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Abstract. In this paper, a shift-share decomposition analysis of business change at plant-level is applied to Italian regions with reference to the period 2004-2009. In particular, a spatial version of shift-share analysis allows to look not only at the national, industrial mix and regional-shift components, as in traditional approaches, but also at the neighbourhood effect. Additionally, we introduce a novel spatial decomposition which is able to conclude more effectively on the neighbourhood influence. Moreover, the micro-level nature of data allows us to analyse the neighbourhood effect at different spatial levels of aggregation (NUTS-2 and NUTS-3 regions). Some results are worth mentioning. First, the spatial level of aggregation affects heavily the results. Second, we find evidence of neighbourhood advantage in the Southern NUTS-3 regions and opposite results for the Central-Northern NUTS-3 regions. Third, we find evidence of positive industrial mix effects only in the Centre-North of Italy. Finally, results obtained over a shorter time span 2004-2007 confirm our conclusions.

Keywords: Business change, Spatial shift-share, Plant-level data, Italian regions.
JEL Classification: C21, L26, R12

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1. Introduction

Abundant literature is focused on spatial dimension of business change. Some among the most prominent special issues on this topic are listed in Audretsch and Peña-Legazkue (2011). However, as asserted by Cheng (2011), most previous literature overlooks that business change can depend on three distinctive sources (i.e. business cycle or national effect, industrial mix and regional advantage) and a decomposition analysis able to isolate the effect of each source seems to be a necessary condition before investigating on spatial aspects of business change. To this end, shift-share decomposition represents a suitable tool of investigation. Moreover, we extend the traditional approach of decomposition to a novel spatial version which allows to look also at the neighbourhood effect. As a matter of fact, Nazara and Hewings (2004) have first introduced the spatial shift-share analysis incorporating a spatial lag growth rate in the basic decomposition. In this pioneering contribution, Nazara and Hewings assert that spatial shift-share includes both simple and combined effects, and these latter may cause problems of interpretation. They find up to twenty different spatial decompositions that can be obtained from all the possible combinations of simple and combined effects. In our contribution, we propose a novel spatial decomposition into four simple effects in order to overcome problems of misleading interpretation of the neighbourhood effect. Indeed, the interpretation of neighbourhood effect is generally based on a component which compares the change of a specific region with that of its neighbours. Following this interpretation, one is not able to distinguish if the competitive effect of a specific region is mainly due to individual characteristics or to neighbourhood advantage. To overcome this drawback, our paper suggests an interpretative scheme able to more effectively conclude on the existence of neighbourhood advantage or disadvantage. In addition, the opportunity of exploiting Italian plant-level data aggregated at two different spatial levels, i.e. NUTS-2 and NUTS-3 regions, allows us to look at spatial aggregation problems (Arbia and Petrarca, 2011), beyond allowing a more effective picture of the distribution of economic activities in Italy[1].

The paper is organised as follows. Section 2 describes shift-share analysis and introduces our novel spatial version. Section 3 includes data source information and descriptive statistics on the spatial distribution of the growth rate of plants in Italy. Section 4 provides the empirical results and section 5 concludes. An appendix on Italian Business Register enriches the paper.

2. Spatial Shift-Share Analysis: A Novel Decomposition

The traditional shift-share analysis decomposes the economic changes (*EC*) in a region into three components (Dunn, 1960):

[1] Plant-level data allows to overcome the well-known problem of multi-located firms.

$$EC = NS + IM + RS \quad (1)$$

where *NS*, *IM* and *RS* refer to national share, industrial mix and regional shift respectively.

In our case, *EC* is the difference over time of the number of plants in a specific region *r*, i.e. $\Delta P_r = (P_{rT} - P_{rt})$. *NS* measures the regional plant change under the assumption that the number of plants in the region has grown at the national rate, i.e.:

$$NS = \sum_i P_{irt} g_n \quad (2)$$

$$g_n = \frac{P_{nT} - P_{nt}}{P_{nt}} \quad (3)$$

where P_{irt} is the number of plants in sector *i* of region *r* at initial year *t*, g_n is the national rate of plant growth over the entire period $t - T$, and P_{nt} and P_{nT} are respectively the number of plants in the nation at initial and final years.

The industrial mix is a measure of specialization at regional level, i.e.:

$$IM = \sum_i P_{irt}(g_{in} - g_n) \quad (4)$$

$$g_{in} = \frac{P_{inT} - P_{int}}{P_{int}} \quad (5)$$

where g_{in} is the national growth rate of plants in sector *i* over the entire period $t - T$, and P_{int} and P_{inT} are respectively the number of plants in sector *i* in the nation at initial and final years. Therefore, if a region has a favourable distribution of industries, in which it is easier to create new business, this region would be expected to have rapid growth in the number of plants.

Finally, *RS* measures the regional advantages or disadvantages that affect the performance of individual industries and, consequently, their change in the number of plants:

$$RS = \sum_i P_{irt}(g_{ir} - g_{in}) \quad (6)$$

$$g_{ir} = \frac{P_{irT} - P_{irt}}{P_{irt}} \tag{7}$$

where g_{ir} is the growth rate of plants in sector i in region r over the entire period $t-T$, and P_{irt} and P_{irT} are respectively the number of plants in sector i in region r at initial and final years.

To sum up, the growth rate of plants g_r can be decomposed as follows:

$$\Delta P_r = (P_{rT} - P_{rt}) = \sum_i P_{irt} g_n + \sum_i P_{irt}(g_{in} - g_n) + \sum_i P_{irt}(g_{ir} - g_{in}) \tag{8}$$

While shift-share analysis in the traditional formulation does not account for interactions across neighbouring regions, a spatial version allows to overcome this drawback. The idea is that the decomposed effects are not spatially independent, i.e. the performance of neighbouring regions can affect the growth performance of a particular region. Nazara and Hewings (2004) have first introduced the shift-share analysis with spatial structure, incorporating a spatial lag growth rate $\breve{g}_r$ in the basic decomposition as follows:

$$\Delta P_r = \sum_i P_{irt} g_n + \sum_i P_{irt}(\breve{g}_{ir} - g_n) + \sum_i P_{irt}(g_{ir} - \breve{g}_{ir}) \tag{9}$$

$$\breve{g}_r = \frac{\sum_s w_{rs} P_{sT} - \sum_s w_{rs} P_{st}}{\sum_s w_{rs} P_{st}} \tag{10}$$

$$\breve{g}_{ir} = \frac{\sum_s w_{rs} P_{isT} - \sum_s w_{rs} P_{ist}}{\sum_s w_{rs} P_{ist}} \tag{11}$$

where w_{rs} is the element of row-standardised binary weights matrix $\boldsymbol{W}$ denoting the intensity of interaction between region r and the neighbouring region s[2]. The spatial weights matrix $\boldsymbol{W}$ is the most common way to formalize the structure of spatial proximity amongst areal data. A natural specification of this matrix does not exist, and a topological notion of spatial proximity needs to be

[2] The row-standardised binary weights matrix $\boldsymbol{W}$ has been constructed by firstly assigning at each generic element w_{rs} value 1 if regions r and s are neighbours and 0 otherwise. Then, dividing w_{rs} by the sum of the elements of the corresponding row so that the weights sum to unit for each region.

arbitrarily introduced by researchers. In the case of irregular areal data (such as administrative units like NUTS-2 and NUTS-3 regions), the proper notion of neighbourhood should be based on the distance between centroids at regional level. The distance-based neighbourhood definition commonly used in the spatial econometrics literature, and here employed, is the *critical cut-off neighbourhood* which defines two regions to be neighbours if their distance is equal, or less than equal, to a certain fixed distance (i.e. the critical cut-off). In our case, the minimum distance is used as critical cut-off so that each region is ensured to have at least one neighbour[3].

On the right-hand side of Equation 9, the first component measures the national effect (*NS*) as in the classical shift-share. The second component is now a measure of the neighbour-nation industry mix effect (*NNIM*) and shows a positive value when the growth rate of the considered sector i in the neighbours of region r is higher than the national rate. Finally, the third component is the region-neighbour regional-shift effect (*RNRS*). This last component has a negative value when the regional change is worse than the one registered in the neighbouring regions, namely the considered region r fails to take advantage of the positive influence of its neighbours.

