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The Etna Valley case**

by
Grazia D. Santangelo



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FDI and local capabilities in peripheral regions: the Etna Valley case

Grazia D. Santangelo *

This article analyzes the locational preferences of transnational corporations across provinces (sub-regional political and economic territorial units) of Sicily (Italy) at 2001 in the light of an incentives programme granted under a new regional development policy. The issue is particularly timely due to the rediscovery of space as a crucial element in economic activity. Scholars are paying increasing attention to sub-national units. However, they have focused mostly on core regions, neglecting the peripheral ones. Moreover, even the few studies investigating the activities of transnational corporations in peripheral regions have disregarded intra-regional disparities due to constraints of data availability. This article, based on a unique set of data, shows through a Poisson regression model that, unlike what is predicted by the current literature, the locational preferences of transnational corporations in Sicily are driven by local high-skilled competences (also reflected in high wages), high degrees of trade openness, proximity to universities, and low information costs. The econometric results also suggest an agglomeration of foreign affiliates in electronics, and chemicals and pharmaceuticals in what has been named the “Etna Valley”. However, while local productive (and indirectly technological) competences in chemicals and pharmaceuticals have acted as a catalyst for foreign direct investment in the province, these competences were initially lacking in electronics.

* Facoltà di Scienze Politiche, Università degli Studi di Catania, Catania, Italy. The author wishes to thank the participants in a research seminar given at the Department of General and Strategic Management of Temple University, three anonymous referees and the participants in the 29th EIBA Conference for comments and suggestions on earlier versions of this article. The author is also grateful to Sergio Mariotti, Marco Mutinelli and Lucia Piscitello from Politecnico di Milano for having provided the FDI data for this study. The author thankfully acknowledges the financial support of 2003-2005 PRIN research programme on “Investimenti diretti esteri e spillover locali di conoscenza: il cluster tecnologico di Catania”, sponsored by MIUR. The usual disclaimer applies. Contact: grsanta@unict.it.

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Introduction

Studies on the location of foreign direct investment (FDI) embracing a macroeconomic perspective have traditionally adopted the nation State as the unit of analysis. Following some major theoretical developments that have re-discovered the role of *space* in economic activity, some articles have started to analyze FDI at a more detailed geographical level (Dunning, 2000). Despite some exceptions (e.g. Mariotti and Piscitello, 1995), the territorial unit of analysis of these more recent streams of research has been the sub-national region. Empirical analysis has been concerned mainly with FDI in production or technology localized in *higher-order* centres disregarding peripheral sites (e.g. Cantwell and Iammarino, 2001). Few studies have been devoted to investigate the location of the activities of transnational corporations (TNCs) *in* or *within* peripheral regions (e.g. Amin *et al.*, 1994), while a large literature investigates the determinants of the location of TNCs in developing countries (e.g. Dunning and Narula, 1996).

However, the understanding of the interplay between the global and local dimensions has become crucial for both corporate managers and local governments for the sake of global competitiveness and local development, respectively. On the one hand, the new role of the foreign affiliate within the corporate network and its greater interaction with the local environment (Birkinshaw, 1996) can be exploited fully if local geography is appreciated correctly. At the intra-regional level, for instance, the agglomeration of potential local capabilities in peripheral centres may attract FDI and, then, shape corporate location strategies by diverting them from mere market-oriented motives. On the other hand, *vicious cycles* of local socio-economic conditions can be inverted by attracting TNCs, which, in turn, act as an engine of local development. Inward FDI is, indeed, an additional channel through which new ideas, working practices

and technologies are sourced into the host economy (Barrell and Pain, 1999). If, in favour of peripheral locations, potential gains have risen from the decentralization of corporate activities generated by new corporate organizational forms and by the emergence of information and communications technology (ICT), some skeptical views have been expressed on their long-run sustainability due to the immobile nature of knowledge (Camagni, 1992). As shown empirically elsewhere (Cantwell and Santangelo, 2002), far from reducing geographical differentials in terms of local capabilities, the ICT revolution has enhanced spatial imbalances both across and within borders.

Within this theoretical framework, the surge of FDI in Sicily in the mid-1990s represents an emblematic case of locational choice by TNCs in a region classified as peripheral both in the national and European context.¹ However, the implications of the implementation of the European Union's (EU) regional policy should be taken into account when evaluating this pattern. Due to the take-off of the EU regional policy, the development of depressed Italian regions is nowadays pursued mainly through the attraction of production by incentives. Nonetheless, although the boom of FDI in high-technology industries in the island may be attributed to the new incentive policy, within Sicily FDI may be distributed unevenly across provinces suggesting the presence of differential basic location determinants.

The aim of the article is twofold: to analyze the geographical and sectoral distribution of production activities carried out by TNCs across Sicilian provinces; and to explain locational preferences of TNCs across provinces and industries once they have chosen to establish their productive activities in Sicily. Within this framework, the study attempts to evaluate whether potential emerging areas of local expertise acting as catalysts for TNCs' investments can be identified within the island. The analysis is carried out by combining territorial data

¹ Sicily is classified as an Objective 1 region within the European Union's regional policy.

(drawn from different sources) with inward FDI data.² The FDI data refer to 48 manufacturing foreign-affiliate plants located in the nine Sicilian provinces (corresponding to level 3 of the Nomenclature of Territorial Units for Statistics (NUTS3) adopted by the European Commission³) in May 2001.

The next section of this article sets the theoretical scene. The subsequent section sketches the situation of FDI in Sicily in the late 1990s in geographical and sectoral terms. Then a description of the variables and the models adopted follows. The pen-ultimate section discusses the econometric results. A few brief policy implications are drawn in the concluding section.

The renewed importance of the location advantage

The issue of FDI location is traditionally linked with a theoretical attempt to explain the existence of TNCs.⁴ More recent literature drawing on Stephen Hymer's (1970) work (i.e. new trade theory, and geography and trade) has emphasized the significance of an imperfect market environment and an imperfect industrial structure as primary conditions creating advantages for FDI. Imperfections of the market environment allow TNCs to obtain monopolistic advantages through FDI *vis-à-vis* local companies. An imperfect industrial structure enables firms to become TNCs by obtaining intangible assets from their investments in

² The data are the result of the updating of the 1998 Reprint (Cnel-R&P-Politecnico of Milan) database up to May 2001. The updating has been conducted by consulting the local and national press as well as by interviewing local agencies involved in local development. Consistently with the Reprint (Cnel-R&P-Politecnico of Milan) database and in line with the 1997 criteria of the International Monetary Fund, FDI is defined as corporate acquisitions of control or (minority or majority) long-term interests embodying a certain degree of involvement of the investor in the direction and management of the company.

