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Regional variety and employment growth in Italian labour market areas: services versus manufacturing industries

by

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Abstract
This paper investigates the impact of regional sectoral diversity on regional employment growth in Italy over the period 1991-2001. Assuming that externalities may be stronger between industries selling similar products or sharing the same skills and technology (i.e. related industries), we analyze the role of different forms of sectoral variety at the Local Labour System (LLS) level. We consider variety both in terms of shared complementary competences that induce effective interactive learning and innovation, as well as a portfolio strategy to protect a region from external shocks in demand. Our results show strong evidence of a general beneficial effect of a diversified sectoral structure but suggest also the need to differentiate the analysis between manufacturing and services. In particular, overall local employment growth seems to be favoured by the presence of a higher variety of related service industries, while no role is played by related variety in manufacturing. When looking at diversity externalities between macro-aggregates, the service industry is affected by related variety in manufacturing, while no evidence of externalities is found from tertiary sectors to manufacturing.

JEL codes: D62, O18, O52, R11,

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1. Introduction

The study of the impact of different types of agglomeration economies and local economic growth has attracted a lot of scholarly attention since the seminal contribution of Glaeser et al. (1992). Following Jacobs (1969), an increasing number of these studies have emphasized the role of regional industrial diversity as a major driver of interactive learning, new knowledge combination and innovation. More recently, evolutionary economic perspectives have pointed out that local externalities, innovation and knowledge spillovers occur effectively only when complementarities exist among sectors in terms of shared knowledge bases and competences. Such complementarities are captured by the notion of related variety (Frenken et al., 2007).

The present study aims to provide additional empirical evidence in understanding how different forms of variety influence local employment growth, paying particular attention to the distinction between manufacturing versus service industries. Following Frenken et al. (2007), Boschma and Iammarino (2009), Bishop and Gripaios (2010), Quatraro (2010), Boschma et al. (2011), Brachert et al. (2011) and Boschma et al. (2012), we disentangle the effects of variety expressed as overall regional inter-sectoral diversity (Jacob externalities); as related variety, that is industries with shared knowledge bases and complementarities that may encourage externalities and knowledge spillovers; and as unrelated variety, that is diversity involving sectors that are not interrelated in terms of shared competences. The paper further adds to the existing literature by differentiating the analysis for manufacturing and services at a detailed level of sectoral breakdown, and by testing the possibility of externalities between the two industrial macro-aggregates (i.e. the impact of diversity of the local manufacturing (service) structure on employment dynamics in the local service (manufacturing) industry) at the Local Labour Systems (LLS) level in Italy. We carry out the analysis by controlling for spatial autocorrelation in the data, and by considering different levels of sectoral disaggregation.

The remainder of the paper is organized as follows. In Section 2 we summarise the main theoretical arguments on variety, with specific attention to the service industry. Section 3 presents the dataset, the indicators and the econometric strategy. Section 4 briefly describes some descriptive features of the phenomenon investigated, whilst Section 5 discusses the empirical results. Section 6 concludes, indicating future research directions.

2. Diversity and regional economic performance

Since the seminal contributions of Glaeser et al. (1992) and Henderson et al. (1995), a large amount of literature has questioned the impact of different types of agglomeration economies on local economic growth (for a review see Rosenthal and Strange, 2004; De Groot et al., 2009). Focusing mainly on a dichotomous framework that places local specialisation in opposition to local diversity, scholars have tried to understand whether knowledge spillovers and externalities arise from the concentration of firms in a specific industry (Marshall-Arrow-Romer externalities) or occur in a diversified firm environment (Jacobs externalities). The debate has failed to provide conclusive evidence in support of one or the other theory (e.g. Van der Panne and Van Beers, 2006; Mameli, 2007; De Groot et al., 2009). This ambiguity in results may depend on the different definitions of diversity indicators used in the analysis (Beaudry and Schiffauerova, 2009) and on the type of sectors analyzed (Bishop and Gripaios, 2010).

The majority of these studies measure regional diversity in terms of what Frenken et al. (2007) refer to as unrelated variety (i.e. co-located sectors that do not share technical and knowledge complementarities). Beaudry and Schiffauerova (2009) have suggested that this may underestimate the importance of Jacobs externalities and inflate the role of MAR externalities. Besides, the indicators used to approximate diversity are often simple measures of average diversity computed across the whole range of economic activities (such as the widely used Hirschman–Herfindahl index or the 'other industry' employment), without taking into consideration the cognitive distance between sectors (Nooteboom, 2000) – in other words, without accounting for the interplay between industries, technology and geographical locations (Iammarino and McCann, 2006; Raspe and van Oort, 2007). However, if knowledge bases are too different, linkages and spillovers between actors may be precluded, while too much cognitive proximity (as implied by the notion of MAR externalities) may result in externalities with little contribution to existing knowledge. Related variety is in fact considered to be the most supportive factor for effective knowledge transfer and, ultimately, regional growth (Frenken et al., 2007).

A further issue is the sectoral scope of the analysis. Most of the literature tends to analyze the effect of agglomeration economies across the whole range of economic activities (as, for example, in Glaeser et al., 1992; Van Soest et al., 2006; Frenken et al., 2007; Boschma and Iammarino, 2009; Boschma et al., 2011; Brachert et al. 2011), or on manufacturing alone (e.g. Henderson et al., 1992; Cainelli and Leoncini, 1999; Bun and El Mackhloufi, 2007).[1] On the other hand, there seems to be ambiguity on the impact of diversity in the local economic structure on employment growth when differentiating between manufacturing and services: some contributions have shown similar results for both industrial aggregates (e.g. Paci and Usai, 2005, 2008; Blien and Suedekum, 2005), whilst others have found substantial differences (Combes, 2000; Deidda et al., 2003; Van Steel and Nieuwenhuijsen, 2004), even at the level of individual sectors (Bishop and Gripaios, 2010).

