KNOWLEDGE, SPILLOVERS AND FIRMS' INTERNATIONAL GROWTH. AN ANALYSIS AT THE ITALIAN NUTS3 LEVEL

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1. Introduction

Data on the internationalisation of the productive processes of Italian firms, as measured by their outward foreign direct investments (FDI), show a remarkable territorial heterogeneity both at the NUTS2 (regions) and NUTS3 level (provinces). Differences in sectoral composition account for part of this heterogeneity, while a growing body of literature has been underlining the role played by the virtuous relationships existing between the international growth of a geographical area and the innovation capabilities of the firms sited in it (Storper, 1997; Cooke and Morgan, 1998). Such a relationship appears to be circular as, on one hand, innovation allows firms to gain competitive advantages that foster their internationalisation processes; on the other hand, scholars have noticed that being multinational stimulates innovative performances, by providing the incentives for introduction of new products and processes and leading, in general, to a better exploitation of innovative capabilities. Foreign subsidiaries act often as sources of new ideas: indeed, they allow the company to absorb local knowledge, thus integrating and enriching its existing technological competence base (Frost, 2001).

At the same time, several studies have acknowledged the importance of the externalities and spillovers stemming from the presence of foreign multinational enterprises (MNEs) in increasing the efficiency and the competitiveness of domestic firms (see Moran et al., 2005 for a recent comprehensive survey of this literature). In this context, one of the most interesting issues is about the geographical extent of these spillovers: how far do their benefits arrive? Are they strictly localised or spread across wider areas? And how much wider? Empirical analyses have provided controversial evidence on the localisation of the knowledge spillovers stemming from private and public R&D, while, up to now, the issue has been poorly investigated with reference to the spillovers stemming from the presence of foreign MNEs (Driffield, 2006).

Framing within this literature, the paper (i) provides empirical evidence on the relationships between innovation capabilities, spillovers and outward FDI of the Italian provinces, and (ii) tests whether spillovers are localised or they rather cross the administrative boundaries. Specifically, we estimate an econometric model which shows, through the introduction of simple spatial lags, that foreign activities by the province's firms are influenced, not only by the local characteristics and innovative performances, but also on what happens in the neighbouring provinces.

2. The internationalisation of production by the Italian provinces

Table 1 reports data on the internationalisation of production by the Italian provinces. Data refer to the Reprint data base of the Politecnico di Milano[1] which provides a census of inward and outward FDI since 1986 and is updated every year. As in 2004, Italian firms record 9,333 foreign affiliates, accounting for almost 1,600,000 employees. Lombardia ranks first among regions, capturing about 20% of the phenomenon, both in terms of firms and employees. Emilia Romagna (6.8% and 7.1%), Piemonte (6.5% and 11.6%), and Veneto (5.9% and 3.9%) follow, ranking second, third and fourth respectively.
A strong territorial heterogeneity emerges: coefficients of variation and Gini's indices (calculated both among provinces in macro-areas, and at the national level) turn out to be fairly high, particularly, as far as employees in foreign enterprises participated by Italian companies are concerned[2]. Figure 1 shows this latter indicator at the NUTS3 level using a quantile[3] representation.

Moreover, inequality indices highlight an even higher heterogeneity when the sectoral dimension is also introduced (15 sectors, NACE code classification, 2 digit; their descriptions are reported in the Appendix) and this holds both within each macro area and at the national level. It emerges that foreign activities (as measured by employees in foreign affiliates in each province-sector) are more heterogeneous than the corresponding domestic activities. The coefficient of variation and the Gini's index calculated on the 1,545 overall observations (103 provinces per 15 sectors) are 6.749 and 0.948 for foreign activities vs. 2.288 and 0. 714 for the domestic ones.

In order to measure the degree of internationalisation of production at the NUTS3 level, we adopted the following indicator

$INT_{ij} = EMPLOYEESfor_{ij}/EMPLOYEES_{ij}$

With:

INT_{ij} = degree of internalisation of province i in sector j;

i = 1, .., 103 and j = 1, .. 15 (NACE code, 2 digit)

$EMPLOYEESfor_{ij}$ = number of employees in foreign affiliates by Italian companies set in province i and operating in sector j;

$EMPLOYEES_{ij}$ = number of employees of domestic firms set in province i and operating in sector j (such a measure does not include the employees of the Italian firms that are participated by foreign companies).

Data on outward FDI in each province have been extracted from the REPRINT database as in December 31st 2004, while the ones on domestic employees are from the *Censimento Generale dell'Industria e dei Servizi 2001* of the Italian National Statistic Institute (ISTAT).