Differently to the standard version, the spatial shift-share includes both simple and combined effects. The combined effect, measuring differences of more than one aspect at the same time, is characterised by problems of interpretation. For example, the neighbour-nation industry mix effect, $(\breve{g}_{ir} - g_n)$, in Equation 9 measures at the same time the sectoral difference between sector i and all sectors and the spatial-unit difference between the neighbours of region r and the nation. If, on the one hand, a combined effect can be decomposed in a sequence of simple effects, on the other hand, a certain degree of parsimony is requested in the decomposing procedures. As shown in Nazara and Hewings (2004), twenty different spatial decompositions can be obtained from all the possible combinations of simple and combined effects and their selection can only depend on the aim of research. In our case, the main object is to look at the neighbourhood effect in business change at different spatial levels of aggregation. To this end, the decomposition in Equation 9 is just partly suitable and a further step seems to be needed. Generally, the interpretation of neighbourhood effect is exclusively based on the third component of Equation 9[4]. As a matter of fact, the information contained in this component could be even misleading as, for example, in the case where the neighbourhood effect shows a positive value but the difference of performance between neighbours and nation is negative. In such a case, the competitive effect of region r is mainly due to individual

[3] The minimum distance is 380 km for the Italian NUTS-2 regions and 75 km for the Italian NUTS-3regions. Increasing cut-off distances are also used for a robustness check: 400, 420 and 440 km for the NUTS-2 regions and 95, 110, 120 and 150 km for the NUTS-3 regions. The results begin significantly to change just with the longest distance.
[4] Mayor and Lopez (2008) use an alternative approach based on spatial filtering.

factors rather than to neighbourhood advantages. In order to overcome this drawback, the second component of Equation 9 can be decomposed into two simple effects:

$$(\breve{g}_{ir} - g_n) = (\breve{g}_{ir} - g_{in}) + (g_{in} - g_n) \tag{12}$$

Our attention will be focused on the first component, $(\breve{g}_{ir} - g_{in})$, of Equation 12 that can be interpreted as a measure of neighbour-nation regional-shift effect (*NNRS*). Looking jointly at the two regional-shift effects (neighbour-nation and region-neighbour), we are able to conclude more effectively on the neighbourhood influence. In particular, we can expect to have four possible scenarios: (a) positive value of *RNRS* and positive value of *NNRS*; (b) negative value of *RNRS* but positive value of *NNRS*; (c) negative value of *RNRS* and negative value of *NNRS*; (d) positive value of *RNRS* but negative value of *NNRS*. We can conclude in favour of a competitive regional advantage or disadvantage due to neighbourhood influence only in scenarios (a) and (c). While in scenarios (b) and (d), competitive regional advantage or disadvantage are due to individual characteristics of the specific region *r*. Figure 1 graphically represents the interpretation of neighbourhood effect with respect to our version of spatial shift-share analysis.

To sum up, the decomposition adopted in the rest of the analysis is as follows:

$$\Delta P_r = \sum_i P_{irt} g_n + \sum_i P_{irt}(g_{in} - g_n) + \sum_i P_{irt}(\breve{g}_{ir} - g_{in}) + \sum_i P_{irt}(g_{ir} - \breve{g}_{ir}) \tag{13}$$

Or in other terms:

$$EC = NS + IM + NNRS + RNRS \tag{14}$$

Equation 13 will be applied to our data on Italian plants at different spatial levels of aggregation, i.e. NUTS-2 and NUTS-3 regions. Before introducing the empirical results, a description of statistical source and a preliminary analysis of data are provided in next section.

3. Data and Descriptive Statistics

3.1. Data

The spatial shift-share analysis has been carried out using plant-level data collected by Italian National Institute of Statistics (ISTAT) in the Business Register[5] of Local Units (ASIA) during 2004-2009. The shift-share decomposition has been applied to data aggregated at two different spatial levels, i.e. NUTS-2 and NUTS-3, and at four macro-sectors of economic activity, i.e. (a) manufacturing, (b) construction, (c) trade, transportation and accommodation, and (d) other service activities[6]. The Business Register ASIA yearly collects, at plant level and with the highest spatial and sectoral levels of disaggregation, statistical information which was, before now, ten-yearly available in the Economic Census. Additional information on the Italian Business Register is available in Appendix 1.

The spatial reorganization over the years 2004-2009 and the implementation in the 2007 of the revised NACE (from NACE Rev 1.1 to NACE Rev 2.) have implied a disruption of time series in Business Register database. The harmonization of time series in terms of both sectoral and spatial aggregations has been therefore a necessary step before proceeding with the rest of analysis. The *backcasting* of data, i.e. the harmonization of the NACE Rev.1 time series with respect to the NACE Rev. 2 classification, has been carried out using a *proportional approach* which operates by conversion matrices based on old and new classifications.

The next subsection provides some descriptive statistics on the spatial distribution of the growth rate of plants in Italy.

3.2. Descriptive statistics

In order to assess the necessity of incorporating a neighbourhood effect within the shift-share decomposition, a preliminary investigation on the spatial dependence of business change rate is here carried out. Figure 2 shows two quantile maps of the Italian NUTS-2 regions that depict the spatial distribution of the growth rate of plants during the period 2004-2009 and the sub-period 2004-2007, respectively. With the aim of easily introducing results, quantiles refer in both maps to the same period, i.e. 2004-2009. The sub-period 2004-2007 is therefore taken into account just as a robustness check in consequence of the breakpoint due to the financial crisis started in 2007. From a first visual inspection of map (a) in Figure 2, a certain degree of spatial correlation across NUTS-2 regions emerges in relation to the growth rates of plants. Specifically, regions with relatively low (high) growth rates seem to be located in the Northern (Southern) area of Italy. Furthermore, map

[5] At the best of our knowledge, only Zaccomer and Mason (2011) have until now applied the spatial shift-share analysis to Italian Business Register database with the aim of decomposing employment growth in a single region, i.e. Friuli Venezia Giulia.

[6] Manufacturing sector is here defined by the economic activities belonging to group C of the NACE Rev 2 classification scheme; Construction refers to group F; Trade, transportation and accommodation refer to groups G, H and I; Other service activities refer to groups J, K, L, M, N, P, Q, R and S.

(b) in Figure 2 points out a general decrease of growth rates due to a common effect of the crisis, even if with a harder impact on the Northern regions.

Figure 3, containing the corresponding quantile maps for the Italian NUTS-3 regions, exhibits a pattern of spatial dependence amongst regions even at a finer level of spatial resolution. Specifically, a cluster of relatively high business change rates seems to be located in the Central area of Italy.

With the aim of corroborating such intuitive visual impressions of spatial dependence, we rely on the well-known Moran's *I* statistic (Moran, 1950). This is a global summary measure of spatial autocorrelation which allows to evaluate how similar the values of spatial neighbouring areas tend to be. Applied to the growth rate of plants, the Moran's *I* statistic can be defined as follows:

$$I = \frac{n}{\sum_r^n \sum_s^n w_{rs}} \frac{\sum_r^n \sum_s^n w_{rs} (g_r - \bar{g})(g_s - \bar{g})}{\sum_r^n (g_r - \bar{g})^2} \tag{15}$$

where n represents the total number of regions; g_r and g_s respectively indicate the growth rate of plants in areas r and s; $\bar{g}$ is the average regional growth rate of plants; and, finally, w_{rs} is the generic element of the spatial weights matrix as defined in Section 2.

The spatial weights matrix, which conventionally describes the neighbourhood relationships, is not naturally defined so that an arbitrary choice is imposed about the specification. With regard to this aspect, the Moran's *I* statistic is quite sensitive to different specifications. In order to control for such a problem and to obtain robust results, the Moran's *I* statistic is computed with respect to some alternative spatial weights matrices on the basis of different critical cut-off distances (see Section 2). Table 1 summarizes the results of the Moran's *I* statistic-based spatial autocorrelation test applied to the growth rate of plants in the Italian NUTS-2 regions[7]. Regardless of the period under analysis, the spatial weights matrix used and the underlying distribution of the estimator assumed, the null hypothesis of no spatial autocorrelation is rejected manifesting significant evidence of spatial dependence across Italian regions. In other words, the growth rates of plants tend to be similar amongst neighboring regions.

Table 2 confirms the evidence of spatial autocorrelation also for the Italian NUTS-3 regions. To sum up, we find evidence of spatial dependence in the growth rate of plants across Italian regions independently on the spatial level of aggregation. Hence, we can conclude that, in our case,

[7] For a comprehensive set of different critical cut-off distances, the *p-values* are based on both the asymptotic normality and the analytical randomisation assumption on the distribution of *I* (for more technical details see Schabenberger and Gotway, 2005).

the neighbourhood effect component may substantially improve the explanatory power of the shift-share decomposition analysis of business change.

4. Empirical Results

The spatial shift-share decomposition of the regional change in the number of plants (*EC*) has been carried out on the basis of equations 13 and 14. Data are available for the period 2004-2009, which is characterized by the financial crisis started in 2007. Hence, we look also at the sub-period 2004-2007 in order to have a robustness check[8]. Table 1 shows the value of each component at both NUTS-2 and NUTS-3 spatial levels of aggregation and for the two periods under analysis. First, we can note as the national component (*NS*) is positive in each region. In other words, we find a positive common trend in the change of the number of plants so that deviations from this trend will be due to regional-shift (*NNRS* and *RNRS*) or industrial mix (*IM*) effects. Considering the dualism of Italian economy (e.g. Piacentino and Vassallo, 2011), we concentrate our attention on the comparison between Central-Northern regions and Southern regions. Following the interpretative scheme in Figure 1, we use some scatter plots in order to look at the neighbourhood effect. Figure 4 shows, in particular, the relationship at NUTS-2 level of aggregation between *NNRS* and *RNRS*. Only few Central-Northern regions, i.e. black circles in the first quadrant, exhibit a neighbourhood advantage. On the contrary, most of the Southern regions show a neighbourhood disadvantage, i.e. white circles in the third quadrant. The results in terms of comparison between Centre-North and South do not relevantly change looking at the sub-period 2004-2007. Expectedly, we note a general worsening, which is manifested by a common movement of the regions towards the left part of diagram, when the period 2004-2009 is considered. In Figure 5, the same relationship between *NNRS* and *RNRS* is shown at the NUTS-3 spatial level of aggregation. In this case, the interpretation of results would be favoured by excluding the extreme values in the diagram as in panels (c) and (d). Surprisingly, opposite results are obtained looking at the NUTS-3 regional level which represents our finest level of spatial aggregation. Indeed, panels (c) and (d) of Figure 5 show that almost all the Southern regions have positive values of *NNRS* and most of them have also positive values of *RNRS*, i.e. a neighbourhood advantage. On the contrary, a relevant number of Central-Northern regions exhibits a neighbourhood disadvantage. Also in this case, the analysis over the time span 2004-2007 confirms the results in terms of comparison between Centre-North and South. To sum up, we prevalently find neighbourhood advantages in the South and disadvantages in the Centre-North when we look at the NUTS-3 regions. Very different results are obtained for the NUTS-2 regions. In order to show the different nature of regional change in the number of plants,