Several arguments lay behind our choice of investigating the effects of regional service diversification. Firstly, nowadays services dominate modern economies (e.g. Guile, 1988; Miles, 1993; Williams, 1997; Schettkat and Yocarini, 2003) and they are seen – particularly knowledge-intensive services such as ICT and business services – as an increasingly important engine of overall economic growth. In fact, the observed trends of deindustrialization and tertiarisation in the

[1] It should also be considered that the ISIC classification tends to over-emphasises the weight of manufacturing over services, and pooling together the two industrial aggregates inevitably reflects this bias.

developed economies have prompted a major rethinking of the traditional view of services as slow-growth activities lagging behind in terms of innovation, technology creation and diffusion with respect to manufacturing (e.g. Tether et al., 2001; Triplett and Bosworth, 2001; Tomlinson, 2002). Some service industries, and particularly knowledge-intensive services (e.g. R&D, communication and computer services, consulting), are also recognized to be both important users and main vehicles of technology diffusion across sectors (e.g. OECD, 1997; Tomlinson, 2002; Gallouj and Savona, 2009), as well as providing beneficial effects to the rest of the economy in terms of technological spillovers (Antonelli, 1998). Indeed, nowadays services are increasingly being embodied in manufactured products and the boundaries between the two types of activity have become rather blurred (e.g. Gallouj and Djellal, 2010). The two industries do not carry separate sets of activities but instead their interaction and complementarities contribute to determine the overall performance of the economy. Therefore, various contributions have empirically assessed the increasing interdependence between service and manufacturing industries (e.g. Evangelista, 2000; Miozzo and Soete, 2001; Castellacci, 2008), stressing in particular the role of demand of the latter as one of the major sources of growth in the service industry (Miozzo and Miles, 2003; Guerrieri and Meliciani, 2005).

Secondly, as mentioned above, different diversity effects have been found for manufacturing and services when using average measures of Jacobs externalities computed across very different types of economic activities (i.e. without considering sectors' relatedness). In particular, diversity turns out to have a positive effect on growth in service industries and a negative or non-significant effect in manufacturing (Combes, 2000; Van Steel and Nieuwenhuijsen, 2004; Bishop, 2008). Indeed, being more diversified in their input consumption and in the industries they supply, services benefit more from diversity than manufacturing (Combes, 2000). Services have in fact wide opportunities to learn and assimilate new knowledge from their networks of customers and suppliers, while manufacturing tends to rely more heavily on internal knowledge (Bishop, 2008). Furthermore, as suggested by Van Steel and Nieuwenhuijsen (2004), it is more likely that services gain from externalities produced by a diverse manufacturing base rather than by other sectors within the service industry, due the higher R&D performed in manufacturing. In turn, manufacturing firms may benefit from their interaction with a variety of service suppliers through spillovers of technological knowledge as well as organizational, management, and marketing practices.

This paper applies the relatedness perspective to manufacturing versus service industries and considers the possibility of a two-way diversity externality effect between the two industrial macro-aggregates. In line with the copious literature spurred by Glaeser et al. (1992), highly urbanised and densely populated areas are *ceteris paribus* more likely to attract business and knowledge-intensive service activities (Meliciani and Savona, 2011). Our empirical study, therefore, controls for urbanisation economies when analysing the effects of different types of variety.

3. Data and variable construction

The present study uses a spatially detailed dataset based on the *7th* and *8th Italian Census of Industry and Services* and the *13th Population Census* conducted by the Italian National Institute of Statistics (ISTAT). Original data included over 2.5 million data points reporting the number of employees and plants located in Italy for the period 1991-2001 (censuses in Italy are conducted every ten years), disaggregated by municipal level (8,101 municipalities) and up to 5-digit ATECO'91 sectoral classification of economic activities. Data were spatially harmonized (using the 1991 LLS definition) and aggregated into 784 local labour systems and different sectoral digit levels. The choice of using the LLS as geographical unit of reference is motivated by the economic criteria laying behind their construction as "functional regions" (OECD, 2002). LLS are clusters of municipalities identified on the basis of the self-containment of the daily commuting flows between the place of residence and the place of work (i.e. travel-to-work areas). They seem therefore appropriate to study externality effects, given that these are usually generated through social

interactions between workers in the labour market. As for the sectoral breakdown, we consider 53 sectors at the 2-digit level (29 manufacturing sectors and 24 service sectors) and 207 sectors at the 3-digit level (119 in manufacturing and 88 in services).[2]

The dependent variable in our model (*LabGr*) is defined as the average annual employment growth rate in a LLS (r = 1, 2,…, n) over the period 1991 to 2001 (in %).

$$LabGr_r = \frac{1}{10}(\log E_{r,2001} - \log E_{r,1991}) \quad (1)$$

All explanatory variables are measured in 1991 and, except for the regional dummies, are taken in log form. Among the regressors, a set of indicators based on entropy (Shannon, 1948; Theil, 1972) approximate the different extents of regional variety. These indices assume that an ideally diversified economy is one with equal levels of employment across all sectors. The greater the concentration of employment in a few industries, the less diversified (or more specialized) the economy and the smaller the entropy index of diversification. These measures, as expressed in equations (2), (3) and (4), vary from zero – the case where all employment is concentrated in one industry – to ln(*n)*, the case where employment is spread evenly across all sectors.

As a proxy for conventional Jacobs externalities, we use the entropy index measured at the 3-digit level calculated as follows:

$$Var_r = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i} \right) \quad (2)$$

where $p_i = E_{ir}/E_r$, E denotes the share of each 3-digit sector *i* in total employment of LLS *r*.