Figure 2 provides a graphical representation of the variable INT_{ij} that confirms the existence of strong differences in the international activities by the Italian provinces. Such differences are highlighted also by the descriptive statistics of the indicator which has a

[1] The database was developed by the DIG - Politecnico di Milano and is sponsored by ICE (National Institute for Foreign Trade) since the beginning of 2001.
[2] The coefficient of variation calculated on the overall provinces is 3. 067 while the Gini's index is 0.848.
[3] Seven quantiles have been taken into account.

highly skewed distribution (skewness = 19.116) with mean 0.15 and standard deviation 1.45 (coefficient of variation = 9.667).

3. The determinants of the international growth at the local level

The heterogeneity in the internationalisation of the productive processes described in the previous paragraph leads to hypothesize a crucial role for the differences in structure, and behaviours at the local level. Particularly, the paper focuses on the relationships between the level of internationalisation of a geographical area and its peculiar virtuous aspects, as firms' innovativeness, knowledge generation processes and their spillovers, externalities and spillovers stemming from the presence and the interactions with foreign MNEs sited in the province, and previous international experiences.

The studies on knowledge spillovers from private and public R&D activities, and particularly from the proximity of Universities and research centres, frame mainly within the traditional literature à la Griliches-Jaffe[4]. These works highlight, through the modelling of various specifications of the *knowledge production function*, as spillovers from private research have a narrower range than whose stemming from public research, even if they both often cross administrative boundaries (Anselin et al., 1997; Autant-Bernard, 2001).

Additionally, the literature on foreign MNEs has acknowledged the importance of spillovers stemming from the presence of actors in a geographical area. It has been observed that MNEs necessarily own more efficient resources and technologies and often benefit from a more valuable knowledge (in other words, they posses ownership advantages allowing them to overcome the so called *liability of foreignness*). Thus, scholars have wondered whether these advantages *spill over* across the territory providing benefits also to the surrounding domestic firms. Spillovers from foreign MNEs have been classified as: (i) horizontal (or *intra-industry*) and vertical (or *inter- industry*). The former deal with knowledge and assets that are sector-specific and, therefore, exploitable also by competitors; they act through human capital mobility, reverse engineering, and imitation processes. The latter refer, instead, to assets that are utilizable by MNEs' suppliers or customers and encompass the creation of the so called *backward and forward linkages* between foreign multinational enterprises and domestic firms (Rodriguez-Clare, 1996). For instance, the demand for specialised inputs by MNEs creates linkages that increase the demand for local inputs. This drives the introduction of new advanced intermediate goods that stimulates the productivity of domestic firms and determines competitive advantages in the production of up to date final goods.

Finally, it is worth observing that spillovers may also assume a broader nature. Indeed, the presence in an area of foreign actors breeds a cosmopolitan atmosphere that acts as "bridge to foreign markets" for local firms. We define such spillovers as *lateral* (see Mariotti et al., 2006).

However, it is worth noting that the presence of foreign MNEs might also have negative effects on domestic companies. Indeed, multinational companies are likely to increase the competition in the sector in which they enter, thus leading local firms to reduce their production levels and their technical efficiency (*crowding out effect*). Aitken and Harrison (1999) have provided one of the most robust evidence on such a negative impact of the presence of foreign MNEs in a given sector (*intra-industry spillovers*), through a panel data

[4] We refer to the well known works by Griliches (1979) and Jaffe (1986, 1989).

analysis on Venezuela. Namely, the authors have shown that an increase in the foreign presence in a sector reduces the output and productivity levels of the domestic companies, both in the short and in the medium run, this holding particularly for smallest firms.

Therefore, the net impact on innovation and efficiency of the host economy does actually depend on which force will prevail, but different results have been obtained depending on the unit of observation, the methodology, and the indicators used in the analysis.

As in the above cited case of knowledge spillovers from private and public R&D activities, an additional recent debate has focused on the localisation of spillovers generated by the presence of foreign MNEs, investigating the existence of *inter-region* other than *intra-region* spillovers. Results dealing with the NUTS2 level in the United Kingdom (Driffield, 2006) have shown that MNEs externalities spread across neighbouring areas, but they are strictly localised within the regions in which foreign companies are located .

Finally, it is worth observing that other virtuous relationships play a role in determining the international growth, through FDI, of a province. Previous internationalisation experiences are likely to have a positive effect. Firms which pride themselves on a long experience in foreign markets, benefit from a reduced uncertainty in investing abroad; while their costs for overcoming the "liability of foreignness" are, in general, lower (Zaheer, 1995).