³ For a comprehensive description of the NUTS classification, see Eurostat, 1995.

⁴ For a review on international production theories, see e.g. Ietto-Gilles, 1992.

advertising and research and development (R&D) (Markusen, 1995). Conversely, internalization theory (Buckley and Casson, 1976) has stressed the importance of asymmetric information in operations carried out abroad, arguing that high information costs (and more general transaction costs) push firms to internalize rather than licensing foreign operations. A more comprehensive framework has been provided by John H. Dunning's (1993) eclectic paradigm, which, moving away from the predictive theories of TNCs, identifies the determinants of international production in ownership, location and internalization (OLI) advantages. According to this framework, TNCs have competitive *ownership* (O) advantages by comparison to their competitors in terms of both intangible and productive assets. Ownership advantages can be utilized to establish affiliates in sites that are attractive for their *location* (L) advantages. Across different locations, TNCs can enjoy *internalization* (I) advantages rising from the ease of appropriating returns and from the exploitation of complementary assets within their integrated corporate structure. Major attention has been devoted to the study of I advantages in explaining the existence and growth of the firms so far. Nonetheless, although firm-specific determinants of international economic activity is still a major topic of academic research, international business scholars have shown a renewed interest in the spatial aspect of FDI (Dunning, 1998).

Due to the drastic technological, economic and political changes of the past two decades, as well as to the theoretical attempts (i.e. new trade theory, economic geography, and international political economy) to analyze further and integrate this aspect into mainstream research, L advantages have gained increasing relevance in academic investigation. Among the changes that have geared the rethinking of L advantages, the emergence of knowledge as a crucial asset and the technological revolution starting in the late 1960s have doubtless played a major role. These two aspects have, indeed, generated concurrent centripetal and centrifugal forces in the sense that, if technological advantage has eased the transfer of knowledge across and within borders, the production of knowledge is still

embedded locally. Thus, contrary to what is sometimes alleged, globalization and national/regional specialization are complementary parts of a common process, and not conflicting trends (Archibugi and Michie, 1997). Along these lines, it has been stressed that TNCs arise “not out of the failure of markets for the buying and selling of knowledge, but out of its superior efficiency as an organizational vehicle by which to transfer this knowledge across borders” (Kogut and Zander, 1993, p. 625). Besides FDI motives dictated by adaptation to host markets (i.e. home-base exploiting motives (Kuemmerle, 1996)), TNCs’ decisions on setting up foreign affiliates are geared increasingly by the need to tap into local capabilities (i.e. home-base augmenting motives (*ibid.*)). The recent growth of strategic asset-seeking FDI – and consequently the more embedded ties of foreign affiliates with the local environment – bear testament to this view. Accordingly, empirical evidence on FDI as a strategy to source abroad knowledge-intensive assets (Dunning and Lundan, 1998), as well as to acquire know-how reinforcing the strengths or complementing the weakness of investors (Chen and Chen, 1998), has been gathered. Therefore, TNCs are increasingly looking for high-value capabilities in order to complement their core competences, with the due exceptions for some labour and resource investments in developing countries.

This new techno-socio-economic situation raises two orders of implications. The first order concerns corporate organization: at the inter-firm level, a relational, collective and collaborative form of capitalism, “alliance capitalism” (Dunning, 1995), has emerged; at the intra-firm level, TNCs are coordinating increasingly their internal networks through heterarchical (as opposite to hierarchical) organizational forms. The interaction of affiliates with the local environment, which results from broad mandates granted by the parent company, enables the whole corporate structure to tap into locally specific and differentiated streams of innovation in each site, and reinforces local strengths. The second order of implications refers to the paradox of “sticky places within slippery regions” (Markusen, 1996) resulting from the more pronounced

geographical concentration of production and technology within countries and regions. FDI may, indeed, lead to the establishment of local manufacturing industries (Markusen and Venables, 1999).

The growing significance of knowledge-related infrastructures and the theoretical stream of research started by Paul Krugman's (1991) work have drawn attention to sub-national spatial units (mainly sub-national regions) based on the idea that increasing returns are essentially a regional and local phenomenon arising from economic agglomeration and specialization.⁵ This implies that the locational factors attracting TNCs can be analyzed at local levels since those environments are "the product of historical processes that are not easily imitated or altered" (Saxenian, 1994, p. 162). Unlike classical locational theory (Lösch, 1954) – which explains agglomeration economies mainly in terms of a reduction in transaction costs and cheap labour – the theoretical developments which have taken place since the 1980s have underlined the importance of localized high value added and its cumulative and path-dependent nature in explaining economic agglomeration and performance.⁶

However, economic agglomerations may show a more specific spatial pattern as a result of intra-regional disparities. Agglomerations rise from the immobile nature of knowledge, which may further feed intra-regional disparities. John Cantwell and Lucia Piscitello (2002), for instance, show the significance of potential intra- and inter-industry knowledge spillovers as crucial locational determinants of R&D in foreign affiliates. In turn, TNCs can play a role as flagship firms in the establishment

⁵ For a survey on the new economic geography see e.g. Ottaviano and Puga, 1997.

⁶ These theoretical lines can be summarized in the neo-Marshallian model of industrial districts and local production systems (concerning mainly the studies on the "Third Italy"); the development of the evolutionary theory and the notion of "innovative milieu" (Maillat, 1995) and 'technopole' (Castells and Hall, 1994); and the extension of work on the organization of industrial production (Piore and Sabel, 1984).

of new high-technology clusters (Arora *et al.*, 2000), in which cascading effects due to the observation of other investors can reinforce this process (Mody and Srinivasan, 1998). Thus, countries/regions engage in international tournaments to attract FDI in order to improve their locational advantages and local-firms ownership advantages through spillovers and linkages generated by activities of foreign affiliates (Cantwell and Narula, 2001). However, the impact of TNCs' activities on host economies depends greatly on the type of the local affiliate, its technical capabilities (relative to the corporate network), the scale of its innovative activity, as well as on the positions of the home and host locations in the field in which the affiliate operates (Frost, 2001). As argued by Catherine Beaudry and Stefano Breschi (2000), clustering *per se* is not sufficient to explain firms' innovative performance since it needs to be complemented by innovative persistence and accumulated stock of knowledge. Thus, in the emergence of high-technology clusters, the *coevolution* of emergent and guided processes should be accounted for. As far as the former is concerned, the unintentional impact of firms, for instance, on the creation of locational advantages, are the relevant factors. Conversely, guided processes are the intentional results of institutional actors (i.e. Governments) aiming at contributing to the development of L advantages.