[8] In section 3.2, we noted the hardest impact of crisis in terms of growth rate of plants in the Northern regions.

we compare the regional-shift components, i.e. *NNRS* and *RNRS*, with the industrial mix component, i.e. *IM*. In particular, Figures 6 and 7 compare *NNRS* and *RNRS* respectively with *IM* at NUTS-2 level of aggregation. The concentration of white circles in the second quadrant of each graph is evidence of the positive effect of *IM* in terms of growth rate of plants in the Southern NUTS-2 regions. On the contrary, *IM* seems to negatively affect the change of the number of plants in the Centre-North. The conclusions do not change if we look at the sub-period 2004-2007. However, opposite results are once again obtained when we look at the NUTS-3 regions. Figures 8 and 9 show indeed a negative effect of *IM* in almost all the Southern NUTS-3 regions in opposition to a positive effect in a relevant number of Central-Northern NUTS-3 regions. In conclusion, we find at least three results which are worth mentioning. First, the level of spatial aggregation affects heavily the results[9]. Of course, we rely on the results obtained by the finest level of aggregation, i.e. the NUTS-3 regions in our case. Second, we find evidence of neighbourhood advantage in the Southern NUTS-3 regions and opposite results for the Central-Northern NUTS-3 regions. Third, we find evidence of positive industrial mix effects only in the Centre-North. Moreover, the results seem to be robust with respect to the period under analysis. Indeed, results obtained over a shorter time span 2004-2007 confirm our conclusions.

5. Conclusions

According to Cheng (2011), most previous literature overlooks that business change can depend on three distinctive sources, i.e. business cycle or national effect, industrial mix and regional advantage. To this end, a decomposition analysis able to isolate the effect of each source seems to be a necessary condition before investigating on spatial aspects of business change. This suggestion have inspired our contribution on the analysis of business change in Italian regions during 2004-2009. Moreover, we have extended the traditional shift-share decomposition to a novel spatial version which allows to look at the neighbourhood effect. On the basis of the pioneering contribution by Nazara and Hewings (2004) in which spatial shift-share is firstly introduced, we propose a specific spatial decomposition into four simple effects able to give a more effective interpretation of the neighbourhood advantage or disadvantage. In other words, we are able to conclude if the regional competitive effect (i.e. the regional-shift effect) is mainly due to regional specific features or to the influence of the neighbouring regions. Data at plant-level collected in the Italian Business Register allows to overcome problems related to multi-located firms and to obtain a more effective picture of the distribution of economic activities across space. Moreover, data aggregation at two different spatial levels (NUTS-2 and NUTS-3 regions) allows to look at spatial

[9] On this point, Arbia and Petrarca (2011) have recently provided a reanalysis of spatial aggregation problems and MAUP (Modifiable Areal Unit Problem).

aggregation problems. At least three results are worth mentioning. First, the level of spatial aggregation affects heavily the results: opposite results emerge when analysis moves from NUTS-2 to NUTS-3 regions. Second, relying on the results obtained by Italian NUTS-3 regions (i.e. our finest spatial level), we find evidence of neighbourhood advantage in the South and disadvantage in the Centre-North. Finally, we find evidence of positive industrial mix effect only in the Central-Northern regions. Moreover, the results seem to be robust with respect to the period under analysis.

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APPENDIX 1: The Italian Business Register

The increasing demand for businesses statistics harmonized at European level, together with the obligation deriving from the community legislation on the harmonization of official statistical information (European Regulation N. 177/2008), has led to the development of national businesses registers capable of supplying a continuous, up-to-date and comparable flow of data on the national productive systems. The Italian Business Register, named *Archivio Statistico delle Imprese Attive* (ASIA), is managed and updated by the Italian National Institute of Statistics (ISTAT). The Business Register ASIA records the entire population of active enterprises operating in the manufacturing and services sectors. The economic activities related to agriculture, fisheries and public administration are excluded, as well as all the units having the legal form of public institution and private non-profit institution. In this paper, we use in particular data collected at plant level in the Italian Business Register of Local Units (ASIA-*Unità locali*). Specific statistical methods have been carried out to set up and update the Business Register. ASIA is the result of the integration of information coming from both administrative sources, managed by public agencies or private companies, and statistical sources owned by ISTAT. The main problem in producing statistical information from administrative sources is to establish correspondences between the administrative rules and laws which define a legal picture of the observed universe and the statistical picture of the same universe. The updating procedure, with reference to a generic year *t*, consists of the following phases. First, the *integration of administrative and statistical sources.* All the records present in the various input sources, after the common procedures of normalization and standardization, are linked by means of common keys (e.g. tax code and address). The matching with respect to both *intra-archive* and *inter-archives* linkages allows to avoid possible redundancies and to obtain a cluster of records for each statistical unit. The set of statistical units for the reference year *t* represents the informative basis for the subsequent choice and assignment of the statistical characteristics. The main administrative sources used to identifying the statistical units (i.e. enterprises and local units) and to define their characters are: (a) the Tax Register (VAT), owned by the Ministry of Economy and Finances; (b) the Register of Enterprises and Local Units (CCIAA), owned by the Chambers of Commerce; (c) The archives managed by the Social Security Authority (INPS); (d) The archive of the business telephone lines (SEAT-Yellow Pages). The statistical sources include all the structural and short-term surveys on the enterprises carried out by ISTAT. In particular, the structural business surveys (i.e. a total survey on enterprises with more than 100 employees, a sample survey on small and medium enterprises and the PRODCOM survey) and the short-term surveys (i.e. a monthly survey on manufacturing turnover, a quarterly survey on services turnover, a survey on external trade, a monthly survey on domestic trade, etc.). Second, the *identification of active enterprises at* *year t and the estimation of their attributes*. The errors commonly made in using administrative data for statistical purposes are generally of two types: (a) coverage errors, over or under-coverage of the reference universe; (b) errors due to the lack of the characteristics or incorrect assignment of them to the statistical units. These errors can be reduced significantly by comparing information derived from different sources. In general, it is necessary to establish which source is more reliable for each variable, i.e. choosing the information which probably is more correct among the available sources. The choice depends on the number and reliability of the available sources. Some 'rank' functions will be applied only if the correct information is clearly contained in the available sources, otherwise some probabilistic functions will be needed. The identification of the active enterprises is carried out through a logistic model, taking into account some signals of activity obtained from the available sources (e.g. a yearly amount turnover for the Tax Register, the payment of the annual tax for the Chamber of Commerce, the employees for the Social Security archive and the number of telephone lines for Yellow Pages). The choice of the economic activity code, amongst the different values provided by administrative sources, depends on a probabilistic procedure based on the use of appropriate quality indicators derived from data. Third, the *identification of active local units at year t and the estimation of their attributes*. The administrative and statistical information available in Italy do not provide reliable and complete information on local units, especially with regard to the spatial distribution of employees. A yearly survey on local units (i.e. plants) of multi-location enterprises of large size (IULGI) is therefore carried out in order to fill this lack of information. The observation field includes: (a) all enterprises with more than 249 employees; (b) a panel, which rotates every two years, of enterprises with a number of employees between 100 and 249; (c) a panel, which rotates every three years, of enterprises with a number of employees between 50 and 99. IULGI represents the basis on which a significant number of local units are updated in the register. For the enterprises not represented in IULGI, an estimation procedure is needed. In particular, a generalized linear mixed model (GLMM) is used to estimate the probability that a local unit is active using administrative/statistical data. Fourth, the *quality controls*. The edit and imputation procedure has been developed at different level of analysis. Micro controls intended to detect errors at individual enterprise or local units level. The control plan only relates to the main characters of the units (e.g. activity status, legal status, economic activity code and average number of employees). Macro controls intended to detect errors at aggregated level. Longitudinal comparisons using the available years of the Business Register on the number of enterprises, local units and employees stratify by division of economic activity code and municipality are carried out. The longitudinal analysis allows to find anomalous counts with respect to specific variables of stratification (province, municipality and division of economic activity) or incoherent counts compared to previous releases of the Business Register.

Table 1 – Moran's *I* statistic-based spatial autocorrelation test of the growth rate of plants (Italian NUTS-2 regions)

	2004-2009			2004-2007		
Critical cut-off distance (Km)	*I*	*p-value* (normality)	*p-value* (randomisation)	*I*	*p-value* (normality)	*p-value* (randomisation)
380	0.2234	0.0021	0.0017	0.3976	0.0000	0.0000
400	0.2096	0.0027	0.0023	0.3799	0.0000	0.0000
420	0.1567	0.0045	0.0038	0.2960	0.0000	0.0000
440	0.1339	0.0054	0.0046	0.2685	0.0000	0.0000

Table 2 – Moran's *I* statistic-based spatial autocorrelation test of the growth rate of plants (Italian NUTS-3 regions).