Likewise, it has been observed that lively external exchanges are likely to enhance the propensity to internationalisation of production by of a local area; however this is a much debated question. A traditional approach (see for instance Johanson and Vahlne, 1993) has postulated the existence of a direct linkage between trade and FDI. Exports and related market activities create favourable conditions in terms of information about countries, culture, and managerial resources that do pave the way for engaging in FDI initiatives (Lipsey and Weiss, 1981, 1984; Markusen, 1995). On the contrary, it is well known that the interplay of complementarity and substitution effects make the relationship between exports and foreign direct investments rather complex, and this holds for both horizontal and vertical FDI (Blonigen, 2001; Markusen, 2002; Helpman et al., 2004; Greenaway and Kneller, 2005). The former have *market seeking* objectives and aim at replicating abroad the parent company activities, thus possibly displacing exportations. The latter are instead mainly *resource-seeking* and often feed intra and inter-industry flows, thus contributing to make the relationship with trade fairly complex.

4. The econometric analysis: variables and models

The econometric analysis aims at shedding light on the heterogeneity of the Italian provinces with respect to the intensity of outward FDI of the firms sited in them. Hence, the dependent variable is the degree of internationalisation of production, as defined in section 2. The explanatory variables refer to the determinants discussed in the previous section and are defined as follows:

1) Local innovativeness has been proxied by the number patents granted by the European Patent Office, and weighted on the number of firms in each province. In particular, the variable INNOVATION has been constructed as the 2001-2003[5] period average.

[5] Data on patents have been provided by *The CRENoS-Centro Ricerche Economiche Nord Sud*. Particularly, we wish to acknowledge the valuable help of Barbara Dettori.

2) Knowledge spillovers stemming from the presence of Universities and research centres have been proxied by scientific publications. The variable PUBLICATIONS measures the total number of publications by public research institutes in each province (in thousand) in the period 1986-2002[6].

3) The presence of foreign MNEs has been proxied by two variables (source: REPRINT Database) taking into account inter- and intra-industry effects of inward FDI, respectively. Particularly, referring to each sector j:

- MNEs_SPEC assesses the presence of foreign MNEs, as the share in terms of employees on the total number of employees in the province. Hence it proxies the potential effects of *intra-industry* spillovers;

- MNEs_LAT refer to the presence of foreign MNEs in the province in all the other sectors but j, as the share in terms of employees. Hence it proxies the potential effects of the *inter-industry* (and lateral) spillovers.

In order to overcome possible endogeneity problems, these two indicators have been calculated as in 1.1.2002, namely lagged by three years with respect to the dependent variable.

4) The international experience (EXPERIENCE) has been proxied by a dummy variable assuming value 1 if sector j in the province i had been already internationalised at the end of 1994, and 0 otherwise.

5) The export propensity of a province (EXPORT) has been measured by the overall value (by sector) of its exportations weighted on the number of firms in each province/sector. Data have been extracted from the ISTAT databases and the variable is the 2000-2002 period average.

In order to take into consideration the effects of the general economic conditions of each local area, a general indicator of wellbeing has been included as a control variable (source: Il Sole 24 Ore, the variable refers to 2001). The industry-specific effects often reported by the literature (see for instance Hatzichronoglou, 1999) have been controlled through the introduction of sectoral dummies, while geographical dummies account for the disparities in economic development.

As we aim at testing the existence of spillovers among neighbouring provinces, the corresponding variables have been spatially lagged using a simple contiguity matrix W[7]. Hence, for each province/sector ij, the generic variable W_Xij is, the sum of the values that X assumes the neighbouring provinces.

The dependent variable is non negative, therefore traditional OLS estimations turn out to be inconsistent (Greene, 1993) and not suitable for the analysis. Scholars have proposed several estimation methods for these models, but the use of the two stage correction of the

[6] Data on scientific publication per province have been elaborated (ISI source), within the Prime Network of Excellence, by the research team of the University of Pisa. The authors wish to thank Andrea Bonaccorsi for providing the data.

[7] The generic w_{ik} element of the W matrix assumes value 1 if the provinces i and k share a common border and 0 otherwise *(Queen Contiguity Matrix).* Other representations of the spatial relationships among geographical areas take into account, in various ways, the geographical distance and/or other possible linkages among the areas (see for instance Doring and Schnellenback, 2006). So far, we only tried the Queen Contiguity Matrix in the econometric analysis.

OLS model, as proposed by Heckman (1979), has largely prevailed in the recent empirical literature. Its application to our case consists of: (i) a first stage corresponding to the estimation of a selection model (Probit model) that explains the probability that a province starts international growth processes; (ii) a second stage corresponding to the estimation of a truncated regression that accounts for the extent of the phenomenon.