The findings concerning incentives are controversial despite of the recognized role of governments in promoting FDI-assisted growth (Dunning and Narula, 1996) and the worthwhile participation of governments in location tournaments (Mudambi, 1995). If evidence has been provided on the irrelevance of incentives in attracting FDI in Italy in the 1980s (Mariotti and Piscitello, 1995), it has also been shown that there is not single recipe as far as incentive are concerned since different kinds of incentives attract different kinds of FDI (Rolfe *et al.*, 1993). Accordingly, at a more theoretical level, it has been argued that the impact of incentives seems to be more effective in R&D intensive industries (Sanna-Randaccio, 2002). The Irish case appears to be indicative in this respect due to the successful attraction of FDI in high-technology industries in the 1990s

through a policy of trade liberalization and locational incentives (Barry and Bradley, 1997). However, this model seems to have provided only a short-term solution to the development issue, given the recent intention of some major TNCs to move outside Ireland (see e.g. *Business Week*, 30 July 2001). This suggests a structural weakness of the local system in absorbing foreign capabilities and feeding them locally in order to invert the vicious cycle.⁷ Local absorptive capacity is a key factor for local firms to benefit from optimal potential spillovers and linkages, which are the outcome of the “right kind” of FDI. In fact, if local technological capabilities are weak in the sector of TNCs’ activity, FDI may drive out local competition and further reduce local technological expertise (Cantwell, 1987). Conversely, strong local capabilities are reinforced by a dynamic interaction with foreign investors. Thus, the success of incentive for high quality inward investment requires the host location to have a rich resource base (Cantwell and Mudambi, 2000).

The debate on the role of incentives in enhancing the L advantages of depressed regions through the attraction of FDI and, consequently, that of TNCs in the take-off of local high-technology clusters gains particular momentum in the case of Sicily, for two reasons. First, radical changes in governmental policy towards depressed regions in the early 1990s (entering into force in the mid-1990s), stimulated by the take-off of the EU regional policy,⁸ transferred the right to implement economic policies to sub-national regional governments. Within this new

⁷ As shown empirically by Barry and Bradley (1997, p. 1801): “FDI inflows in Ireland have not gone primarily into industries in which the economy has a traditional comparative advantage”. Therefore, a TNC’s threat of relocating its investment from the country once an incentive policy comes to an end seems to be revealing of a lack of local competences in the industries of interest for TNCs.

⁸ Up to then, the issue of Italy’s *Mezzogiorno* was tackled through a national policy inspired by a model of basic industrialization targeting the development of depressed regions by locating there public companies operating in energy industries in order to boost the local economy. Given the weakness of the industrial structure of southern regions (mainly based on traditional manufacturing industries), this policy had the effect of further hampering their economic development.

political approach, incentives have been granted for the establishment of productive activities in depressed Italian regions. Second, in the mid-1990s, massive FDI flows into the southern regions (as compared to the rest of the country) took place (Mariotti and Mutinelli, 1999). Moreover, inward FDI flows targeted especially high-technology industries and Sicily.

Given that new kinds of incentives are available for all Sicilian provinces, the aim of this article is to investigate whether there are specific drivers to locational decisions of TNCs once they have decided to establish their production plants in the island in order to investigate whether some provinces show greater agglomerations of FDI than others. International, national and local newspapers, as well as some major consulting companies (e.g. KPMG, 2002, Appendix C), have claimed increasingly that a phenomenon of agglomeration in high-technology industries (such as electronics, chemicals and pharmaceuticals) appears to be at work in the Sicilian province of Catania, wishfully labelled “Etna Valley” after the nearby volcano. Thus, this may suggest that the locational preferences of TNCs may be driven by local capabilities and embedded value-added.

The geography and sectoral structure of inward FDI in Sicily

Before evaluating the determinants of the decisions of TNCs, the geographical and sectoral structure of inward FDI in Sicily is analyzed briefly. FDI inflows into the island have originated in different home countries. United States TNCs own by far the greatest number of foreign affiliates (more than 40%), followed by French TNCs, which account for almost 23% (table 1). German and United Kingdom FDI is more contained (each of them represent slightly more than 6%), although it is more important than FDI from other Western European countries (such as Sweden and Switzerland, whose shares equal those of Canada and Japan). If this suggests that geographical distance does not matter for United States TNCs and, to a lesser extent, for the Canadian and Japanese one, it does for European TNCs accounting for small shares of FDI in the region (with the

exception of French TNCs). These disparities may be due to different degrees of experience across national groups of TNCs (Davidson, 1980). Firms with extensive experience (such as United States TNCs) exhibit less preference for near and similar markets. Conversely, less experienced firms (e.g. European TNCs) may perceive Sicily as less attractive because of high uncertainty due to the lack of an inward FDI record. However, international trends should be also borne in mind when reading these figures since the 1990s witnessed a rise in United States outward FDI, showing a peak in the years 1996 and 1997 (UNCTAD, 1997). This pattern is also confirmed when looking at the distribution of foreign affiliates by country of origin in Italy as a whole (table 1). It is worth noting the presence, although contained, of Swedish TNCs in Italy, despite their traditional preference for high-income locations (Blomström *et al.*, 1997).

Table 1. Share of foreign-owned plants located in Sicily and Italy, by firm national group
(Per cent)

Country of origin	Sicily	Italy
Canada	4.2	1.3
Finland	2.1	1.2
France	22.9	13.9
Germany	6.3	19.1
Japan	4.2	5.7
Kuwait	2.1	0.0
Netherlands	2.1	4.5
Sweden	4.2	1.4
Switzerland	4.2	12.0
United Kingdom	6.3	11.8
United States	41.7	29.0
European total	47.9	63.9
North American total	45.8	30.3
Asian total	6.3	5.7
Total	100.0	100.0

Source: author's calculations, based on *Italia Multinazionale 1998* (1999).

The idea of an uneven distribution of foreign affiliates across the nine Sicilian provinces gathers support from a two-way ANOVA analysis – grouping foreign affiliates by province and industry – which aims at identifying significant effects of specific factors (namely, PROVINCE and SECTOR) on the distribution of FDI. The results of the analysis reported in table 2 show that the factor PROVINCE is statistically significant ($p < 0.05$) while the factor SECTOR is not, thus confirming the uneven distribution of foreign affiliates across the Sicilian provinces, but not across industries. These results have been further plotted in figure 1, in which Catania is by far the province hosting the highest number of foreign affiliates, followed by Syracuse. Although the ANOVA analysis does not enable to identify a statistically significant difference in the distribution of foreign affiliates across the 10 industries considered, table 3 shows that “mechanical equipment and metal products” (which in the database mainly contains electronics firms), “chemicals and pharmaceuticals” and “oil and energy products” represent together almost 80% of the total number of manufacturing foreign affiliates located in the island.⁹ However, if the significance of the latter industry is understandable due to the

Table 2. Two-way ANOVA results^a

Item		Sum of Squares	df	Mean Square	F
Main Effects	(Combined)	93.02	17	5.472	1.83 ^b
	PROVINCE	52.40	8	6.55	2.19 ^b
	SECTOR	40.62	9	4.514	1.51
Model		93.02	17	5.472	1.83 ^b
Residual		215.38	72	2.99	
Total		308.40	89	3.47	

Source: author’s calculations.