	2004-2009			2004-2007		
Critical cut-off distance (Km)	*I*	*p-value* (normality)	*p-value* (randomisation)	*I*	*p-value* (normality)	*p-value* (randomisation)
75	0.1420	0.0162	0.0123	0.4774	0.0000	0.0000
95	0.1082	0.0163	0.0124	0.4406	0.0000	0.0000
110	0.0981	0.0147	0.0110	0.4101	0.0000	0.0000
120	0.1019	0.0068	0.0048	0.3608	0.0000	0.0000
150	0.0807	0.0086	0.0062	0.3256	0.0000	0.0000

Table 3 – Spatial shift-share analysis of business change in Italian regions

		2004-2009					2004-2007				
NUTS-2 regions	**NUTS-3 regions**	***EC***	***NS***	***IM***	***NNRS***	***RNRS***	***EC***	***NS***	***IM***	***NNRS***	***RNRS***
					CENTRE-NORTH						
Piemonte		746.0	6199.2	174.3	-3260.0	-2367.5	9983.0	14851.2	333.3	-2967.5	-2234.0
	Torino	631.0	3195.8	1088.2	-5507.5	1854.4	5538.0	7656.1	699.4	-4042.3	1224.8
	Vercelli	-369.0	243.5	-51.3	-254.1	-307.1	280.0	583.3	-14.1	-304.5	15.3
	Novara	117.0	499.8	-26.3	-554.5	197.9	833.0	1197.4	4.8	-528.7	159.5
	Cuneo	1558.0	837.5	-328.0	407.5	641.0	1897.0	2006.3	-119.9	223.5	-212.9
	Asti	232.0	295.8	-82.3	-150.5	169.0	549.0	708.7	-23.2	-149.8	13.4
	Verbano-C-O	-263.0	233.2	-118.1	-170.2	-207.8	138.0	558.6	-56.5	-147.9	-216.1
	Biella	-860.0	287.2	-63.4	-288.2	-795.7	-78.0	688.1	-24.6	-227.6	-514.0
	Alessandria	-300.0	606.4	-244.5	-384.7	-277.2	826.0	1452.7	-132.6	-206.9	-287.2
Valle Aosta		187.0	215.0	129.7	-149.2	-8.4	446.0	515.1	108.4	-135.6	-41.9
	Aosta	187.0	215.0	129.7	-292.6	134.9	446.0	515.1	108.4	-226.1	48.6
Liguria		932.0	2370.0	947.3	-1096.1	-1289.3	5002.0	5677.8	609.0	-995.1	-289.7
	Imperia	444.0	330.7	66.6	283.2	-236.5	1013.0	792.2	67.8	15.7	137.3
	Savona	748.0	459.3	99.4	-290.2	479.5	1306.0	1100.2	90.3	-275.0	390.5
	Genova	-361.0	1263.2	736.6	-483.2	-1877.6	2094.0	3026.2	426.5	-356.7	-1002.0
	La Spezia	101.0	316.9	44.8	-268.0	7.3	589.0	759.2	24.4	-133.8	-60.8
Lombardia		14673.0	14660.7	6409.7	-9039.6	2642.2	31139.0	35122.0	4045.7	-6638.8	-1389.8
	Varese	776.0	1204.9	109.1	-1529.9	991.8	2713.0	2886.6	88.1	-1537.0	1275.2
	Como	1005.0	827.7	-75.7	-740.3	993.3	1610.0	1982.9	-15.8	-788.9	431.9
	Sondrio	460.0	246.5	-50.0	199.2	64.3	683.0	590.5	-11.6	42.4	61.7
	Milano	6228.0	5334.7	7486.9	-810.3	-5783.2	7774.0	12780.0	4189.0	553.1	-9748.1
	Bergamo	2339.0	1539.7	-119.5	-1040.0	1958.8	4037.0	3688.7	155.6	-1296.8	1489.6
	Brescia	3164.0	1839.7	-663.9	734.3	1254.0	4972.0	4407.3	-349.2	281.4	632.6
	Pavia	864.0	699.5	94.9	-902.6	972.2	2001.0	1675.9	85.3	-805.9	1045.7
	Cremona	409.0	456.7	-77.9	-302.9	333.0	1116.0	1094.2	-21.9	-322.4	366.1
	Mantova	177.0	585.8	-224.7	-77.0	-107.1	1199.0	1403.4	-89.3	18.8	-133.9
	Lecco	890.0	459.5	-177.8	-403.9	1012.2	1057.0	1100.9	-96.6	-437.9	490.7
	Lodi	462.0	262.7	76.4	-253.8	376.7	932.0	629.3	75.0	-237.9	465.5
	Monza-Brianza	-2101.0	1203.2	32.0	-580.6	-2755.5	3045.0	2882.4	37.2	-1029.8	1155.2
Alto Adige		-433.0	777.2	-313.3	-454.9	-442.0	223.0	1861.8	-182.2	-394.4	-1062.2
	Bolzano	-433.0	777.2	-313.3	-139.0	-757.9	223.0	1861.8	-182.2	-549.9	-906.8
Trentino		951.0	735.8	61.5	-448.9	602.5	1628.0	1762.8	91.3	-368.9	142.9
	Trento	951.0	735.8	61.5	-646.6	800.2	1628.0	1762.8	91.3	-905.1	679.1
Veneto		2780.0	7265.0	-2228.4	-4427.1	2170.5	13767.0	17404.4	-1113.4	-3627.9	1104.0
	Verona	1349.0	1343.8	-159.7	353.6	-188.7	3356.0	3219.2	-21.2	-95.2	253.2
	Vicenza	-420.0	1284.3	-1021.2	74.3	-757.5	1523.0	3076.8	-615.6	-188.6	-749.7
	Belluno	-327.0	284.4	-182.4	-227.8	-201.2	41.0	681.3	-99.5	-277.5	-263.3
	Treviso	458.0	1300.4	-408.0	-680.9	246.6	2467.0	3115.2	-189.2	-733.8	274.8
	Venezia	287.0	1212.6	-90.1	-312.2	-523.3	2572.0	2904.9	-9.1	-432.9	109.1
	Padova	1746.0	1495.9	-171.9	-771.6	1193.5	3389.0	3583.7	-77.0	-584.3	466.5
	Rovigo	-313.0	343.6	-195.2	-220.4	-241.1	419.0	823.2	-101.8	-128.6	-173.8
Friuli V.G.		-1803.0	1645.3	-12.7	-694.4	-2741.3	1519.0	3941.6	30.7	-615.2	-1838.2
	Udine	-409.0	766.4	-79.3	-1588.1	492.0	840.0	1836.1	-13.1	-1059.9	76.9
	Gorizia	-470.0	176.9	-28.9	-333.7	-284.3	76.0	423.7	-17.6	-250.4	-79.7
	Trieste	-655.0	294.0	203.0	-1014.5	-137.5	136.0	704.3	113.5	-566.4	-115.5
	Pordenone	-269.0	408.0	-107.5	-372.2	-197.3	467.0	977.4	-52.1	-288.7	-169.6
Emilia R.		1419.0	6887.8	689.6	-1866.5	-4291.8	13575.0	16500.7	638.5	-1456.5	-2107.7
	Piacenza	421.0	426.6	-18.5	-322.9	335.8	927.0	1021.9	8.9	-138.2	34.4
	Parma	191.0	695.6	22.1	-534.5	7.8	1579.0	1666.5	54.4	-189.0	47.2
	Reggio Emilia	-300.0	792.7	-327.7	-851.8	86.7	1951.0	1899.0	-80.3	-402.7	535.0
	Modena	-1155.0	1102.9	-375.2	-628.1	-1254.6	1455.0	2642.2	-204.1	-153.9	-829.3