Formally the overall model is expressed as follows:

$p^*_{ij} = z_{ij}\gamma + v_{ij}$ (probability of starting productive internationalisation processes)

$INT^*_{ij} = x_{ij}\beta + u_{ij}$ (truncated regression, dependent variable: degree of internationalisation)

With:

$INT_{ij} = INT^*_{ij}$ if $p^*_{ij} > 0$

$INT_{ij} = 0$ if $p^*_{ij} = 0$

and

$p_{ij} = 1$ if $p^*_{ij} > 0$

$p_{ij} = 0$ if $p^*_{ij} = 0$

According to this specification, the degree of internationalisation (INT_{ij}) assumes value 0 if no firm in the i province/ sector j has carried out outward FDI ($p_{ij} = 0$), while it is positive otherwise ($p_{ij} = 1$). Even if no a priori reason leads to exclude that explanatory variables act on both the specifications, their impact might be different in each stage.

Table 3 reports the descriptive statistics and the correlation matrix of the variables, showing that some rather high correlations should be taken into account in the interpretation the results. Particularly, the spatial lag of lateral MNEs spillovers (W_MNE_LAT) turns out to be significantly correlated not only with the variable from which it has been calculated (MNEs_LAT) but also with the spatially lagged indicators of the private (W_INNOVATION) and public (W_PUBLICATIONS) research. However, such high correlations are probably related to the peculiar definition of the W matrix, which assigns the same distance to two provinces independently of the sectors (see the concluding section for a detailed discussion of this point), this suggests to be cautious in interpreting of the results.

5. Results and conclusions

Tables 4 and 5 show the results of the econometric estimations. The former reports the results of the first stage (Probit models), while the latter summarises the estimations of the truncated models.

Probit models corroborate the hypothesis of a positive effect of private and public knowledge, both at the local level and in the neighbouring provinces on the starting of outward FDI processes of the generation. The coefficients of PUBLICATIONS and INNOVATION (correlation coefficient 0. 623) are both positive and significant in all the models ($p<.01$), and the same holds for their spatial lags (W_PUBLICATIONS and W_INNOVATION). Conversely, the presence of foreign MNEs seems to play no role, neither through MNEs' linkages with the local context nor through more general effects (the coefficient of the variables MNE_SPEC and MNE_LAT are not significantly different

from zero in any of the models, as well as their spatial spillovers). Finally, the local contest matters, the wellbeing indicator turning out to be significantly different from zero in all the specifications ($p<.01$), while the geographical dummies confirm the stronger propensity of the North West and North East to start international growth by FDI.

The truncated models, summarised in table 5, show that spillovers stemming from the presence of foreign MNEs (in particular from those in the same sector) determine an increase in the international involvement of the local areas. Foreign MNEs seem to affect the level of outward FDI, rather than triggering the starting of the internationalisation processes[8].

Additionally, it is worth noting that the propensity to export is positively related to the level of internationalisation of production, thus suggesting positive complementarity effects leading trade and outward FDI to move in the same direction. No significant result emerges with respect to whatever spatial lag.

Nevertheless, it should be acknowledged that the models have been estimated referring to contiguous spatial units that can hardly be considered as independent. Namely, spatial autocorrelation is likely to emerge and it should be taken into account in the specifications of the models. Thus, the future developments of the research aim at making use of the bridging-edge techniques developed within the spatial econometric framework (Arbia, 2006). Moreover, as our unit of observation is not simply geographical, but encompasses also the sectoral dimension, the contiguity matrix should be modified in a non traditional manner, in order to account also for structural/sectoral/technological similarities among provinces.

[8] A more robust and detailed analysis of this aspect, would require a precise measure of how much multinational enterprises are rooted in a territory (*embeddedness).* Nevertheless, the operationalisation of this concept is hardly operationalisable (Mariotti et al., 2006).

References

Arbia G. (2006), Spatial Econometrics. Statistical Foundations and Applications to Regional Convergence, Berlin, Springer.

Aitken B.J., Harrison A. E. (1999), Do domestic firms benefit from direct foreign investment? Evidence from Venezuela, American Economic Review, 89, pp.605-618.

Autant-Bernard C. (2001), The geography of knowledge spillovers and technological proximity, Economics of Innovation and New Technology, 100, pp. 237-254.

Anselin L., Varga A., Acs Z.A. (1997), Entrepreneurship, geographic spillovers and university research: A spatial econometric approach, Working paper n. 59, ESRC Centre for Business Research, University of Cambridge.

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

Cooke P., Morgan K. (1998), The Associational Economy: Firms, Regions, and Innovation, Oxford, Oxford University Press.

Doring T., Schnellenbach J. (2006) What Do We Know about Geographical Knowledge Spillover and Regional Growth? A Survey of the Literature, Regional Studies, 40, pp. 375-395.

Driffield N. (2006), On the search for spillovers from Foreign Direct Investment (FDI) with spatial dependency, Regional Studies, 40, pp. 107-119.

Frost T.S. (2001), The geography sources of foreign subsidiaries' innovation, in Strategic Management Journal, 22, pp. 101-123.