Following Frenken et al. (2007) and subsequent aligned research, we disentangle two specific forms of regional diversification. Making use of the Ateco'91-ISIC sectoral classification, we compute a related variety index as a weighted sum of the entropy at the 3-digit level within each 2-digit class. This variable measures the degree of variety between sub-sectors belonging to the same upper sectoral class: sectors at the 3-digit level are defined as related when they share the same category at the 2-digit level. It is therefore implicitly assumed that activities belonging to one sectoral category are more similar than those belonging to different categories, and that spillovers may be stronger between sectors selling similar products or sharing the same technology.[3] The logic behind this measure is that learning opportunities and transmission of skills and ideas may in fact be higher if the cognitive distance between sectors is neither too little nor too large, that is, if sectors are somehow related in terms of sectoral classification.

$$RelVar_r = \sum_{g=1}^{G} P_g H_g \quad (4)$$

$$\text{where } H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \log_2 \left(\frac{1}{p_i / P_g} \right) \quad (5)$$

$P_g = E_{gr}/E_r$ stands for the share of each 2-digit sector *g* in total employment of LLS *r*.

The unrelated variety index is calculated as the entropy at the 1-digit level:

[2] As explained in Section 5 below, the analysis was also performed using measures of related variety up to 5-digit level of sectoral disaggregation, that is 381 sectors for manufacturing, and 427 for services.

[3] The Ateco'91 classification is used to approximate technological complementarities between sectors as no other variable (e.g. input-output tables) is available to measure it directly at the level of sectoral and geographical breakdown of the analysis carried out here.

$$UnrelVar_r = \sum_{j=1}^{N} P_j \log_2 \left(\frac{1}{P_j} \right) \quad (6)$$

where $P_j = E_{jr}/E_r$ is the share of each 1-digit sector *j* in total LLS employment.

All together, the three diversity indicators represent different extents of regional sectoral diversification: *Var* is a measure of diversity between highly disaggregated sectoral activities (i.e. classified at the fine-grained 3-digit level of Ateco'91 nomenclature); *Unrelvar* is diversity measured between broadly classified sectors (1-digit level) very different from one another; *Relvar* represents diversity of complementary related activities in a LLS (share of 3-digit sectors within each 2-digit class).

In line with Frenken et al. (2007) and other literature, it is expected that relatively more Jacobs externalities are captured by our *Relvar* measure of variety between complementary activities.

Urbanization externalities (*Urban*) are captured by the size of local labour systems, measured by population density (log). Finally, a set of dummies is used for macro-areas (North-West, North-East, and Centre) in order to control for spatial heterogeneity.

4. Some descriptive features

The time period under analysis was one of overall positive employment growth in Italy. The relative stagnation of the Italian economy in the first six years of the decade was followed by a rapid expansion which led to an annual average employment variation of 1.02% (see Table 1). As shown in Figure 1 and Table 1, this aggregate trend hides a highly differentiated growth pattern for manufacturing and services. In particular, the tertiary industry has acted as a main engine of growth in the country, outperforming manufacturing sectors with an increase of 1.94% per year. When looking at macro-regions (see Appendix A for their definition), the North-East appears as the most dynamic area with a positive growth trend in both macro-sectors, while the worst overall performance is typically recorded by the Southern regions.

These heterogeneous growth patterns motivated our choice to differentiate the analysis for manufacturing and services and controlling for spatial heterogeneity in the model.

[Table 1 about here]
[Figure 1 about here]

As shown in Figures 2 and 3, the maps of the three diversity measures present different regional patterns for the two industry aggregates, especially for unrelated variety.

[Figure 2 about here]
[Figure 3 about here]

5. The empirical analysis

5.1 Econometric strategy

Building upon previous studies on relatedness and agglomeration, we estimate the impact of different forms of regional variety on local employment growth in Italian LLS over the period 1991-2001. As mentioned above, the analysis is carried out at three different levels: 1) by considering the whole range of economic activities: 2) by distinguishing the specific role played by regional variety in manufacturing and services; and 3) by testing the possibility of diversity spillovers from one industry aggregate to the other. Different estimations and data breakdown were used for each level of analysis, resulting in a total of 140 regressions.

For each level, two model specifications are presented. As *Var* is highly correlated with both *Relvar* an *UnrelVar* (above 0.75) it was not possible to include all independent variables in the same regression. In order to avoid multicollinearity problems, we estimated a first model including the Jacobs externality measure (*Var*) and the urbanization economies proxy (*Popdens*), and a second model where we split the Jacobs externality notion by considering its related (*Relvar*) and unrelated components (*UnrelVar*). To test for potential multicollinearity, we checked cross-correlations and computed the Variance Inflation Factor (VIF) for each explanatory variable. In all models, the highest VIF value is 2.04 and even the highest mean VIF value shows no serious multicollinearity (it is only 1.60).

The employment growth models were initially estimated using standard ordinary-least squares (OLS). However, preliminary testing[4] revealed the presence of heteroskedasticity, which was partly relieved by using a log transformation of the variables. White-robust standard errors were estimated to partially correct for this problem.

Considering that LLS are not isolated islands and geographical patterns of similarity and dissimilarity in local employment growth may arise, we also checked for a potential lack of independence amongst the observations by examining their spatial correlation.[5] Using queen and rook row-standardized contiguity matrices[6] and different orders of contiguity, we first computed Global Moran's I index measures which suggested the presence of possible externality and spillover effects between local labour systems. In order to check if the OLS estimates were able to correctly model the spatial features of the employment growth variable, we then checked the presence of autocorrelation in the residuals of each model and whether this could be best represented by a spatial lag or an error process. On the whole, the residual spatial correlation coefficient and the coefficient of the spatially lagged dependent variable were always positive and statistically significant ($p<0.01$), and the general model fit improved in the spatial regressions (as indicated in higher values of log likelihood). These outcomes, combined with the results from the Lagrange Multiplier tests (LM-lag, LM-error and their robust versions) for spatial correlation suggested to consider the spatial relationships across LLS in our models. In particular, the spatial error model seemed to be favoured over the spatial lag model in all regressions.

On the other hand, the exclusion of spatial dependence in the traditional least squares regression for manufacturing and services does not affect the sign and significance of the coefficients' estimates which, a part for some of the regional dummies, remain virtually the same as in the spatial models. On the whole the White corrected OLS estimations proved to be robust to changes in the model specifications that take into account these spatial effects. For the sake of complete information, the results from both spatial lag and spatial error models for manufacturing and services are reported in Appendix B.