	Bologna	58.0	1614.7	1125.9	-1341.0	-1341.6	2675.0	3868.3	634.8	-702.1	-1125.9
	Ferrara	-730.0	488.7	38.3	-413.0	-844.1	500.0	1170.8	46.2	-296.5	-420.4
	Ravenna	146.0	561.7	144.1	-461.1	-98.8	1347.0	1345.7	110.6	-409.5	300.2
	Forlì-Cesena	757.0	620.5	-12.5	-579.1	728.1	1354.0	1486.5	20.6	-307.0	153.9
	Rimini	2031.0	584.3	92.9	-331.1	1684.8	1787.0	1399.9	47.3	-62.4	402.2
Marche		677.0	2368.1	-1426.4	-262.9	-1.8	5877.0	5673.1	-873.8	-39.1	1116.7
	Pesaro-Urbino	-946.0	595.3	-331.5	295.7	-1505.5	1548.0	1426.1	-184.9	101.2	205.7
	Ancona	419.0	669.1	-104.3	368.5	-514.3	1432.0	1602.8	-81.9	392.9	-481.8
	Macerata	507.0	502.4	-401.6	62.6	343.6	1216.0	1203.7	-240.2	371.5	-119.0
	Ascoli Piceno	376.0	310.2	-93.2	442.0	-282.9	981.0	743.0	-48.5	436.7	-150.2
	Fermo	321.0	291.2	-495.7	143.0	382.5	700.0	697.6	-318.3	235.6	85.2
Toscana		2684.0	5983.5	-1467.8	-1900.0	68.4	12391.0	14334.3	-858.9	-1387.5	303.2
	Massa-Carrara	140.0	307.4	-108.8	-268.8	210.3	583.0	736.3	-63.2	-100.6	10.5
	Lucca	955.0	657.3	-81.6	-417.8	797.1	2073.0	1574.6	-16.0	-186.3	700.6
	Pistoia	-245.0	473.7	-284.5	-339.0	-95.3	739.0	1134.9	-154.8	-146.8	-94.3
	Firenze	-150.0	1694.5	87.0	-441.3	-1490.3	2740.0	4059.6	10.3	-389.5	-940.4
	Livorno	-321.0	481.6	69.8	159.1	-1031.5	665.0	1153.7	32.8	-12.2	-509.3
	Pisa	1235.0	610.0	-72.6	-317.5	1015.1	1750.0	1461.3	-39.1	-159.9	487.7
	Arezzo	-48.0	523.4	-364.2	-305.1	97.9	779.0	1253.8	-207.7	-152.6	-114.5
	Siena	8.0	416.6	2.3	-267.3	-143.6	675.0	998.1	21.2	-194.2	-150.2
	Grosseto	305.0	330.2	38.9	407.8	-472.0	892.0	791.1	39.2	282.5	-220.9
	Prato	805.0	488.7	-754.2	-498.1	1568.7	1495.0	1170.7	-481.7	-280.1	1086.2
Umbria		1815.0	1236.2	-144.3	-154.1	877.2	3698.0	2961.5	-73.0	-8.4	817.8
	Perugia	1274.0	939.2	-140.6	-306.3	781.6	2734.0	2250.1	-70.6	326.7	227.8
	Terni	541.0	297.0	-3.8	443.3	-195.5	964.0	711.4	-2.4	359.3	-104.3
Lazio		24903.0	7108.8	7450.1	1461.0	8883.1	28218.0	17030.2	4311.1	2736.6	4140.1
	Viterbo	1669.0	380.1	-94.8	357.6	1026.2	1897.0	910.5	-34.6	210.2	810.9
	Rieti	567.0	167.8	-18.4	67.2	350.5	682.0	401.9	4.4	123.3	152.5
	Roma	18626.0	5381.8	7989.8	15335.7	-10081.4	20451.0	12893.0	4624.6	11438.0	-8504.6
	Latina	1996.0	624.6	-138.6	724.7	785.3	2524.0	1496.2	-105.6	463.9	669.5
	Frosinone	2045.0	554.6	-287.9	-268.4	2046.7	2664.0	1328.5	-177.6	906.6	606.5
					SOUTH						
Abruzzo		-565.0	1744.8	-544.3	838.4	-2603.9	6892.0	4180.1	-323.8	787.9	2247.9
	L'Aquila	-3708.0	374.9	-54.9	801.4	-4829.3	1273.0	898.1	-19.9	760.5	-365.6
	Teramo	708.0	433.0	-352.6	-359.1	986.6	1790.0	1037.4	-198.9	478.8	472.7
	Pescara	1125.0	452.9	88.1	-725.7	1309.8	1894.0	1084.9	38.0	688.9	82.2
	Chieti	1310.0	484.1	-224.9	-1025.4	2076.1	1935.0	1159.7	-143.0	627.6	290.7
Campania		9511.0	5988.4	-2979.5	4518.6	1983.5	19694.0	14346.0	-2230.7	3879.5	3699.2
	Caserta	1861.0	840.7	-386.6	772.7	634.2	3475.0	2014.1	-224.5	993.5	692.0
	Benevento	918.0	308.0	-127.2	246.3	490.8	1145.0	737.8	-88.1	359.2	136.0
	Napoli	1600.0	3121.0	-1546.7	6285.9	-6260.2	8279.0	7476.9	-1276.3	5771.5	-3693.2
	Avellino	1437.0	465.8	-274.9	459.5	786.6	2014.0	1115.8	-180.1	502.9	575.4
	Salerno	3695.0	1252.9	-644.1	1623.6	1462.6	4781.0	3001.4	-461.8	1449.2	792.1
Molise		1059.0	372.5	-132.6	254.2	564.9	1235.0	892.4	-72.5	262.9	152.2
	Campobasso	846.0	264.6	-114.2	468.9	226.7	1000.0	633.9	-63.7	400.7	29.1
	Isernia	213.0	107.9	-18.4	66.4	57.1	235.0	258.5	-8.8	212.5	-227.2
Puglia		8117.0	4331.8	-2828.8	3807.1	2806.9	11742.0	10377.5	-1872.7	4265.9	-1028.8
	Foggia	1028.0	622.9	-385.7	1194.0	-403.1	1656.0	1492.1	-242.6	788.5	-382.0
	Bari	2912.0	1430.1	-636.0	948.6	1169.2	4385.0	3426.0	-433.0	360.8	1031.1
	Taranto	890.0	518.5	-148.4	715.6	-195.7	1387.0	1242.1	-121.8	383.0	-116.3
	Brindisi	871.0	392.1	-260.1	766.4	-27.3	808.0	939.2	-173.5	413.0	-370.8
	Lecce	2473.0	918.9	-696.1	1867.2	383.1	2966.0	2201.3	-441.7	147.7	1058.8
	Barletta-A-T	-57.0	449.4	-702.5	596.0	-400.0	540.0	1076.7	-460.1	363.1	-439.7
Basilicata		409.0	634.5	-220.5	681.2	-686.2	1507.0	1520.0	-132.3	580.3	-461.0
	Potenza	217.0	425.8	-141.4	941.3	-1008.7	952.0	1020.0	-83.5	712.8	-697.3
	Matera	192.0	208.7	-79.1	231.9	-169.5	555.0	500.0	-48.8	150.4	-46.5
Calabria		770.0	1977.1	-1012.1	2222.1	-2417.1	3601.0	4736.3	-689.3	1658.8	-2104.8
	Cosenza	398.0	750.5	-301.9	268.1	-318.7	1835.0	1797.9	-199.0	-92.0	328.2
	Catanzaro	250.0	385.3	-111.1	35.7	-60.0	801.0	923.2	-79.2	-202.1	159.1

	Reggio Calabria	-2.0	520.0	-330.6	-52.9	-138.6	492.0	1245.8	-244.7	-457.9	-51.2
	Crotone	93.0	161.0	-128.6	10.2	50.4	296.0	385.8	-76.8	45.1	-58.1
	Vibo Valentia	31.0	160.2	-139.9	-18.9	29.7	177.0	383.7	-89.6	-81.2	-35.9
Sicilia		6745.0	4797.3	-2066.6	3601.4	412.9	12071.0	11492.6	-1465.7	4139.4	-2095.3
	Trapani	334.0	441.8	-316.0	-329.4	537.6	1212.0	1058.5	-211.5	-468.7	833.7
	Palermo	87.0	1094.2	-174.6	61.8	-894.3	1275.0	2621.4	-193.1	287.0	-1440.3
	Messina	773.0	690.2	-171.3	1630.6	-1376.5	1639.0	1653.4	-111.5	997.1	-900.0
	Agrigento	442.0	405.2	-322.3	-376.1	735.2	1091.0	970.8	-213.6	-452.8	786.7
	Caltanissetta	-292.0	247.9	-154.6	274.0	-659.3	179.0	593.9	-105.7	122.3	-431.5
	Enna	195.0	153.8	-95.6	211.1	-74.4	363.0	368.5	-58.0	120.9	-68.4
	Catania	3139.0	1086.5	-558.8	946.2	1665.1	3823.0	2602.9	-397.7	487.5	1130.3
	Ragusa	1219.0	326.6	-206.6	592.1	506.8	1325.0	782.5	-124.3	365.5	301.3
	Siracusa	848.0	350.9	-66.9	961.2	-397.2	1164.0	840.7	-50.2	594.6	-221.1
Sardegna		3669.0	1947.1	-485.1	2872.1	-665.0	5638.0	4664.6	-279.4	1908.1	-655.2
	Sassari	510.0	378.2	-13.8	905.7	-760.1	1288.0	906.1	-7.5	577.9	-188.5
	Nuoro	63.0	189.9	-194.7	402.1	-334.4	651.0	455.0	-113.3	211.4	97.9
	Cagliari	1064.0	686.7	264.2	797.8	-684.7	2109.0	1645.1	147.6	-995.6	1311.8
	Oristano	105.0	182.9	-146.0	145.0	-76.9	354.0	438.1	-86.5	115.8	-113.4
	Olbia-Tempio	1504.0	236.3	-145.5	166.2	1247.0	1135.0	566.1	-70.4	351.7	287.6
	Ogliastra	184.0	61.4	-48.3	26.2	144.6	36.0	147.2	-26.3	41.9	-126.8
	Medio Campidano	138.0	96.4	-110.0	42.0	109.6	4.0	230.9	-67.4	21.3	-180.8
	Carbonia-Iglesias	101.0	115.2	-91.1	50.9	26.0	61.0	276.1	-55.8	24.9	-184.2

Note: *EC* = change in the number of plants; *NS* = national effect; *IM* = industrial mix effect; *NNRS* = neighbour-nation regional-shift effect; *RNRS* = region-neighbour regional-shift effect.