Greenaway D., Kneller R. (2005), Firm Heterogeneity, Exporting and Foreign Direct Investment: A Survey, GEP working paper n. 32, Leverhulme Centre.

Griliches Z. (1979) Issues in assessing the contribution of R&D to productivity growth, Bell Journal of Economics, 10, pp. 92-116.

Hatzichronoglou T. (1999), The Globalisation of Industry in Oecd Countries, in STI Working Papers, n. 2.

Heckman L. (1979), Sample selection bias as a specification error, Econometrica, 47, pp. 153-161.

Helpman E., Melitz M.J., Yeaple S.R. (2004), Export versus FDI with heterogeneous firms, American Economic Review, 94, pp. 300-316.

Jaffe A. (1986), Technological opportunity and spillovers of R&D: evidence from firms' patents, profits and market value, American Economic Review, 76, pp. 984-1001.

Jaffe A. (1989), Real effects of academic research, American Economic Review, 79, pp. 957-970.

Johanson J, Vahlne J.E. (1993), The internationalisation process of the firm. A model of knowledge development and increasing foreign commitments, in Buckley P., Ghauri P. (a cura di), The internationalisation of the firm, London, Academic Press.

Lipsey R.E, Weiss M.Y. (1981), Foreign production and exports in manufacturing industries, Review of Economics and Statistics, 63, pp. 488-494.

Lipsey R.E, Weiss M.Y. (1984), Foreign production and exports of individual firms, Review of Economics and Statistics, 66, pp. 304-308.

Markusen J.R. (1995), The boundaries of multinational enterprises and the theory of international trade, Journal of Economic Perspectives, 9, pp. 169-189.

Mariotti S., Mutinelli M., Piscitello L. (2006), Eterogeneità ed internazionalizzazione produttiva dei distretti industriali italiani, L'Industria, 27, pp. 173-201.

Moran T.H., Graham E.M., Blomstrom M. (a cura di), 2005, Does Foreign Direct Investment Promote Development?, Institute for International Economics, Center for Global Development: Washington DC.

Markusen J.R. (2002), Multinational Firms and the Theory of International Trade, Cambridge, MIT Press.

Rodriguez-Clare A. (1996) Multinationals, Linkages and Economic Development, American Economic Review, 86, pp. 852-873.

Storper M. (1997), The Regional World: Territorial Development in a Global Economy, New York, The Guilford Press.

Zaheer, S. (1995), Overcoming the liability of foreignness, Academy of Management Journal, 38, pp. 341-63.

Table 1 – Outward FDI by Italian firms – Foreign companies participated by Italian firms and their employees. 2004

(Gini's indices and coefficients of variation)

Macro-area	Region (No)	Foreign companies participated by Italian firms		Employees in foreign companies participated by Italian firms	
		Number	%	Number	%
NORTH WEST	Liguria (4)	28	0.30	2094	0.13
	Lombardia (11)	1824	19.54	311985	19.56
	Piemonte (8)	608	6.51	185407	11.62
	Valle d'Aosta (1)	1	0.01	56	0.00
	Total (24)	2461	26.37	499542	31.32
	Gini's index	0735		0.769	
	Coefficient of variation	1.975		2.131	
NORTH EAST	Emilia Romagna (9)	630	6.75	114043	7.15
	Friuli Venezia Giulia (4)	97	1.04	7993	0.50
	Trentino Alto Adige (2)	76	0.81	7669	0.48
	Veneto (6)	551	5.90	62910	3.94
	Total (22)	1354	14.51	192615	12.08
	Gini's index	0.508		0.628	
	Coefficient of variation	1.005		1.616	
CENTRE	Lazio (5)	355	3.80	42042	2.64
	Marche (4)	120	1.29	21223	1.33
	Toscana (10)	217	2.33	22615	1.42
	Umbria (2)	34	0.36	3283	0.21
	Total (21)	726	7.78	89163	5.59
	Gini's index	0.715		0.784	
	Coefficient of variation	2.145		2.246	
SOUTH	Abruzzo (4)	26	0.28	2331	0.15
	Basilicata (2)	5	0.05	181	0.01
	Calabria (5)	4	0.04	1030	0.06
	Campania (5)	40	0.43	5342	0.33
	Molise (2)	2	0.02	105	0.01
	Puglia (5)	38	0.41	6274	0.39
	Total (23)	115	1.23	15263	0.96
	Gini's index	0.609		0.713	
	Coefficient of variation	1.359		1.644	
ISLANDS	Sardegna (4)	7	0.08	680	0.04
	Sicilia (9)	14	0.15	1199	0.08
	Total (13)	21		1879	
	Gini's index	0.630		0.716	
	Coefficient of variation	1.252		1.594	
ITALY	Total	9333	100.00	1595045	100.00
	Gini's index	0.776		0.848	
	Coefficient of variation	2.470		3.067	