We also tested for robustness of the models to the use of different sectoral classifications by using a related variety indicator measured at different digit levels (i.e. as weighted sum of the entropy at the four- or five-digit level within each two-digit class). The significance and sign of the related variety measures proved to be robust over all regressions.[7]

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[4] Breush-Pagan/Cook-Weisberg heteroskedasticity test.

[5] Statistical and spatial analysis were performed in ArcView and GeoDa. Spatial dependence occurs when values of a variable observed in neighbouring locations are more similar than those observed at locations more distant from each other. This may arise from real spatial interaction effects (e.g. externalities or spillover effects) among geographical units or from measurement error (e.g. regional characteristics that are not part of the model but affect neighbouring areas similarly).

[6] A queen weights contiguity matrix defines a location's neighbors as those sharing a common boundary or vertex, while a rook matrix defines neighbours as those cells to the east, west, north and south (yielding four neighbours for each spatial unit).

[7] These results are available upon request from the authors.

5.2 Results for the whole range of activities

Table 2 presents the main results when employment growth in the whole local economy (manufacturing and services together) is selected as a dependent variable. Each model is distinguished by a letter, according as to whether the variety measures are computed for the whole economy (a), manufacturing (b) or services (c).

[Table 2 about here]

When looking at the effect of diversity across the whole local economy (Models 1a-2a), we find that variety in general (i.e. all our three variety measures) is a crucial factor in favouring local employment dynamics. As all coefficients are statistically significant and display a positive sign, we observe that both related and unrelated variety have a positive effect on local employment growth. A different picture emerges though when assessing the specific role of variety in manufacturing or services. In particular, the growth of overall employment in local areas is positively and strongly affected by related variety in services (Model 2c) and unrelated variety in manufacturing (Model 2b). This indicates that having regions characterized by a concentration of complementary service sectors and highly diversified unrelated manufacturing activities impacts positively on job creation. Although we are not directly testing the models with unemployment data (not available at such a disaggregated sectoral and geographical level of analysis), our finding may suggest a portfolio-effect in manufacturing: higher diversified areas with unrelated manufacturing sectors have a better performance as they are more protected against external shocks in demand.

Urbanization economies, as proxied by population density, have always a significant effect in all estimations. Densely populated territorial systems are those with higher employment growth. In relation to the macro-region dummies, being located in the Northern regions and the Centre favour total employment growth of local labour systems. Over the period 1991-2001, the North-East has experienced the highest annual growth rate in total employment and the second best performance in terms of employment growth in services (Table 1).

Although the R-squared values are not very high (which is to be expected due to the diversity of cross-sectional units) the F-test is always significant at 1% level.[8]

5.3 Results for macro industries: manufacturing vs services

Table 3 provides the results of the analysis by industry macro-aggregates, taking local employment growth in manufacturing and local employment growth in services as dependent variables. As expected, the effect of the different variety measures is consistent with the findings reported in Table 2. While local variety in general seems crucial for job creation in both manufacturing and services industries, only the latter benefit from having local related variety in production activities.

[Table 3 about here]

With regards to urbanization economies, population density is either non significant or displays a negative coefficient sign in the manufacturing regressions (Models 1m-2m). This seems to indicate that urbanization economies in manufacturing are offset by diseconomies arising, for instance, from congestion or high land rents. As Jacobs' externalities are mainly present in densely populated locations like cities (Jacobs, 1969), and because population density adversely affects local employment growth in manufacturing, job creation seems to derive only from (unrelated) diversity in manufacturing irrespective of relatedness (*Relvar* is not significant) and urban density in itself. In other words, only unrelated variety in manufacturing emerges as responsible for the growth in local manufacturing employment.

[8] The same applies for all estimations presented in the following sections.

The spatial heterogeneity analysis carried out for macro-regions shows a specific polarization when focusing on services (Models 1s-2s), with the South performing significantly worse than the rest of the country in terms of employment growth. This reflects the typical spatial dualism between the richer North and the less developed South characterizing Italy. However, with respect to manufacturing (Models 1m and 2m), the North-west dummy shows that local labour systems in this area performed significantly worse as far as employment growth is concerned. This macro-region has in fact experienced an annual fall in manufacturing employment of -2.05% from 1991 to 2001 (see Table 1), consistent with a general de-industrialisation trend experienced by other industrial regions in Europe.

5.4 Analysis of diversity externality effects from/to manufacturing and services

An interesting picture emerges when looking at the outcomes concerning diversity-induced externalities and spillovers from manufacturing to services and vice versa. Results are shown in Table 4 relative to the dependent variable used in the analysis: employment growth in manufacturing and employment growth in services respectively.

[Table 4 about here]

As shown in Models 1s and 2s, there is evidence of diversity externalities only from manufacturing to services. LLS with higher rates of variety in services do not affect local employment growth in manufacturing, while LLS with higher rates of variety in manufacturing do experience higher rates of employment growth in services, irrespective of how variety is measured (i.e. general variety, related or unrelated variety, although the effect tends to become weaker across the three measures). This may depend on several factors. In line with the service literature discussed in Section 2, inter-industry knowledge spillovers are likely to occur as a result of the growing integration between manufacturing and services activities. One of the main determinants of growth in services is their increased demand as intermediate goods from manufacturing (Francois, 1990; Guerrieri and Meliciani, 2005). As suggested by Miozzo and Soete (2001), in fact, the growing complexity of organization and coordination in manufacturing production and distribution resulting from the application of new technologies have increased the service content of many manufacturing products (see also OECD, 1997). In particular, there has been also a rising trend in the latter industry to outsource some functions (e.g. legal, financial, R&D) to the tertiary sector in order to concentrate operations on core competencies, reduce costs and effectively exploit external, specialized expertise (Bhagwati, 1984; OECD, 2000). This may involve not just a simple substitution of internal services but, instead, a more complex process of knowledge transfer that requires reciprocal learning and interaction (Gadrey and Gallouj, 1998). We are however unable to distinguish whether such external effects on services employment growth come from the cumulative innovative output of the manufacturing sector, or simply from an increased demand for services by manufacturing firms.