^a Unique method: all effects entered simultaneously

^b significant at $p < 0.05$.

⁹ The author of this article is aware of the drawback of the aggregate sectoral level. However she had to accept a trade-off between the detailed geographical unit of analysis adopted and the sectoral disaggregation available at this spatial level.

availability of natural resources,¹⁰ the presence of foreign affiliates in the former two high-technology industries is surprising given the socio-economic conditions of the region.

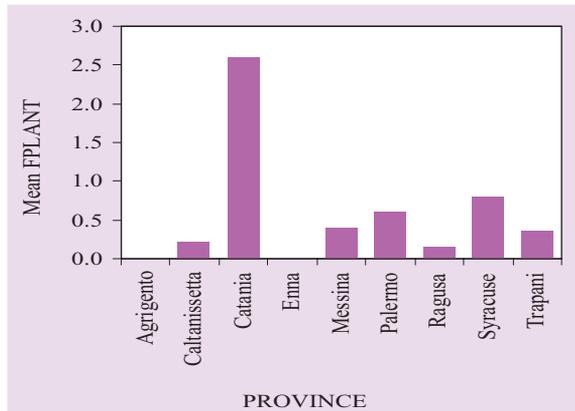
Table 3. Distribution of foreign affiliates in Sicily by industry

Industry	Share (%)	Number of plants
Food, drink and tobacco	6.3	3
Textiles, clothing and leather products	0.0	0
Wood, rubber and other manufacturing	6.3	3
Paper and publishing	4.2	2
Chemicals and pharmaceuticals	25.0	12
Oil and other energetic products	10.4	5
Non-metallic ores ^a	4.2	2
Metallic ores	-	-
Mechanical equipment and metal products	41.7	20
Vehicles and other means of transport	2.1	1
Total	100.0	48

Source: author's calculations, based on *Italia Multinazionale 1998* (1999).

^a Estimate.

Figure 1. Means of firms, by province



Source: author's calculation.

¹⁰ Syracuse is a major national pole of oil extraction.

The econometric models and the specification of the variables

The phenomenon under investigation is the location preferences of TNCs between alternative provinces once they have decided to locate their technological activities in Sicily. The dependent variable is the number of foreign affiliates located in each province i and manufacturing industries j . That provides the following equation:¹¹

$FPLANT_{ij}$ = number of foreign affiliate plants in province i and industry j at May 2001: $i = 1, 2, \dots, 9$ and $j = 1, 2, \dots, 10$.

A Poisson regression model was fitted to the data when considering a series of covariates that account for factors affecting the location preference of TNC activity across provinces and industries.¹² Since the phenomenon under analysis is the locational preferences of foreign affiliates established in Sicily by 2001, the independent variables have been calculated over the period 1996-1998, in which the incentives were offered. It should be highlighted that the variables considered do not intend to be comprehensive due to constraints of data availability at the level of geographical disaggregation. The variables used and the relative sources are reported in annex table 1.

The first set of variables considered refers to *traditional locational factors* such as availability of labour and market size. If availability of labour may attract potentially FDI by lowering labour costs (Markusen and Venables, 1998), it also reveals the

¹¹ Clearly, considering this channel of FDI only limits the generalizability of the results since different channels of FDI (such as joint venture and greenfield plants) may have a different impact on the local sourcing of knowledge (Cantwell and Mudambi, 2003). However, constraints in data availability should be taken into account.

¹² Although the theory prescribes a negative binomial model to deal with the overdispersion generated by the count-data nature of the dependent variable (Green, 2000), the test of overdispersion was not statistically significant. Conversely, the test of goodness of fit of the Poisson regression model insures robust results.

backwardness of the island. This factor has been proxied for each province i by the average percentage of unemployed people over the period 1996-1998 ($UNEMP_i$). Similarly, the size of the local market may be a crucial variable in the locational decision of TNCs since, the larger the local market, the greater the opportunities of adapting and customizing production locally without incurring in further costs (*ibid.*). Thus, for each province (i), the size of the local market is proxied by the average *per capita* value added calculated over the period considered ($MSIZE_i$).

A second set of variables concerns variables related to *local competences and intangible assets*. The quality of the labour force is a recognized factor of attracting of FDI seeking high skills (Audretsch and Feldman, 1996). For each province i in each industry j , the average share of managers and white-collar employees in total employment in the manufacturing industry ($SKILL_{ij}$) is calculated. Similarly, high-quality competences may be also reflected in high wages. Thus, for each province i in each industry j the weighted average of the annual average retribution of managers and white-collar employees over the period under analysis ($WAGE_{ij}$) is taken into account. Innovative capabilities are proxied by the share of patents granted to residents in the province (i) relative to the total regional patenting activity (PAT_i).¹³ The presence of a university in the province should also act as a factor of attraction in terms of potential access to local R&D, as well as of a source of skilled labour. Therefore, for each province (i) a dummy variable (UNI_i) equalling 1 if the province has a university and equalling 0 otherwise is inserted. The commitment to higher education may be seen by TNCs as a potential local source of knowledge. In order to capture this aspect, for each province (i) the average number of full-time students enrolled in secondary education (EDU_i) over the period 1996-1998 is considered. Local

¹³ Following an established stream of literature (e.g. Pavitt, 1985), patents are adopted as alternative indirect measures of knowledge creation as they capture the generation of new knowledge and, accordingly, provide some indirect evidence on the establishment of tacit capabilities, which make such knowledge operational (*ibid.*).

productive (and indirectly technological) competences have, instead, been included in the analysis by calculating the average of the revealed comparative advantage (RCA) index (RCA_{ij}) calculated for each province (i) in each industry (j) over the period 1996-1998.¹⁴ The breath of local productive (and technological) competences (DIV_i) has been captured in each province (i) across the 10 industries (j) by the average of the inverse of the coefficient of variation of the RCA distribution.¹⁵ A variable related to the *economic policy*, which can influence FDI location, is the presence of incentives. For each province (i), the proxy used is a dummy variable ($INCE_i$) equal to 1 if any of the foreign affiliates located in province (i) and operating in industry (j) has been granted incentives to locate its productive activity there over the period under analysis, and 0 otherwise.¹⁶

A third set of variables covers the *information costs* TNCs face when establishing production plants abroad. Firstly, the

¹⁴ RCA_{ij} is the average of the following index calculated over the period considered:

$$rca_{ij} = (X_{ij}/S_jX)/(S_iX_{ij}/S_{ij}X_{ij})$$

where X_{ij} is the total export of province (i) in industry (j). Therefore, the nominator is the share of exports of province (i) in industry (j) relative to all other industries, while the denominator is the share of exports of all provinces in that industry relative to the regional total in all industries. Values greater (lower) than 1 denote specialization (despecialization) of province i in industry j .