Figure 1- A novel interpretation of neighbourhood effect in spatial shift-share analysis

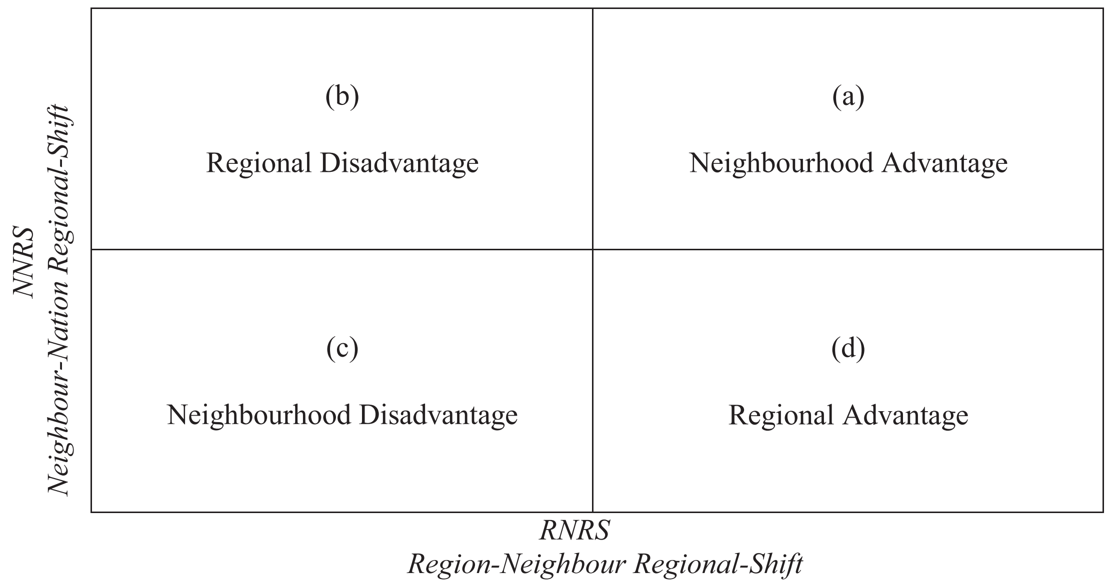


Figure 2- The spatial distribution of the growth rate of plants (Italian NUTS-2 regions)

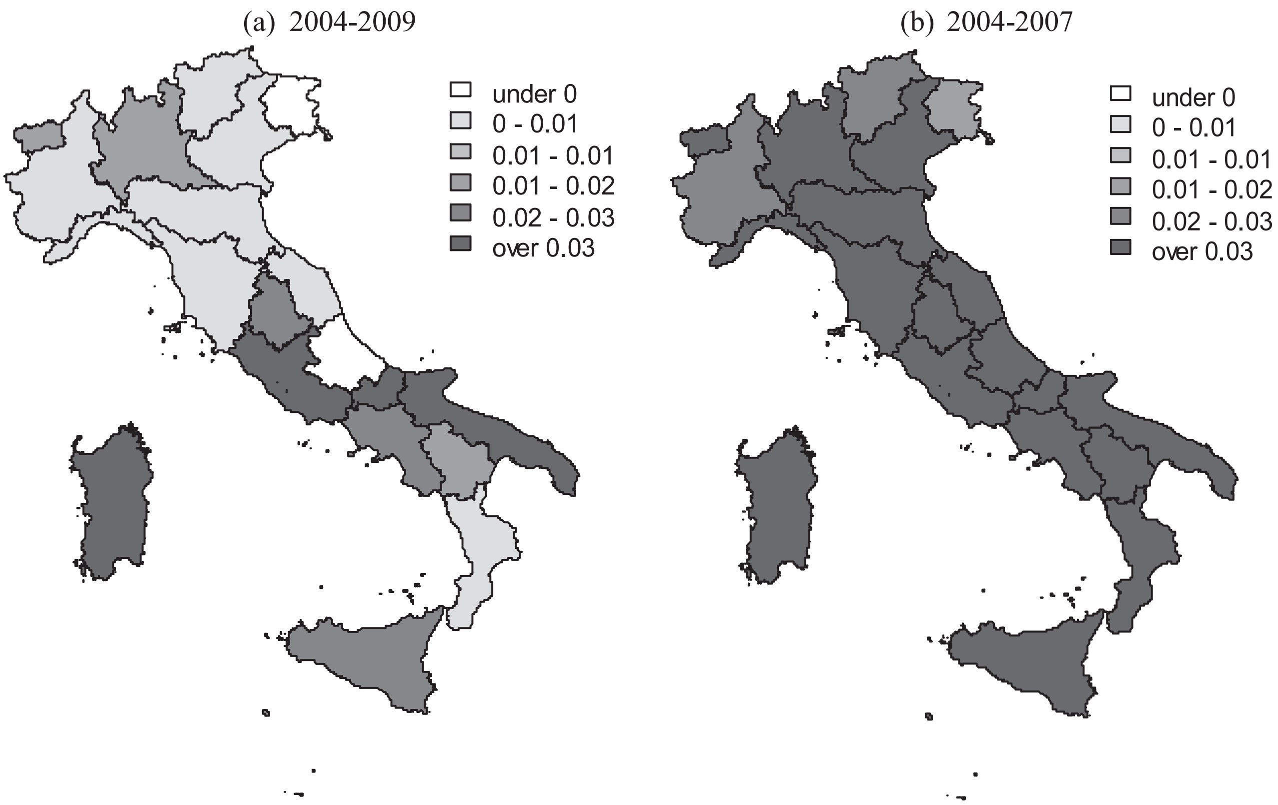
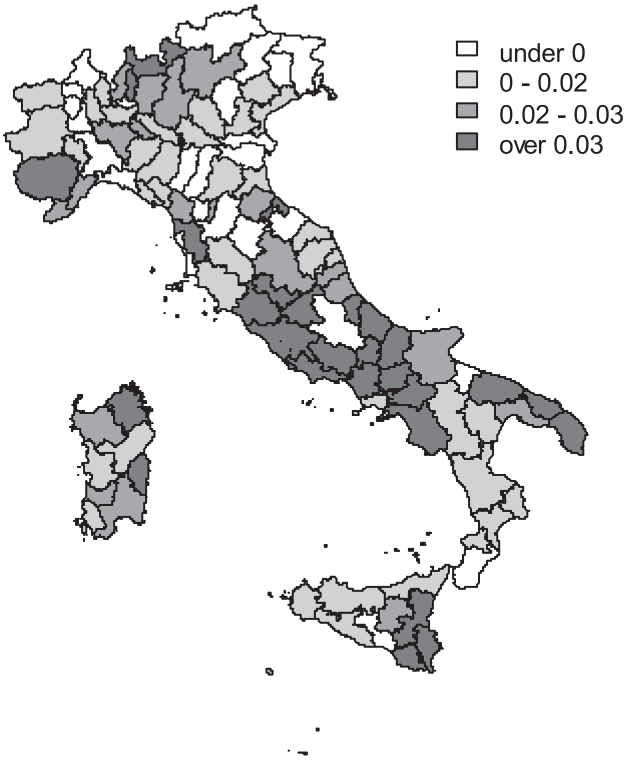


Figure 3- The spatial distribution of the growth rate of plants (Italian NUTS-3 regions)

(a) 2004-2009



(b) 2004-2007

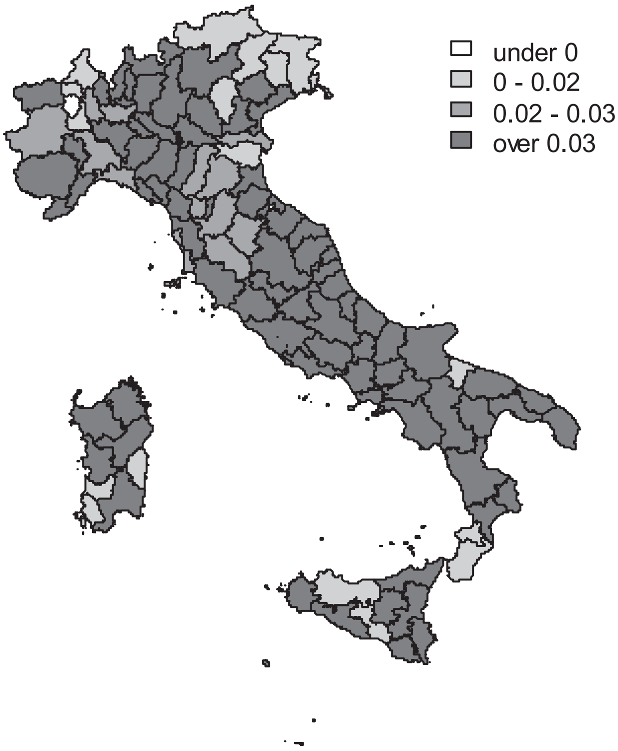
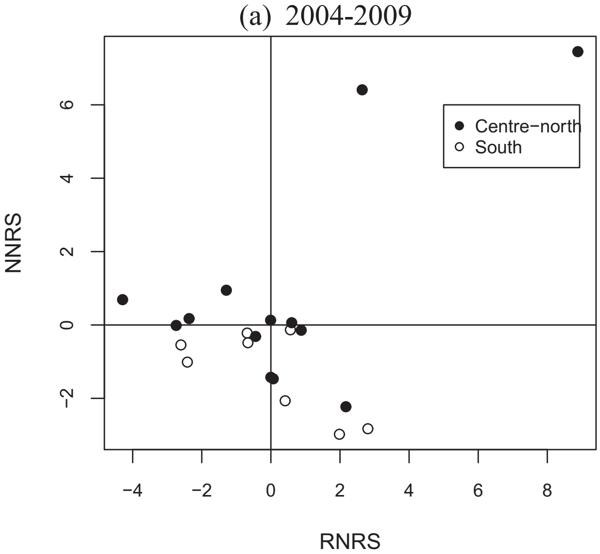