6. Conclusions

The aim of this paper was to assess the effects of regional sectoral diversification on employment growth in Italian local labour systems. The main contribution is that we provide a better understanding of how variety may differently affect job creation in manufacturing and service industries and, adopting a novel perspective, we consider the possibility of observing diversity externalities from one industry aggregate to the other.

When considering the effects of regional diversity across the whole economy (i.e. without distinguishing manufacturing from services), the empirical results show that variety is in general an important driver of local employment growth. Both related and unrelated variety display positive and significant effects. Only when distinguishing between manufacturing and service activities

remarkable differences arise: in particular, local employment dynamics – both overall (Tab. 2) and macro-industry (Tab. 3) employment – are positively affected by the presence of related variety only in services, whilst unrelated variety seems to spur growth only in manufacturing. Concerning potential complementarities between the industry macro-aggregates, we find evidence of diversity externalities only from manufacturing to services at the local level. When considering employment growth by industry aggregate, differences are also found with respect to the role of urbanization economies. A higher population density favours job creation in the services industry, while the density variable has either a negative or a non-significant coefficient in manufacturing.

Two limitations have to be taken into account when interpreting our findings. First of all, it is possible that the widely used ISIC classification is less adequate to measure related variety. This nomenclature assumes that sectors belonging to a given sub-category are more similar than those belonging to different categories, while this is not necessarily the case. Sectors are categorized by product relatedness without taking directly into account the role of knowledge flows, the sectoral technological proximity (see Quatraro, 2010) or input-output relationships. Secondly, as recently suggested by Bishop and Gripaios (2010) and Boschma et al (2012), the impact of related and unrelated variety may be heterogeneous across sectors within each macro-branch of activity.

In this respect, the present work is open to further research. In particular, rather than relying on the Ateco'91-ISIC nomenclature, a different sectoral taxonomy of economic activities could be used, like the Pavitt taxonomy, or the sectoral taxonomy provided by Neffke and Svensson Henning (2008) which is based on the intensity of labour mobility between sectors. Moreover, sectoral heterogeneity could be further explored by performing separate regressions for each sector of the economy, which would mean a further step to increase our understanding of how regional variety, and in particular related variety affects regional growth.

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Table 1. Average annual employment growth in Italy

Areas	**Average annual employment growth (%)**		
	Total	**Manufacturing**	**Services**
North-East	1.50	0.24	2.23
North-West	0.84	-2.05	2.51
Centre	1.20	-1.12	2.03
South (with islands)	0.67	-0.65	1.03
Italy	***1.02***	***-1.03***	***1.94***

Figure 1. Employment growth in Italy (annual average 1991-2001):

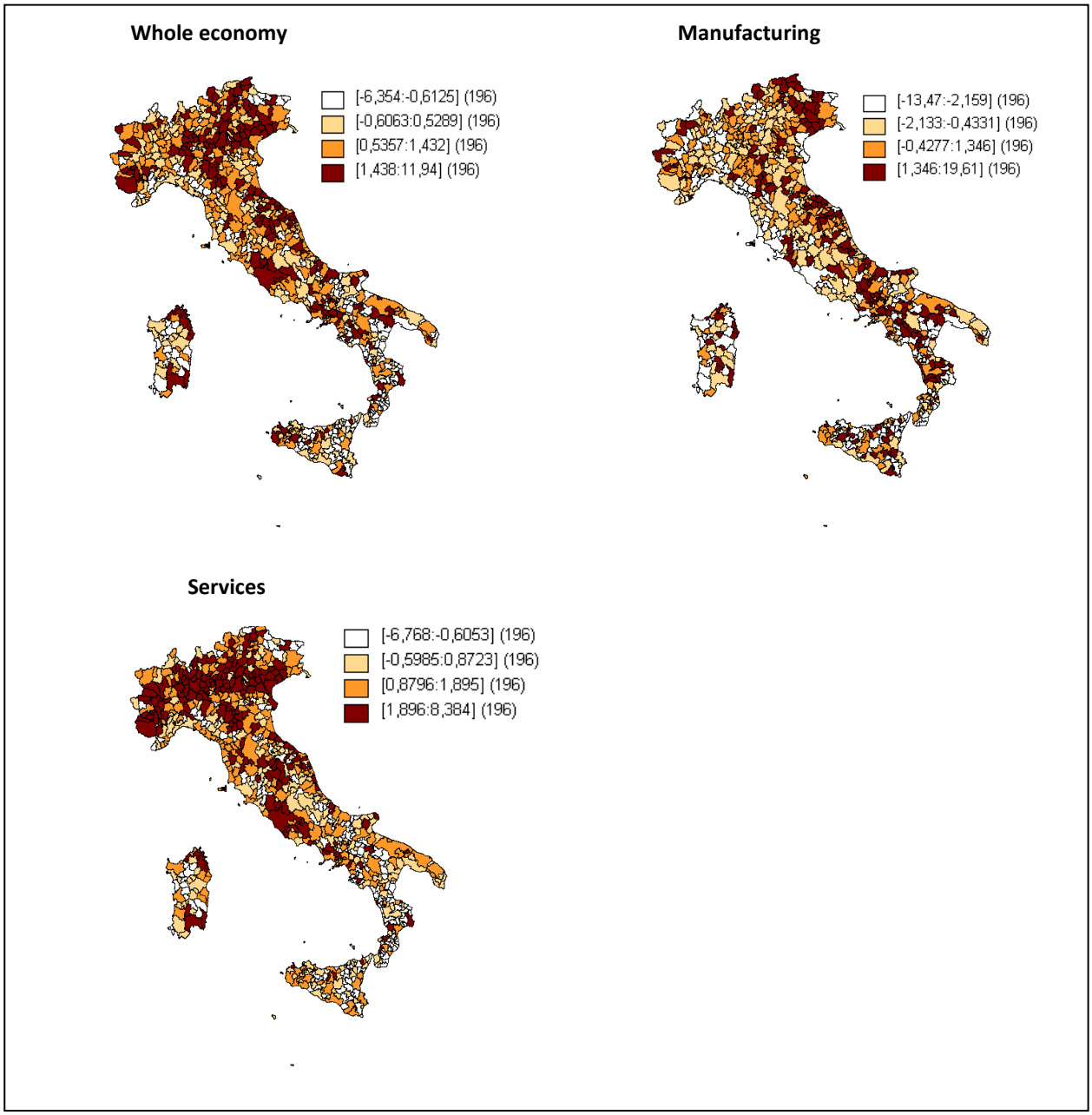

Figure 2. Maps of the variety measures for manufacturing (1991-2001):