¹⁵ DIV_i can be formalised as the average of the following index:

$$div_i = m_{RCAi}/s_{RCAi}$$

where m_{RCAi} and s_{RCAi} are the mean and the standard deviation of the RCA_{ij} distribution, respectively. The drawbacks of using these indicators based on exports to proxy technological capabilities needs to be acknowledged (Kumar, 2001): firstly, a province may be able to export a particular good by serving as export-platform for foreign TNCs as a result of imported knowledge and, therefore, it has not the corresponding local technological competences in that particular industry; secondly, local technological capabilities in certain industries may not be reflected adequately by exporting behaviour because of the relocation from the home base by local enterprises.

¹⁶ The incentives considered refer to incentives granted to the TNCs in the sample under law 488/92 for production investment in each of the Sicilian province from 1997 to the year 2000.

degree of trade openness (TOP_{ij}) of each province (i) in each industry (j) may lower information costs for TNCs as provinces more active in the international trade arena display a trade history for TNCs interested in selecting local production sites. TOP_{ij} is defined as the average of the following index over the period of time under analysis:

$$top_{ij} = (X_{ij} + M_{ij})/VA_i \quad (1)$$

where X_{ij} are the exports of province (i) in industry (j), M_{ij} are the imports of province (i) in the same industry, and VA_i is the province's value added in manufacturing. Uncertainty will be also lower in provinces in which large foreign affiliates are already operating, insuring diffusion of information within the international business community. For each province (i) the number of firms with 500 or more employees as compared with the total number of manufacturing firms in 1996 has been considered ($F > 500_i$).

Variables related to the *socio-economic context* can play a role in the locational decision of TNCs. Given the characteristics of Sicily, a variable accounting for the presence of crime, which may obviously act as a deterrent for the location of economic activities (Gastanga *et al.*, 1998), has been included in the analysis. This variable ($CRIME_i$) has been defined for each province (i) by the average number of illegal acts per inhabitant over the years 1996-1998. Moreover, the turnover of local firms has been considered as a deterrent to FDI location since it reveals instability of the local market. The variable ($FTURNOVER_{ij}$) included is given for each province (i) in each industry (j) by the average of the following index over the period considered:

$$fturnover_{ij} = (R_{ij} + C_{ij})/A_{ij} \quad (2)$$

where R_{ij} is the number of firms registered at the Chamber of Commerce of province (i) in industry (j), C_{ij} and A_{ij} are the number of firms that have closed down and the number of active firms in that province and industry, respectively.

A final variable is related to *transport infrastructure*, which may be a determinant in the location of foreign activities. Given the geography of Sicily, in this study the presence of airports in the Sicilian provinces is taken into account. For each province (i), a dummy variable ($AIRP_i$) is considered equal to 1 if in the province under consideration there is an airport, equal to 0 otherwise.

The summary statistics of the variables and the correlation matrix are reported in tables 4 and 5, respectively.¹⁷

Table 4. Summary statistics

Dependent variable	Mean	Std. Dev.	Min	Max
FPLANT _{ij}	0.53	1.86	0	15
Independent Variable	Mean	Std. Dev.	Min	Max
UNEMP _i	0.24	0.05	0.13	0.31
MSIZE _i	30.05	28.73	8.06	105.02
SKILL _{ij}	0.24	0.46	0.00	3.64
WAGE _{ij}	71512146	147725332	0	732744730
PAT _i	0.11	0.11	0.01	0.31
UNI _i	0.33	0.47	0.00	1.00
EDU _i	29023	18192	9394	63836
RCA _{ij}	2.46	3.53	0.01	20.18
DIV _{ij}	2.24	2.59	0.58	17.37
INCE _i	0.06	0.23	0.00	1.00
TOP _{ij}	0.17	0.71	0.00	6.13
F>500 _i	0.00	0.00	0.00	0.00
CRIME _i	0.03	0.01	0.01	0.05
FTURNOVER _{ij}	0.12	0.06	0.00	0.33
AIRP _i	0.33	0.47	0.00	1.00

Source: author's calculations.

¹⁷ Given the high correlation between UNI_i and PAT_i and EDU_i (0.94 and 0.87, respectively), and between PAT_i and EDU_i (0.94), only UNI_i has been considered in the econometric exercise. Similarly, DIV_i has been excluded because of its high correlation with SKILL_{ij}.

Table 5. Correlation matrix

	UNEMP _{<i>t</i>}	MSIZE _{<i>t</i>}	SKILL _{<i>tj</i>}	WAGE _{<i>tj</i>}	PAT _{<i>t</i>}	UNI _{<i>t</i>}	EDU _{<i>t</i>}	RCA _{<i>tj</i>}	DIV _{<i>tj</i>}	INCE _{<i>t</i>}	TOP _{<i>tj</i>}	F>500 _{<i>t</i>}	CRIME _{<i>t</i>}	FTURNOVER _{<i>tj</i>}	AIRP _{<i>t</i>}	
UNEMP _{<i>t</i>}	1.00															
MSIZE _{<i>t</i>}	-0.82	1.00														
SKILL _{<i>tj</i>}	-0.09	0.28	1.00													
WAGE _{<i>tj</i>}	-0.25	0.02	0.11	1.00												
PAT _{<i>t</i>}	-0.77	0.78	-0.05	0.44	1.00											
UNI _{<i>t</i>}	-0.61	0.72	-0.09	0.42	0.94	1.00										
EDU _{<i>t</i>}	-0.665	0.80	-0.02	0.45	0.94	0.87	1.00									
RCA _{<i>tj</i>}	0.13	-0.08	0.02	0.02	-0.07	-0.05	-0.07	1.00								
DIV _{<i>tj</i>}	0.16	-0.18	0.05	0.99	-0.20	-0.19	-0.16	0.20	1.00							
INCE _{<i>t</i>}	0.01	-0.03	0.34	0.32	0.12	0.14	0.10	-0.02	0.06	1.00						
TOP _{<i>tj</i>}	0.01	-0.02	-0.01	-0.01	-0.06	-0.06	-0.04	-0.03	0.10	0.11	1.00					
F>500 _{<i>t</i>}	-0.10	-0.28	0.08	-0.14	-0.20	-0.43	-0.30	-0.09	0.02	-0.04	0.02	1.00				
CRIME _{<i>t</i>}	-0.34	0.15	0.31	0.27	0.35	0.29	0.27	-0.26	-0.10	0.20	0.20	0.15	1.00			
FTURNOVER _{<i>tj</i>}	0.01	-0.15	-0.12	-0.06	-0.04	-0.10	-0.06	-0.08	0.01	-0.05	-0.14	0.35	-0.02	1.00		
AIRP _{<i>t</i>}	-0.43	0.51	-0.03	0.31	0.63	0.50	0.73	-0.05	-0.13	0.03	-0.04	0.21	0.07	0.08	1.00	

Source: author's calculations.