Figure 4- Neighbour-nation regional-shift (*NNRS*) vs region-neighbour regional-shift (*RNRS*) in Italian NUTS-2 regions

(a) 2004-2009



(b) 2004-2007

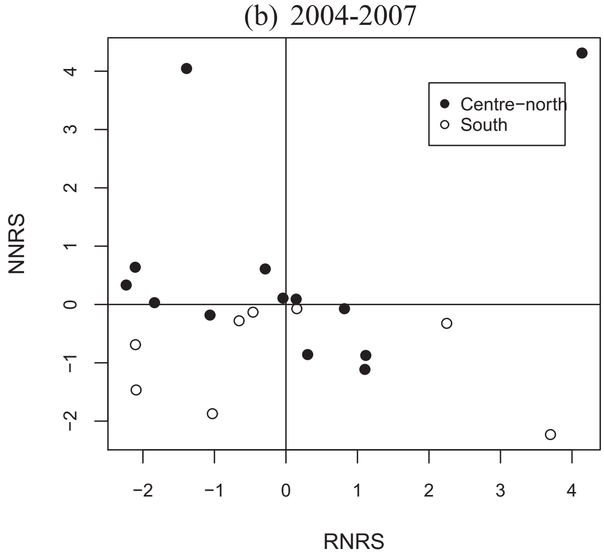


Figure 5- Neighbour-nation regional-shift (*NNRS*) vs region-neighbour regional-shift (*RNRS*) in Italian NUTS-3 regions

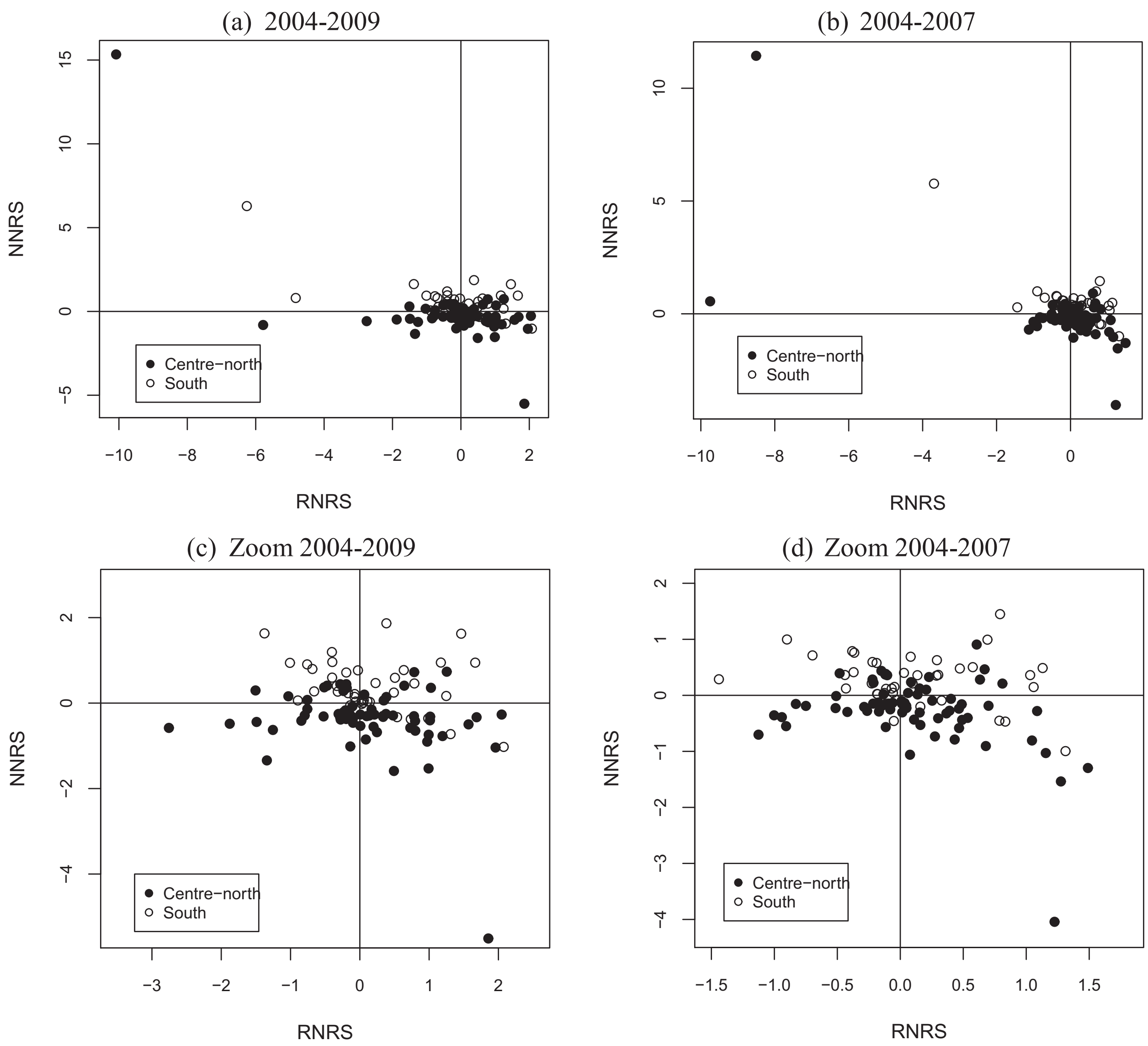


Figure 6- Industrial mix (*IM*) vs neighbour-nation regional-shift (*NNRS*) in Italian NUTS-2 regions

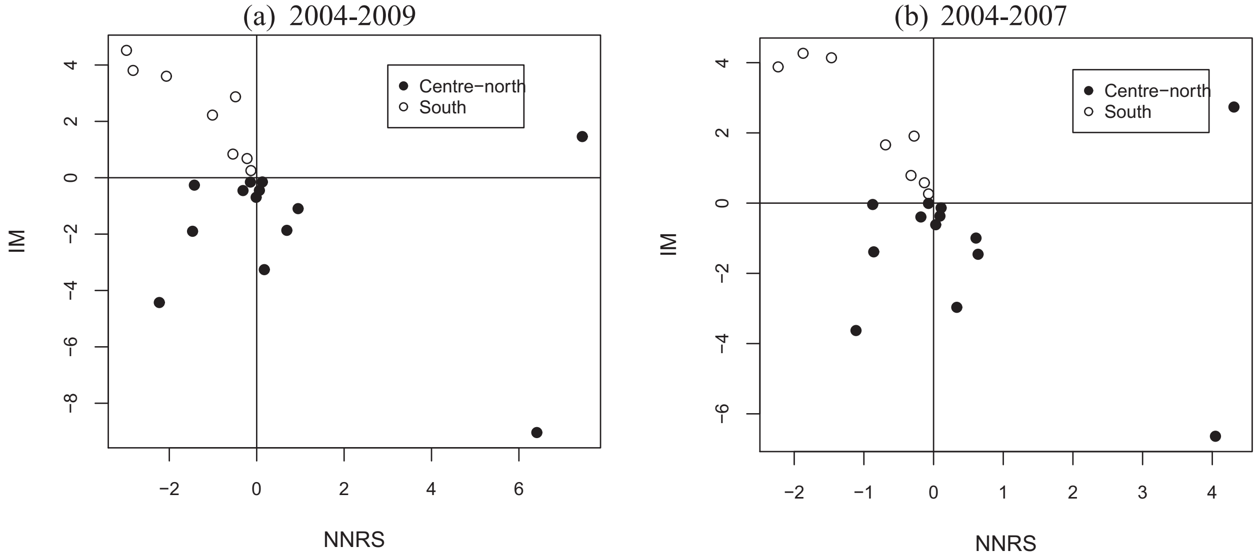


Figure 7- Industrial mix (*IM*) vs region-neighbour regional-shift (*RNRS*) in Italian NUTS-2 regions