Table 2 Province/sector heterogeneity in the industrial structure and outward FDI

Macro-area	Region	Employees by sectors (a)		Employees (by sector) of the foreign companies participated by Italian firms (b)	
		Coefficient of variation	Gini's Index	Coefficient of variation	Gini's index
NORTH WEST	Liguria (60)	1.583	0.647	2.787	0.893
	Lombardia (165)	1.956	0.715	3.454	0.882
	Piemonte (120)	0.905	0.478	1.519	0.667
	Valle d'Aosta (15)	1.207	0.588	3.873	0.933
Total North West (360)		2.339	0.755	4.478	0.928
NORTH EAST	Emilia Romagna (135)	1.559	0.610	6.295	0.923
	Friuli Venezia G.(60)	1.480	0.658	2.404	0.829
	Trentino A.A. (30)	0.778	0.419	1.596	0.722
	Veneto (105)	1.134	0.572	2.043	0.796
Total North East (330)		1.340	0.618	5.959	0.884
CENTRE	Lazio (75)	1.667	0.691	3.655	0.928
	Marche (60)	1.341	0.580	4.197	0.915
	Toscana (150)	1.785	0.650	3.963	0.907
	Umbria (30)	1.253	0.599	2.675	0.850
Total Centre (315)		1.613	0.647	4.485	0.929
SOUTH	Abruzzo (60)	1.157	0.562	5.086	0.946
	Basilicata (30)	1.380	0.565	3.451	0.927
	Calabria (75)	1.274	0.596	5.530	0.969
	Campania (75)	1.163	0.565	3.566	0.911
	Molise (30)	1.291	0.574	5.477	0.967
	Puglia (75)	1.493	0.640	3.803	0.931
Total South (345)		1.548	0.650	4.775	0.950
ISLANDS	Sardegna (60)	1.323	0.601	6.842	0.977
	Sicilia (135)	1.186	0.566	6.053	0.973
Total Islands (195)		1.234	0.579	6.420	0.976
Total Italy (1545)		2.288	0.714	6.749	0.948

Note:
(a) Data as in 2001 (Istat)
(b) Data as at the end of 2004
* No. provinces x no. sectors

Table 3 – Descriptive statistics and correlation matrix

Variable	INT	INNOVATION	W_INNOVATION	PUBLICATIONS	W_PUBLICATIONS	EXPORT	MNEs_SPEC	W_MNEs_SPEC	MNEs_LAT	W_MNEs_LAT	EXPERIENCE	WELLBEING
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	376.00
Maximum	33.33	0.07	0.13	48.92	63.41	402.82	8.17	9.19	0.34	1.21	1.00	575.00
Mean	0.15	0.01	0.04	3.52	19.76	1.22	0.088	0.42	0.07	0.36	0.22	467.77
Standard deviation	1.45	0.01	0.03	7.83	16.96	10.75	0.36	0.81	0.08	0.26	0.41	40.30
Number of observations	1545	1545	1545	1545	1545	1545	1545	1545	1545	1545	1545	1545
INT	1											
INNOVATION	0.010	1										
W_INNOVATION	0.025	0.078	1									
PUBLICATIONS	0.032	0.623	-0.021	1								
W_PUBLICATIONS	-0.023	-0.103	0.624	-0.118	1							
EXPORT	0.186	0.001	-0.015	0.013	-0.008	1						
MNEs_SPEC	0.042	0.017	0.022	0.032	0.044	0.049	1					
W_MNEs_SPEC	-0.009	0.057	0.178	0.085	0.206	0.029	0.067	1				
MNEs_LAT	0.004	0.302	0.152	0.307	0.148	0.006	0.125	0.101	1			
W_MNEs_LAT	0.015	0.173	0.538	0.187	0.567	-0.015	0.056	0.252	0.429	1		
EXPERIENCE	0.034	0.287	0.226	0.288	0.067	-0.004	0.025	0.100	0.102	0.198	1	
WELLBEING	0.025	0.354	0.477	0.160	0.165	0.001	0.031	0.093	0.221	0.313	0.226	1

Table 4 –Probit models

(dependent variable = dummy_INT)