The results

The results of the econometric analysis are reported in table 6.¹⁸ In order to assess whether TNCs show locational preferences for Catania, the province hosting the largest number of foreign affiliates (figure 1) and in which the “Etna Valley” effect is apparently taking place within the electronics and chemicals and pharmaceuticals industries (the industries in which the highest number of foreign affiliates operate; table 3), variables controlling for that effect ($EtnaValley_i$), as well as for an interaction between electronics ($EtnaValley(electronics)_i$), and chemicals and pharmaceuticals ($EtnaValley(chemicals)_i$) industries have been introduced.

The estimates obtained illustrate the significance of local high-skilled competences ($SKILL_{ij}$ is significant at $p < 0.05$ and $p < 0.01$) as a determinant of the locational choice of TNCs across Sicilian provinces. As already highlighted in some studies investigating locational determinants of FDI in southern Italy (e.g. Dell’Aringa *et al.*, 1999), quality of labour appears to be a major strength of southern Italian regions. Contrary to the predictions of more traditional theory on FDI location (Markusen and Venables, 1998), the results of the econometric analysis suggest, too, that high labour costs affect positively the locational decisions of TNCs within the island ($WAGE_{ij}$ is significant at $p < 0.01$). In line with a more heterodox stream of theory (Audretsch, 2000; Cantwell and Piscitello, 2002), since high wages usually reflect high skills, this result may suggest that foreign affiliates seem to rely on a competitiveness based on tacit competences more than low production costs when choosing among Sicilian provinces. Accordingly, proximity to universities seems to act as a factor of attraction (UNI_i is significant at $p < 0.05$) as it allows potential access to the production of local basic scientific research and knowledge

¹⁸ In order to solve the problem of odd-ratio interpretation due to the log-linear nature of the Poisson model (Green, 2000, Chapter 19), the coefficients have been transformed into incident-rate ratio (IRR), which are directly interpretable as elasticities (STATA 7 Manual, 2002).

Table 6. Poisson estimation results

Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	IRR	Z-ratio	IRR	Z-ratio	IRR	Z-ratio	IRR	Z-ratio	IRR	Z-ratio
Traditional location factors										
UNEMP _i	2.00E+07	0.77								
MSIZE _i	1.005586	0.17								
Local competences and intangible assets										
SKILL _{ij}	7.819316	2.99***	7.313207	4.78 ***	4.706789	4.40 ***	3.910143	5.55 ***	3.932888	5.64 ***
WAGE _{ij}	1	3.27***	1	5.39 ***	1	2.53 **	1	5.77 ***	1	3.85 ***
UNI _i	354.7195	2.35**	12.25567	3.23 ***	10.10247	3.14 ***	11.22167	3.31 ***	13.36428	3.55 ***
RCAs _{ij}	1.046447	0.57					1.146034	2.27 **	1.108392	1.42
Economic policy										
INCE _i	1.468004	0.63								
Information costs										
TOP _{ij}	3.188607	3.23***	3.239543	4.76 ***	2.473	4.20 ***	2.258147	5.86 ***	2.212212	5.40 ***
F>50 _{ij}	1.82*			1.84 *		1.75 *		1.75 *		1.89 *
Socio-economic context										
CRIME _i	9.17E-41	-1.59	1.01E-43	-2.22**	4.81E-22	-1.32				
FTURN _{ij}	0.0059225	-0.9								
Transport infrastructures										
AIRP _i	0.2720881	-1.00								
Control Variables										
Etna Valley _i			3.761899	2.06 **			4.549687	2.7 ***	2.199119	1.83 *
Etna Valley (chemicals) _i							4.585332	2.14 **		
Etna Valley (electronics) _i							90	90	1.553753	0.75
No of obs.	90		90		90		90		90	
Log likelihood	-46.003		-50.015		-47.946		-49.924		-51.069	
	LR chi2(12)	156.26***	LR chi2(7)	148.23***	LR chi2(8)	152.37***	LR chi2(7)	148.41***	LR chi2(7)	146.13***
	chi2(77)	46.890***	chi2(82)	54.914***	chi2(81)	50.776***	chi2(82)	54.734***	chi2(82)	57.022**

Source: author's calculations.

*** Significant at p < 0.01

** Significant at p < 0.05

* Significant at p < 0.10

(Anselin *et al.*, 1997) as well as to skilled labour (Bresnahan *et al.*, 2000). The significance of quality of labour, wages and university in the locational decisions of TNCs also reveals a major interaction between the local environment and foreign affiliates, which, being sensitive to these factors, are likely to establish competence-creating affiliates driven by assets-seeking motives (Kuemmerle, 1996; Cantwell and Narula, 2001), and not so merely market-oriented ones. Coherently, market size and availability of labour force do not appear to be determinants of TNC preferences. Thus, these results confirm that different locations within a peripheral region can attract high-quality FDI with skilled labour and innovative capacities (O'Donnell and Blumentritt, 1999).

Like in previous studies (Mariotti and Piscitello, 1995), information costs come out as relevant factors in shaping the locational decisions of TNCs. The degree of trade openness seems to affect positively the locational preferences of foreign affiliates (TOP_{ij} is significant at $p < 0.05$ and $p < 0.01$), consistently with findings at the country level (Narula and Wakelin, 1998). This may suggest that TNCs are more akin towards locations that are already active in international trade when deciding to disperse geographically their operations abroad. Provinces that are heavily trading internationally lower information costs for TNCs interested in investing locally thanks to the existence of past international trade records. This result also suggests that FDI may not be a substitute for export-oriented strategies as suggested by new trade theory (Markusen, 1995; Baldwin and Ottaviano, 2001). Conversely, the two strategic approaches seem to be complementary (Guerrieri and Manzonchi, 1996) as argued in Dunning's (1997a, and b) analysis of the formation of the Common Market and the Single Market Programme, in which FDI flows complemented rather than displaced trade flows. Similarly, TNCs appear to be sensitive to the presence of large companies already operating locally ($F > 500_i$ is significant at $p < 0.10$) since it lowers uncertainty by insuring diffusion of information within the international business community.