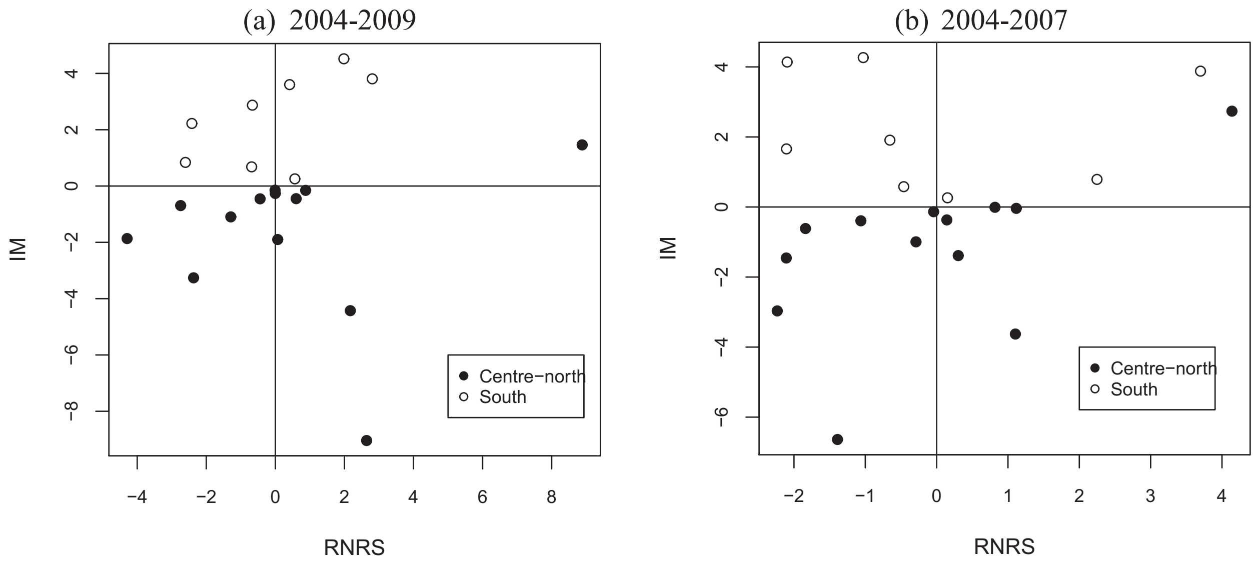


Figure 8- Industrial mix (*IM*) vs neighbour-nation regional-shift (*NNRS*) in Italian NUTS-3 regions

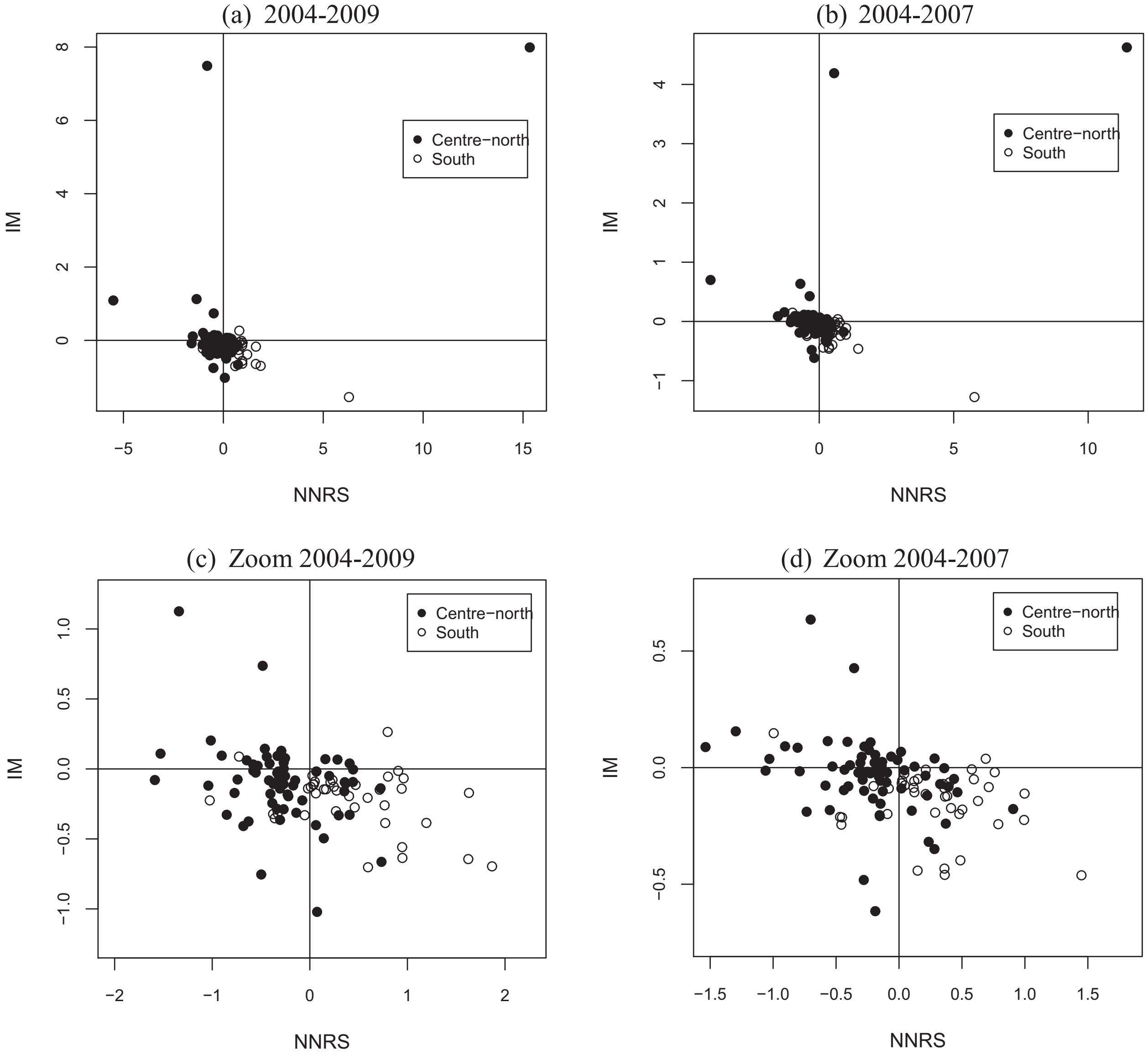
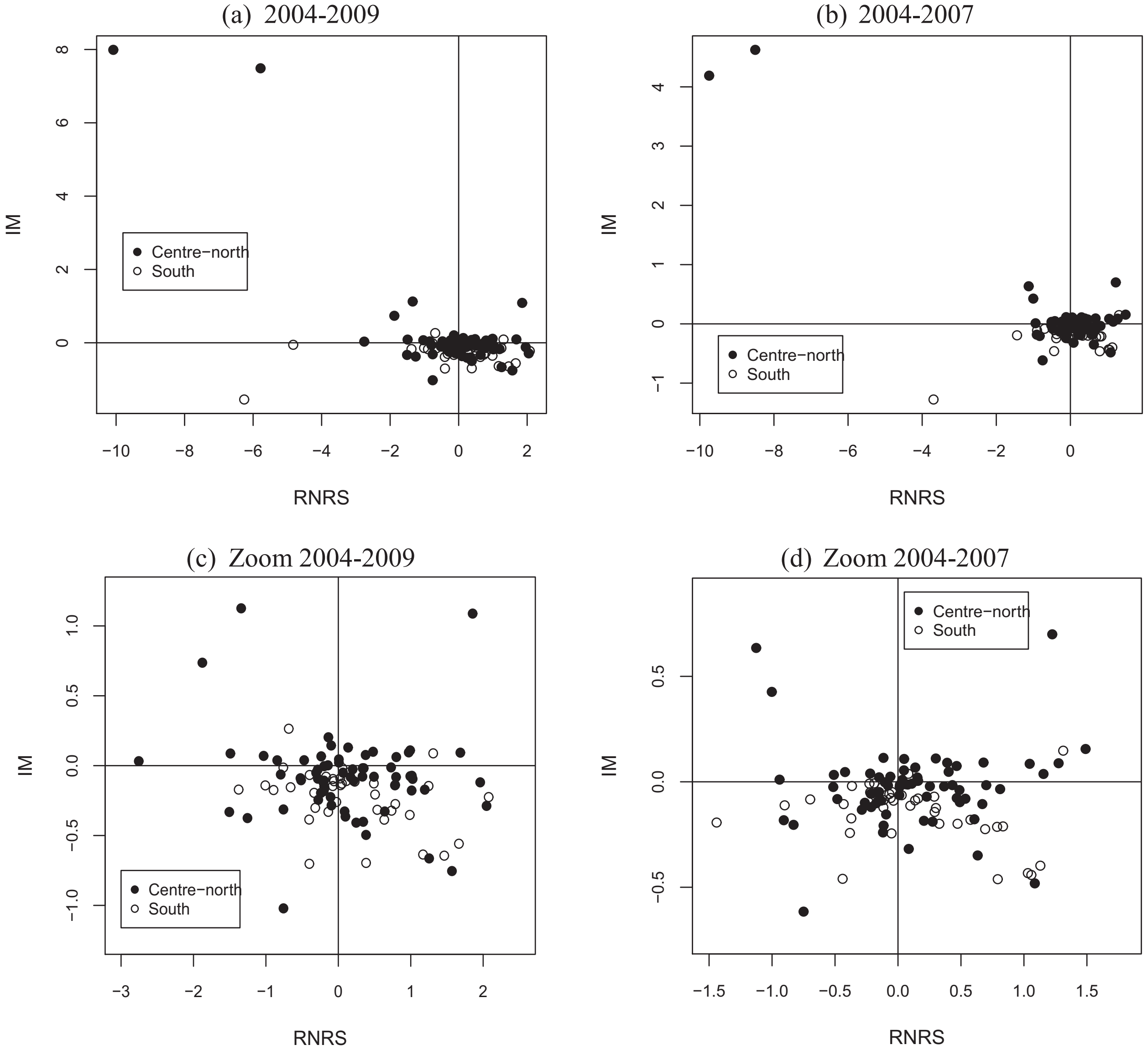


Figure 9- Industrial mix (*IM*) vs region-neighbour regional-shift (*RNRS*) in Italian NUTS-3 regions



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