Variable	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
COSTANT	-3.014 ***	-2.451 ***	-2.896 ***	-2.459 ***	-3.698 ***
	(0.560)	(0.575)	(0.565)	(0.577)	(0.600)
INNOVATION	11.204 **	15.829 ***	13.345 ***	15.842 ***	16.237 ***
	(5.046)	(5.122)	(5.101)	(5.124)	(5.144)
W_INNOVATION		7.870 ***		7.651 ***	8.011 ***
		(1.420)		(1.843)	(1.895)
PUBLICATIONS	0.037 ***	0.035 ***	0.038 ***	0.036 ***	0.036 ***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
W_PUBLICATIONS			0.009 ***	0.001	0.001
			(0.002)	(0.003)	(0.003)
EXPORT	0.007	0.007	0.007	0.007	0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
MNEs_SPEC	-0.031	-0.054	-0.060	-0.055	-0.040
	(0.158)	(0.177)	(0.171)	(0.177)	(0.175)
W_MNEs_SPEC					0.077
					(0.056)
MNEs_LAT	-0.935	-1.187	-1.161 *	-1.195 *	-1.073 *
	(0.611)	(0.620)	(0.617)	(0.621)	(0.642)
W_MNEs_LAT					-0.216
					(0.243)
EXPERIENCE	1.557 ***	1.522 ***	1.541 ***	1.522 ***	1.518 ***
	(0.109)	(0.110)	(0.110)	(0.110)	(0.110)
WELLBEING	0.005 ***	0.003 ***	0.005 ***	0.003 ***	0.004 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NORD OVEST	0.455 ***	0.313 ***	0.397 ***	0.313 ***	0.344 ***
	(0.106)	(0.110)	(0.107)	(0.110)	(0.119)
NORD EST	0.341 ***	0.139	0.363 ***	0.146	0.140
	(0.128)	(0.134)	(0.128)	(0.140)	(0.140)
Sectoral dummies	YES	YES	YES	YES	YES
No. of observations	1,545	1,545	1,545	1,545	1,545

Standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1

Table 5 – Truncated models

(Dependent variable = D_INT)

Variable	Equation 1		Equation 2		Equation 3		Equation 4		Equation 5	
COSTANTE	-0.055		-0.251		-0.996		-0.398		-2.174	
	(2.650)		(2.469)		(2.599)		(2.429)		(2.569)	
INNOVATION	-9.312		-7.004		-9.241		-6.163		-5.561	
	(10.303)		(10.862)		(10.544)		(10.904)		(10.923)	
W_INNOVATION			3.298				8.005		7.822	
			(4.296)				(5.165)		(5.465)	
PUBLICATIONS	0.014		0.016		0.018		0.015		0.015	
	(0.017)		(0.002)		(0.018)		(0.017)		(0.017)	
W_PUBLICATIONS					-0.003		-0.013		-0.012	
					(0.007)		(0.008)		(0.008)	
EXPORT	0.026	***	0.026	***	0.027	***	0.027	***	0.027	***
	(0.006)		(0.007)		(0.007)		(0.007)		(0.007)	
MNEs_SPEC	2.979	***	2.997	***	2.943	***	2.972	***	2.967	***
	(0.674)		(0.674)		(0.674)		(0.673)		(0.674)	
W_MNEs_SPEC									-0.185	
									(0.172)	
MNEs_LAT	-1.112		-1.272		-1.473		-1.446		-1.503	
	(1.782)		(1.795)		(1.801)		(1.798)		(1.867)	
W_MNEs_LAT									0.096	
									(0.668)	
EXPERIENCE	0.484		0.565		0.726		0.653		0.701	
	(0.602)		(0.564)		(0.588)		(0.567)		(0.563)	
WELLBEING	0.001		0.001		0.002		0.001		0.001	
	(0.004)		(0.004)		(0.004)		(0.004)		(0.004)	
NORD OVEST	0.139		0.130		0.265		0.217		0.209	
	(0.326)		(0.308)		(0.323)		(0.312)		(0.343)	
NORD EST	0.337		0.280		0.381		0.155		0.125	
	(0.349)		(0.329)		(0.354)		(0.340)		(0.340)	
Sectoral dummies	SI		SI		SI		SI		SI	
No. of observations	1,545		1,545		1,545		1,545		1,545	
Censored observations	986		986		986		986		986	
Uncensored observations	559		559		559		559		559	
Wald chi2	502.18	***	512.23	***	507.25	***	503.83	***	523.19	***
Mills										
Lambda	0.759		0.901		1.062		1.013		1.044	
	(0.706)		(0.685)		(0.694)		(0.687)		(0.685)	
Rho	0.326		0.383		0.446		0.428		0.441	
Sigma	2.328		2.350		2.379		2.366		2.369	

Standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1

Figure 1 – Employees of foreign companies participated by Italian firms (total, NUTS3 level, as in 2004). Quantile representation