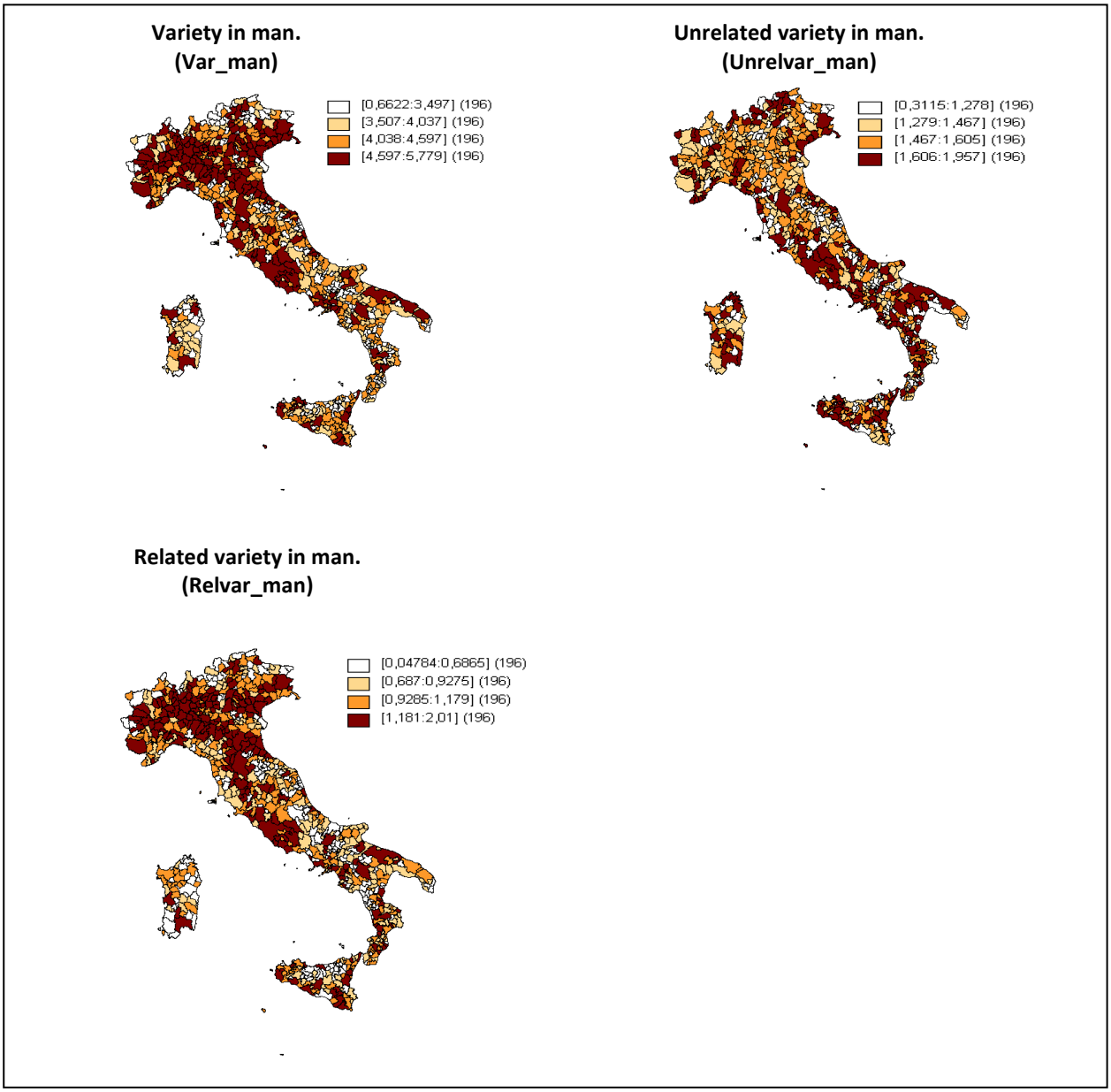

Figure 3. Maps of the variety measures for services (1991-2001):

