noted (Caves (1981) that a major difficulty encountered using the method of ordinary least-squares (OLS) is that it may have predicted values of the dependent variable that lie outside its feasible range from 0 to 1. This problem could be overcome by using the logistic transformation in conjunction with weighted least-squares. However, one has to replace zero and unit values of IIT with  $\epsilon$  and  $(1 - \epsilon)$ , respectively, where  $\epsilon$  is a very small positive number. Since this approach was still unsatisfactory as it yielded estimation bias originating from adjustments to the original data, some scholars (Greenaway and Milner, 1984; Balassa, 1986; Balassa and Bauwens, 1987) overcame this problem by estimating the cumulative logistic distribution function, sometimes known as the non-linear Logit model, using non-linear least-squares.

Following this stream of empirical research, in this work we firstly adopt a non-linear least squares procedure to estimate the logit probability function defined as:

$$y_{ita-k}^j = \frac{1}{1 + \exp(-\beta' z)} + \mu \quad (4)$$

where the dependent variable ( $y$ ) is either the IIT or the IIP index between Italy and partner country  $k$  in sector  $j$ ,  $z$  is the vector of explanatory variables,  $\beta$  is a vector of regression coefficients, and  $u$  the disturbance term.

Despite the above improvements to the non-linear Logit model, a major shortcoming of the Logit model is that it imposes an arbitrary sigmoid or S-shaped curve on the data. In order to avoid this restriction, we used a double-truncated Tobit model that estimates equation (4) in its linear form with both lower truncation below zero and upper truncation above one<sup>4</sup>. The double-truncated Tobit model retains the linear nature of equation (4) while restricting the predicted values of the dependent variables so that they lie within its feasible range from 0 to 1. It overcomes the initial problems encountered in the simple linear regression model without introducing additional undesired restrictions.

## 5 - Estimation results

The models as outlined above are estimated using a data set composed of 22 industries and 10 countries for the years 1996-1999 which produced 561 observations. The results of the regression from non-linear estimations of equation (4) are presented in Table 1<sup>5</sup>.

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<sup>4</sup> The preferred model for this study is the double-truncated Tobit model with both lower truncation below zero and higher truncation above one. This is based on the likelihood function for a Tobit model truncated at zero [see Amemiya (1985)].

<sup>5</sup> As the White test failed in the estimations, we used the White's robust variance-covariance matrix to generate the corrected standard errors and t-statistics.

Table 1 - Determinants of IIP and IIT: regression results with NLS<sup>6</sup>

	IIP		IIT	
	(1)	(2)	(3)	(4)
CONST	0.264 (0.63)	0.374 (0.99)	1.397 (5.61)***	1.411 (6.40)***
DIFYPC		-1.780 (-1.93)*		-1.522 (-3.39)***
DIFPC	-16.321 (-4.46)***		-3.679 (-2.57)**	
DIFRS	-0.015 (-0.79)		0.061 (4.76)***	
DIFY	-0.034 (-7.69)***	-0.032 (-7.03)***	-0.004 (-2.14)**	-0.003 (-1.56)
SIZE	0.019 (7.09)***	0.017 (6.55)***	0.005 (0.02)**	0.004 (2.08)**
DIST	-0.818 (-2.82)***	-0.925 (-3.69)***	-0.647 (-4.47)***	-0.593 (-1.56)
<i>N. of Obs.</i>	560	560	560	560
<i>R</i> <sup>2</sup>	0.518	0.481	0.879	0.876

Looking at the first column, we can observe that the extent of IIP is positively correlated with average country size (SIZE) and negatively correlated with differences in country size (DIFY), distance (DIST), differences in physical capital (DIFPC) and in technological capital (DIFRS). All the coefficients are statistically significant at 1 percent level, with the exception of variable DIFRS which has the expected sign but is not statistically significant.

Column 3 presents the results of the regression for intra-industry trade. As expected, the more similar countries are in relative physical capital endowments, the greater the IIT is. Market size exerts a positive effect on IIT, while distance and difference in country size produce a negative effect. All the coefficients of these variables are statistically significant at 5 percent

<sup>6</sup> \*, \*\*, \*\*\* statistically significant at the 10, 5 and 1 percent level, respectively.

level. The only exception is DIST significant at 1 percent level.

Finally, and contrary to the theory, the difference in technological capital produces a significant positive impact on intra-industry trade.