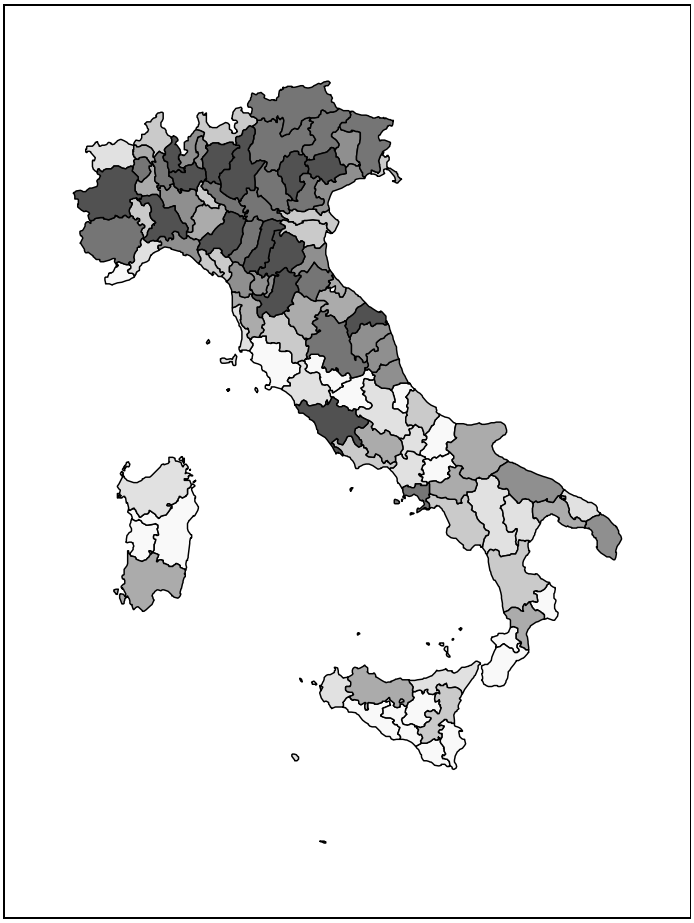
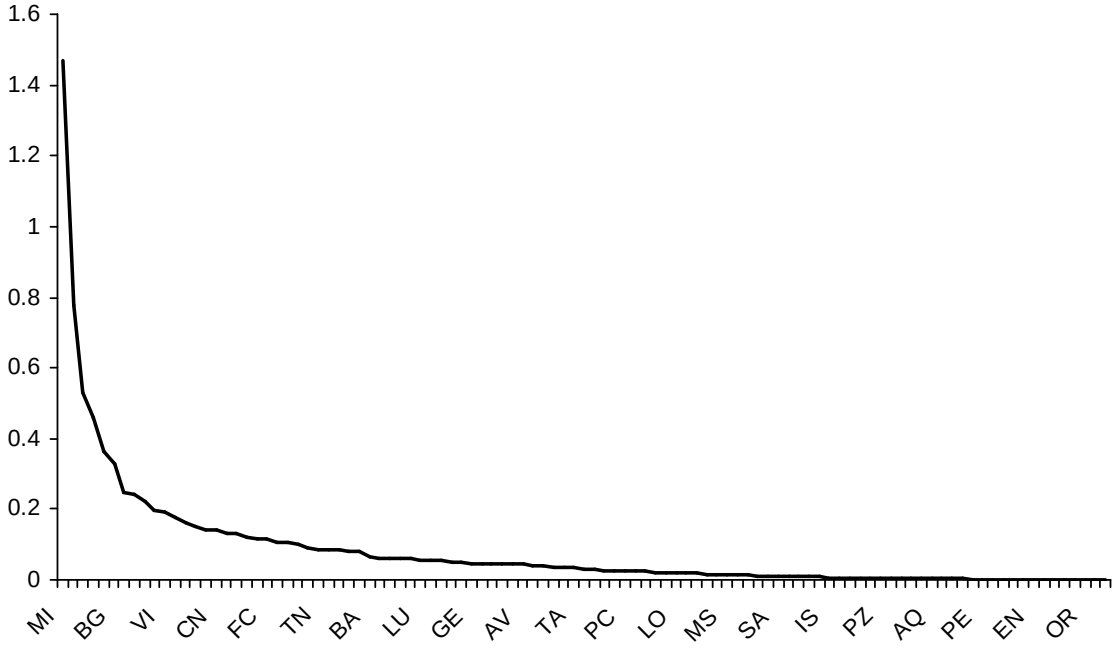


Figure 2 – Degree of internationalisation of the Italian provinces (2004)



APPENDIX I

Table A1: NACE code classification, 2 digit

	SECTORS
S1	Mining industry
S2	Food, drinking and tobacco industry
S3	Textile and clothing industry
S4	Hides, shoes, and leather goods
S5	Wood and wooden goods
S6	Papermaking industry, publishing, and press
S7	Petrol by-products and other fuels
S8	Chemicals, artificial, and synthetic fibres
S9	Plastic and rubber industry
S10	Non metalliferous ore industry
S11	Metalliferous ore industry
S12	Machine tools and mechanical equipments
S13	Electrical and electronic products and equipments
S14	Means of transport
S15	Other sectors