Given that incentives are available equally to all provinces within Sicily, the incentives granted under the new subsidies policy cannot explain the locational preferences of TNCs that have decided to locate their production somewhere in the island. By linking this result with the others discussed above, locations showing high-skilled labour, relatively high wages, high degrees of trade openness and hosting universities and large companies seem to be able to attract FDI (Haaparanta, 1996), one can conclude that embedded local value-added is particularly important.

As illustrated by the two-way ANOVA results, which, plotted in figure 1, show that Catania is by far the province hosting the highest number of foreign affiliates, TNCs do discriminate among provinces when locating their plants. This is confirmed when introducing a variable controlling for the “Etna Valley effect” (model 2), which captures, other things being equal, the fact that the province of Catania has some specific (unobservable) characteristics attracting FDI.¹⁹ Although on the grounds of the ANOVA analysis sectoral differences do not seem to matter, the positive and significant sign of $EtnaValley(electronics)_i$ ($p < 0.05$) and $EtnaValley(chemicals)_i$ ($p < 0.01$) bears witness to the fact that TNCs seem to show a statistically significant preference in locating their production plants in Catania as far as electronics, and chemicals and pharmaceuticals are concerned (model 3). This result is fairly remarkable when considering the context-dependent and tacit nature of these science-based industries characterized by a greater geographical concentration in centres of excellence (Cantwell and Santangelo, 2000). Nonetheless, Bresnahan *et al.* (2000) argue that highly skilled labour is a precondition for the growth of ICT-based entrepreneurial clusters as shown, for instance, by the Silicon Valley story. Accordingly, strong university traditions are widely recognized factors of

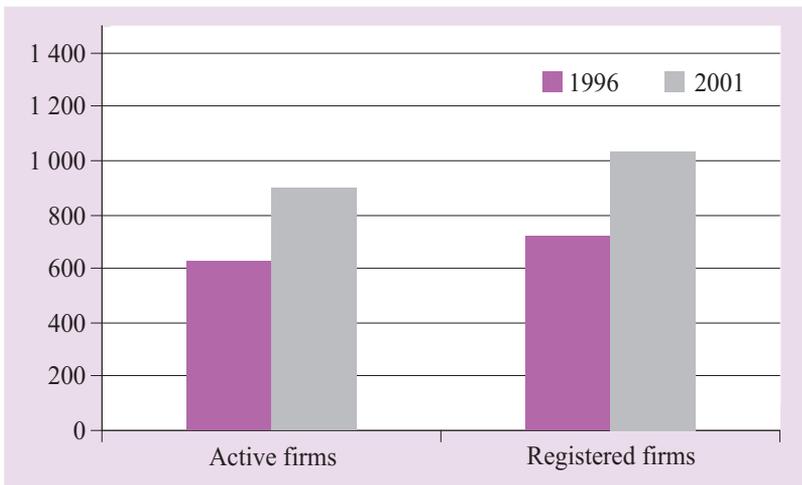
¹⁹ It should be mentioned that, when introducing the “Etna Valley” control variable the socio-economic context also seems to be relevant to FDI location as high degrees of crime ($CRIME_i$ is significant at $p < 0.10$) deter foreign affiliates to sit their production plants locally.

attraction in high-technology clusters (*ibid.*) as well as in peripheral regions, as illustrated in Scotland (United Kingdom) (Santangelo, 2002), due to the more localized nature of academic knowledge spillovers (Adams, 2001). Both factors seem to be present in Catania, in which the active cooperation between the university, research laboratories and high-technology firms on one side, and foreign affiliates on the other may have initiated a process that could turn a marginal area into a high-technology district. Established research collaborations between Catania University and some major foreign affiliates operating in the province (e.g. ST-Microelectronics) have led to several United States patents in high-technology industries and to graduate training programmes.

However, the econometric results point out that in Catania differences exist as far as local productive (and indirectly technological) competences are concerned. While TNCs locate their production plants in Catania in chemicals and pharmaceuticals as a result of local capabilities (*EtnaValley(chemicals)_i*) is significant at $p < 0.10$ and RCA_{ij} is significant at $p < 0.05$ in model 4), in electronics local expertise seemed to lack in the middle-1990s (*EtnaValley(electronics)_i*, and RCA_{ij} are not significant in model 5). By comparing model 3 with model 4 and 5 in table 6, it emerges that Catania is an appealing location in electronics when export specialization (RCA_{ij}), which is a proxy for the profile of local capabilities, is excluded from the model (model 3); it maintains its attractiveness in chemicals and pharmaceuticals (but not in electronics) when including such an explanatory variable (models 4 and 5, respectively). Therefore, in chemicals and pharmaceuticals, Catania was targeted by TNCs because of local capabilities, which may have developed further through dynamic interaction with some of the world's largest TNCs (e.g. Arch Chemicals and Wyeth Lederle). Like in the formation of the Israeli Silicon Wadi (de Fontenay and Carmel, 2000), in the Etna Valley case comparative advantage forces in this industry seem to have acted as a catalyst for TNCs ensuring a critical mass of absorptive capacity for future local development. Conversely, like in Ireland (Barry and Bradley, 1997) and in Bangalore, India

(Arora *et al.*, 2000), in Catania electronics TNCs (such as IBM and ST-Microelectronics) have targeted a location initially lacking comparative advantages. Nonetheless, if the mushrooming of local firms operating in information technology and related industries active in Catania and registered to the local Chamber of Commerce between 1996 and 2001 (see figure 2) can be attributed to the fast-rising nature of the underlying technologies, the presence of electronics TNCs (e.g. Nokia and IBM), may have also played a role, as in the Silicon Valley case (Moore and Davis, 2000).

Figure 2. Number of firms operating in “information technology and related activities” and located in the province of Catania, 1996-2001



Source: author’s calculations.