The signs and significance of our results are robust to the substitution of variables DIFPC and DIFRS with variable DIFYPC. This variable represents the differences in absolute value in GDP per worker between Italy and country  $k$  in industry  $j$ . DIFYPC being a proxy for differences in factor endowments, we predict that both the share of IIT in bilateral trade and the share of IIP in bilateral FDI will be greater the larger the difference in the capital-labor endowment of the two countries and, accordingly, the expected sign of the coefficients is negative in both cases.

Considering the estimations of intra-industry production, we see (column 2) that all coefficients have the expected sign and are statistically significant. In the particular case the difference in factor endowments is smaller, the neighbouring partner countries are nearer to Italy, they are more similar in economic size and the the market size is larger, the more intra-industry production will grow. Results of IIT are not as good. Column 4 highlights that all coefficients have the expected sign and are statistically significant except for variable DIFY and DIST that are consistent with the theoretical predictions but are not significant.

Table 2: Determinants of IIP and IIT: regression results with Tobit model

	IIP		IIT	
	(1)	(2)	(3)	(4)
CONST	0.4218887 (3.65)***	0.2740357 (2.52)**	0.8416479 (16.44)***	.8365282 (16.58)***
DIFYPC		-0.7284434 (-3.30)***		-0.3669562 (-3.06)***
DIFPC	-0.1056239 (-3.12)***		-0.0441836 (-3.26)***	
DIFRS	-0.1698212 (-4.39)***		-0.0181936 (-1.90)*	
DIFY	-0.0223526 (-4.98)***	-0.0061103 (-6.15)***	-0.0020092 (-1.96)**	-0.0006813 (-1.58)
SIZE	0.3618347 (3.82)***	0.0082829 (8.75)***	0.3687752 (0.78)	.00009778 (2.26)*
DIST	-0.1336036 (-1.83)*	-0.1925842 (-2.90)***	-0.1211803 (-3.87)***	-0.1407478 (-4.25)***
<i>N. of Obs.</i>	560	560	560	
<i>Log Likelihood</i>	-344	-353	-337	-320
<i>Chi-Square</i>	125.01	106.42	139.12	105.21

The heteroskedasticity-corrected tobit estimates are presented in table 2. Columns (1) and (3), reveal that all the coefficients have the expected signs in both the regressions. In particular, the estimated coefficients of dissimilarity in physical capital are negative and highly significant both for IIT and IIP. Furthermore, the estimated coefficients of dissimilarity in technological capital have the correct sign in both regressions, although with a different degree of significance. Also, we found evidence that both IIP and IIT indices were higher as the two countries were more similar and less geographically distant from Italy.

Substituting variables DIFPC and DIFRS with variable DIFYPC, we find

(columns 2 and 4 of table 2) that both indices of IIP and IIT are higher as the two countries are more similar in relative factor endowments. Moreover, there is evidence to suggest that both IIT and IIP increase with the vicinity of partner countries. Finally, the estimated coefficients of country similarity and size always have the expected sign in the two different equations but DIFY is highly significant in the regression of IIP while SIZE is significant at 5 percent level in the regression of IIT.

## 6 – Conclusions

A recent strand of literature has investigated the determinants of intra-industry trade and intra-industry affiliate production. In these studies, the authors, assuming homogeneity among countries in analyzing industry-specific factors and homogeneity among sectors in analyzing country-specific factors, have tried to verify that IIT and IIP may share the same determinants.

In this paper we have carried out a similar analysis for Italy with its most representative European trading partners for the years 1996-1999 using a dataset where variables are different not only between countries but also between sectors of the same country.

The analysis carried out using two alternative statistical methods –a logistic function by NLS and a Tobit model – in order to verify the robustness of the results obtained, highlighted more or less the same results for both variables considered.

In the specific case, we found that both intra-industry trade and intra-industry production decrease when countries are less similar in size and physical capital, and are further apart. Moreover, both IIT and IIP increase when in the presence of a larger economic market as a greater space is conducive of greater economic activity.

Differences in technological capital was the only variable producing an opposite impact on IIT (negative) and IIP (positive).

In conclusion, the results obtained suggest, as in the Italian case, that intra-industry trade and intra-industry production tend to share the same determinants, so giving some indications about a complementarity relationship between the two considered variables.

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