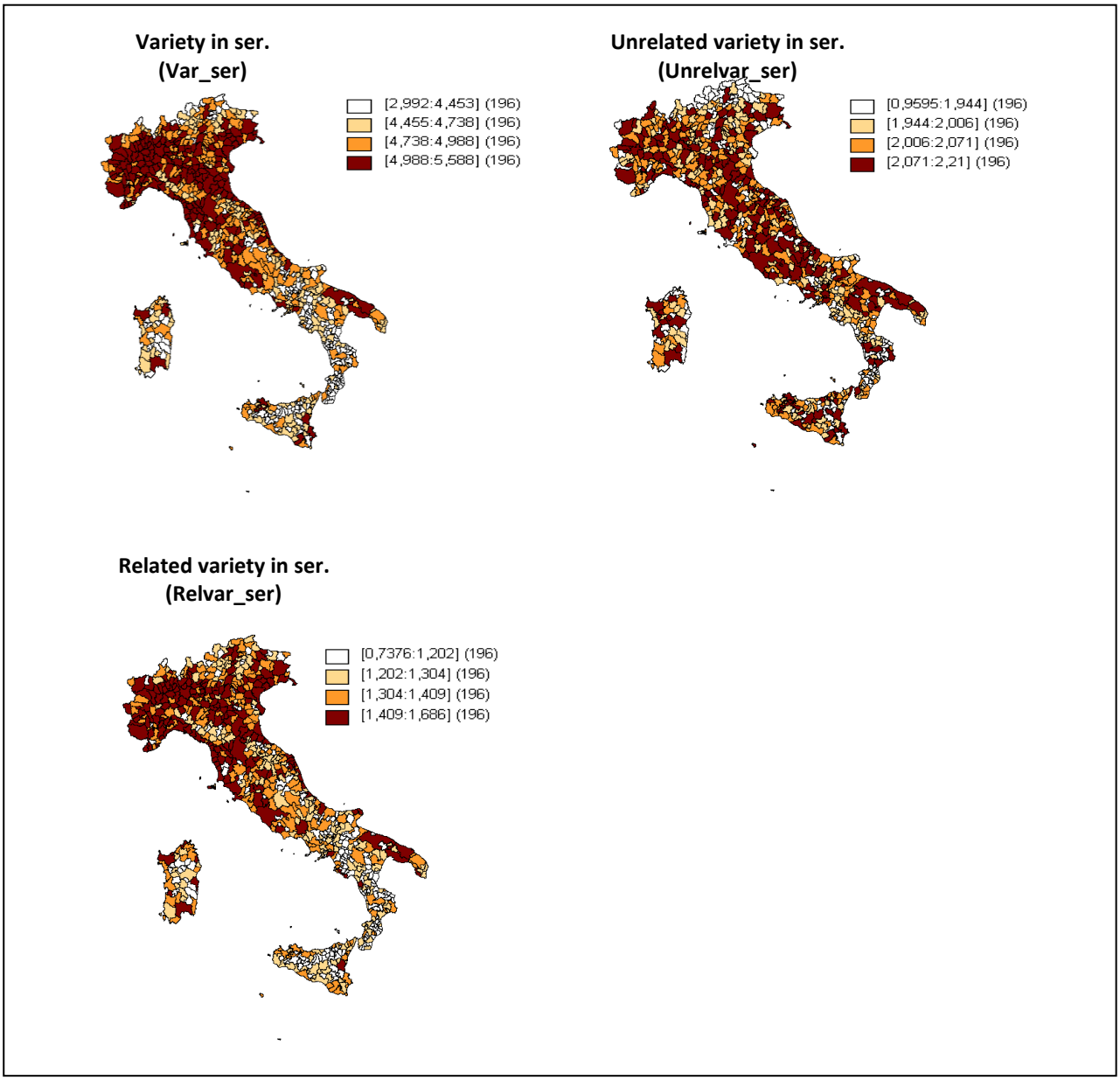

Table 2. Dependent variable: employment growth in local economy (1991-2001)
Estimation method: OLS, White robust standard errors

	Model 1a	**Model 2a**	**Model 1b**	**Model 2b**	**Model 1c**	**Model 2c**
Var_tot	0.957***					
	(0.135)					
Relvar_tot		1.218***				
		(0.347)				
UnrelVar_tot		1.164***				
		(0.333)				
Var_man			0.483***			
			(0.086)			
Relvar_man				0.304		
				(0.193)		
UnrelVar_man				0.985***		
				(0.256)		
Var_ser					1.435***	
					(0.257)	
Relvar_ser						2.611***
						(0.590)
UnrelVar_ser						0.320
						(0.538)
PopDens (ln)	0.246***	0.325***	0.292***	0.391***	0.214***	0.289***
	(0.067)	(0.067)	(0.065)	(0.064)	(0.074)	(0.071)
Nwest	0.179	0.432***	0.487***	0.648***	0.099	0.291
	(0.160)	(0.154)	(0.149)	(0.156)	(0.181)	(0.179)
Neast	0.754***	0.998***	1.047***	1.200***	0.678***	0.894***
	(0.170)	(0.164)	(0.157)	(0.164)	(0.188)	(0.179)
Centre	0.366**	0.553***	0.619***	0.743***	0.138	0.371**
	(0.158)	(0.156)	(0.158)	(0.153)	(0.177)	(0.171)
No.obs	784	784	784	784	784	784
R-squared	0.183	0.165	0.164	0.156	0.177	0.162
F (*sign*)	37.18 *(0.000)*	26.87 *(0.000)*	31.78 *(0.000)*	24.80 *(0.000)*	31.91 *(0.000)*	24.88 *(0.000)*

Excluded dummy variable: South.
Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01

Table 3. Dependent variables: Employment growth in local manufacturing (1991-2001); Employment growth in local services (1991-2001).
Estimation method: OLS, White robust standard errors

	Manufacturing		**Services**	
	Model 1m	**Model 2m**	**Model 1s**	**Model 2s**
Var_man	0.499***			
	(0.159)			
Relvar_man		0.532		
		(0.411)		
UnrelVar_man		1.297**		
		(0.528)		
Var_ser			1.776***	
			(0.261)	
Relvar_ser				3.393***
				(0.605)
UnrelVar_ser				0.585
				(0.611)
PopDens (ln)	-0.251**	-0.186	0.449***	0.526***
	(0.122)	(0.126)	(0.077)	(0.074)
Nwest	-0.828***	-0.723**	0.953***	1.159***
	(0.279)	(0.289)	(0.180)	(0.179)
Neast	0.462	0.569*	0.960***	1.205***
	(0.311)	(0.321)	(0.184)	(0.177)
Centre	-0.485	-0.358	0.589***	0.848***
	(0.320)	(0.324)	(0.161)	(0.158)
No.obs	784	784	784	784
R-squared	0.024	0.027	0.353	0.339
F (*sign*)	7.33 *(0.000)*	5.56 *(0.000)*	71.70 *(0.000)*	57.31*(0.000)*

Excluded dummy variable: South.
Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01

Table 4. Dependent variables: Employment growth in local manufacturing (1991-2001); Employment growth in local services (1991-2001).
Estimation method: OLS, White robust standard errors