Having said so, it should be borne in mind that, as suggested by the Cambridge high-technology cluster story, the formation of new firms and university-industry links do not necessarily ensure the same degree of globalization as in Silicon Valley (Athrey, 2000). For this purpose, “right” linkages creation with indigenous firms is needed to promote local development and clusters formation through technology and knowledge

spillovers (Zanfei, 2000). In turn, positive effects of FDI are likely to increase with the level of local capabilities, which can be enhanced through spillovers and linkages to TNCs' operations (Blomström and Kokko, 1998). If local capabilities were present in chemicals and pharmaceuticals already in the mid-1990s, they might have developed in electronics in the meanwhile as signalled by the mushrooming of the local firms operating in information technology and related industries. However, the phenomenon of agglomeration of TNCs in the province of Catania (i.e. Etna Valley) is still in a gestation period as *backward* and *forward* linkages generated by TNCs with the local economy (Rodriguez-Claire, 1996) have not yet fully displayed their results. In fact, as far as the former are concerned, the increase in the demand for specific inputs may not have been yet able to generate positive externalities to other potential firms without relying on an incentive-based attraction policy. In the case of forward linkages, although the number of firms operating in ICT-related industries has experienced a massive growth, the local network of specialized producers supplying more complex goods at competitive costs is heavily dependent on the foreign affiliates established in the province. This scenario implies that, although promising, Etna Valley can still not be considered a high-technology cluster due to the cumulative and self-reinforcing nature of clustering phenomena (Arthur, 1990). As shown by the recent renegotiations carried out by foreign electronics affiliates on the locational conditions with local governments, incentives (rather than *backward linkages*) are still the main sources of local attraction.

Conclusions and policy implications

Recently, research in economics has rediscovered *space* as a crucial factor in economic activity. Due to recent theoretical developments as well as to the technological, economic and political events of the past two decades, the rediscovery of *space* has pushed investigation on FDI location to look at host locations in greater geographical detail in order to better understand the interplay between the *local* and the *global*. The result has been flourishing of studies going beyond the country as unit of

analysis by focusing on sub-national regions. So far, most of the attention has been devoted to successful regions in order to understand the elements of their socio-economic performance. Conversely, despite the large literature on FDI in developing countries, peripheral regions have been neglected. The few exceptions have mainly treated regions as homogeneous entities without analyzing them *within* their borders. However, nowadays this issue is of particular interest when considering the interplay between location and ownership advantages of the host site, and ownership and internalization advantages of the TNCs. On the one hand, territorial units can increase their location advantage and, consequently, the ownership advantage of local firms by benefiting from knowledge spillovers stemming from the local activity of TNCs. On the other hand, TNCs can enhance their ownership advantage by choosing appropriate locations in which sourcing local value-added into the corporate network through the benefits coming from their internalization advantage. If this is obvious in the case of *core* regions, it can be less clear if considering peripheral regions as a whole without discriminating *within* them, in which centres of excellence may flourish.

In the context of the mid-1990s surge of FDI in Sicily, the concentration of foreign affiliates in the Etna Valley area *versus* other areas of the region can be attributed to basic locational factors. The econometric results gathered in this analysis show that, within Sicily, TNCs' locational decisions are driven by high local skills (also reflected in high wages), high degrees of trade openness and proximity to a university and large companies. Therefore, once TNCs have decided to locate their production plants in the island, they are sensitive to basic factors, which dominate TNCs' locational preferences, while investment incentives may help upgrade the role of a local affiliate in its international network, e.g. by helping to acquire strategic mandates (Cantwell and Mudambi, 2000). Similarly, TNCs appear to discriminate across provinces and industries as shown by their preference for locating their activity in the province of Catania and particularly in electronics, and chemicals and pharmaceuticals (generating the Etna Valley agglomeration). However, while in chemicals and pharmaceuticals local

productive (and indirectly technological competences) have acted as a catalyst for FDI in the province, these competences seemed to lack initially in electronics.

These results points to some policy implications. First of all, factors enhancing local valued added should be nurtured in order to maintain the relative competitiveness of currently more appealing provinces once the subsidies policy comes to an end. On the grounds of the econometric exercise, this means targeting industries of productive (and technological) specialization, promoting labour training programmes, boosting university research and teaching and encouraging international trade. Secondly, note should be taken of the phenomenon of Etna Valley since the fortunate agglomeration of TNCs in science-based industries and the flourishing of complementary local enterprises may, if looked after correctly, generate a district in the industry in question as already happened in the Silicon Valley (Arora *et al.*, 2000). Following Ram Mudambi's findings (1998), this should be pursued by seeking to keep in the province TNCs with current operations, rather than attempting to attract new investors. TNCs already having affiliates in the province are the firms with the highest probability to undertake new investment. Thirdly, attempts should be also made to fill the gap between the more dynamic provinces and the laggards to achieve a more balanced intra-regional development. Nonetheless, although this point should not be disregarded in the medium-term, a balanced intra-regional development may not be a priority for the time being. At this stage, balanced intra-regional development may be risky in the sense that it can divert resources from the most promising areas. Conversely, resources should be concentrated on the more dynamic sites of the island, which may act as engines for the others in the future. ■

Annex table 1. List of variables and relative description, time consistency and source

Variable	Description	Period	Source
<i>Dependent</i>			
FPLANT _{ij}	number of plants acquired by foreign investors and located in Sicilian provinces	2001	Author's updating on 1998 Reprint, Cnel-R&P-Politecnico di Milano database
<i>Independent</i>			
Traditional location factors			
UNEMP _i	number of people on the unemployment lists per inhabitant (%)	average 1996-1998	Confindustria
MSIZE _i	per capite value-added (Lit. billions)	average 1996-1998	Istituto Guglielmo Tagliacarne
Local competences and intangible assets			
SKILL _{ij}	managerial and white collar components to total employees on the manufactory industry (%)	average 1996-1998	INPS
WAGE _{ij}	annual average retribution (Lit. thousand)	weighted average 1996-1998	INPS
PAT _i	share of patents relative to the regional total patenting activity (%)	1995	ISTAT
UNI _i	Dummy variable equals 1 if the province hosts a University, and 0 otherwise.		
EDU _i	number of full-time students enrolled in secondary educations	average 1996-1998	ISTAT
RCA _{ij}	degree of export specialisation (Lit. millions)	average 1996-1998	ISTAT
DIV _i	degree of export diversification	average 1996-1998	ISTAT
Economic policy			
INCE _i	Dummy variable equals 1 if any firm in province (i) and sector (j) has been granted an incentive, and 0 otherwise	1996-2000	Ministry of Industry Trade and Craft
Information costs			
TOP _{ij}	trade openness (Lit. millions)	average 1996-1998	ISTAT
F>500 _i	number of firms with 500 or more employees (normalised with the total number of manufacturing firms) (%)	1996	Census ISTAT
Socio-economic context			
CRIME _i	number of illegal acts per inhabitant (%)	average 1996-1998	ISTAT
FTURNOVER _{ij}	turnover of active firms (%)	average 1996-1998	Unioncamere
Transport infra-structures			
AIRP _i	Dummy variable equals 1 if the province hosts an airport, and 0 otherwise.		

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