	Manufacturing		**Services**	
	Model 1m	**Model 2m**	**Model 1s**	**Model 2s**
Var_man			0.405***	
			(0.091)	
Relvar_man				0.459**
				(0.198)
UnrelVar_man				0.426*
				(0.244)
Var_ser	-0.101			
	(0.480)			
Relvar_ser		-0.031		
		(1.221)		
UnrelVar_ser		-1.149		
		(0.933)		
PopDens (ln)	-0.060	-0.042	0.612***	0.679***
	(0.145)	(0.141)	(0.071)	(0.068)
Nwest	-0.502	-0.524	1.542***	1.645***
	(0.352)	(0.347)	(0.163)	(0.167)
Neast	0.740*	0.700*	1.509***	1.595***
	(0.380)	(0.363)	(0.164)	(0.167)
Centre	-0.337	-0.322	1.225***	1.299***
	(0.375)	(0.358)	(0.152)	(0.152)
No.obs	784	784	784	784
R-squared	0.015	0.016	0.316	0.306
F (*sign*)	4.57 *(0.000)*	3.88 *(0.000)*	68.15 *(0.000)*	54.49 *(0.000)*

Excluded dummy variable: South.
Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01

Appendix A

Italian regions by macro-areas

MACRO-AREA	**REGION** *(NUTS 2)*
NORTH-WEST	Lombardia
	Liguria
	Valle d'Aosta
	Piemonte
NORTH-EAST	Trentino Alto Adige
	Friuli Venezia Giulia
	Veneto
	Emilia Romagna
CENTRE	Toscana
	Marche
	Lazio
	Umbria
SOUTH and islands	Abruzzo
	Calabria
	Molise
	Puglia
	Campania
	Basilicata
	Sardegna
	Sicilia

Appendix B

Table B1. Dependent variable: employment growth in local manufacturing (1991-2001)

Variables	**1**	**2**	**3**	**4**	**5**	**6**
	OLS	ML-LAG	ML-ERR	OLS	ML-LAG	ML-ERR
Var_man	0.491*** (0.183)	0.474*** (0.177)	0.506*** (0.186)			
Relvar_man				0.496 (0.426)	0.453 (0.410)	0.425 (0.435)
UnrelVar_man				1.312*** (0.493)	1.443*** (0.475)	1.661*** (0.478)
PopDens (ln)	-0.247* (0.145)	-0.232* (0.140)	-0.315* (0.166)	-0.179 (0.142)	-0.167 (0.136)	-0.259 (0.163)
Nwest	-0.830** (0.359)	-0.682** (0.347)	-0.855* (0.477)	-0.724** (0.357)	-0.578* (0.345)	-0.755 (0.484)
Neast	0.459 (0.351)	0.252 (0.339)	0.377 (0.464)	0.568 (0.352)	0.356 (0.339)	0.500 (0.473)
Centre	-0.489 (0.348)	-0.452 (0.337)	-0.615 (0.468)	-0.364 (0.348)	-0.321 (0.335)	-0.479 (0.476)
λ			0.308*** (0.048)			0.325*** (0.047)
ρ		0.302*** (0.048)			0.310*** (0.047)	
No.obs[a]	782	782	782	782	782	782
R2	0.024			0.027		
Pseudo-R2		0.085	0.087		0.092	0.097
AIC	4160.16	4126.24	4123.33	4159.34	4123.29	4118.2
SC	4188.14	4158.87	4151.3	4191.88	4160.58	4150.83
LIK	-2074.08	-2056.12	-2055.66	-2072.67	-2053.64	-2052.09
LM error	40.339***			44.686***		
LM lag	39.468***			41.682***		
Robust LM err	0.987			5.774**		
Robust LM lag	0.116			2.771*		
LR test		35.926***	36.838***		38.058***	41.148***

Excluded dummy variable: South;
Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01
[a] Two minor islands, Capri and Lipari, were excluded from the analysis because of their lack of spatial contiguity with other areas.

Table B2. Dependent variable: employment growth in local services (1991-2001)

Variables	**1**	**2**	**3**	**4**	**5**	**6**
	OLS	ML-LAG	ML-ERR	OLS	ML-LAG	ML-ERR
Var_ser	1.769***	1.726***	1.807***			
	(0.218)	(0.213)	(0.228)			
Relvar_ser				3.395***	3.260***	3.134***
				(0.509)	(0.495)	(0.510)
UnrelVar_ser				0.560	0.650	0.638
				(0.499)	(0.485)	(0.508)
PopDens (ln)	0.453***	0.378***	0.473***	0.530***	0.454***	0.584***
	(0.072)	(0.072)	(0.084)	(0.070)	(0.071)	(0.081)
Nwest	0.956***	0.492**	0.901***	1.160***	0.700***	1.160***
	(0.191)	(0.200)	(0.242)	(0.187)	(0.200)	(0.236)
Neast	0.964)***	0.561***	0.970***	1.206***	0.807***	1.280***
	(0.185)	(0.192)	(0.236)	(0.179)	(0.190)	(0.227)
Centre	0.592***	0.274	0.552**	0.850***	0.530***	0.853***
	(0.186)	(0.188)	(0.238)	(0.178)	(0.183)	(0.229)
λ			0.305***			0.293***
			(0.048)			(0.048)
ρ		0.253***			0.252***	
		(0.045)			(0.046)	
No.obs[a]	782	782	782	782	782	782
R2	0.353			0.340		
Pseudo-R2		0.385	0.395		0.371	0.378
AIC	2989.3	2962.79	2952.86	3007.62	2981.71	2975.16
SC	3017.27	2995.42	2980.83	3040.25	3019.01	3007.79
LIK	-1488.65	-1474.39	-1470.43	-1496.81	-1482.86	-1480.58
LM error	40.100***			34.775***		
LM lag	30.657***			30.486***		
Robust LM err	9.884***			4.298**		
Robust LM lag	0.442			0.009		
LR test		28.512***	36.437***		27.910***	32.462***

Excluded dummy variable: South;
Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01
[a] Two minor islands, Capri and Lipari, were excluded from the analysis because of their lack of spatial contiguity with other areas.