"Spatial Agglomeration, innovation and firms survival for Italian Southern manufacture firms"

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Abstract

The purpose of this contribution is to shed light on the role of agglomeration economies as drivers of firm survival in a Southern Italian province over the period 1999-2013. We analyse agglomeration economies related to the geographical context by using a spatial weight matrix, which describe the structure of the process of spatial dependence that often arise in cross-sectional spatial data sample of firms. Our major interest is to analyse how the innovativeness of the firms can create spatial spillover. In particular we explore the differential effect of innovation on firm survival focussing also on the spatial closeness of other innovative firms. We consider the effect of product, process and organisational innovations controlling for the role of the knowledge context and of firm absorptive capacity. At the end of the 1990s, an ad hoc survey was performed on a representative sample of manufacturing firms located in a NUTS3 area of southern Italy, and information on firm survival has been collected for 15 years. A survival analysis is applied. Our estimates confirm that process innovation is a determinant of firm survival not only of the firms is innovative itself but also if it's located closer to other innovative firms.

***JEL classification**:* **L20, O3, D22, C21, C41**

***Keywords**: Firm survival, spatial models, Innovation, Southern Italian SMEs*

1. Introduction

The topic of this paper is the relationship between innovation and firm survival. Innovative activities are crucial to the growth of firms and firms' sectors (Nelson and Winter 1982; Schumpeter 1942). To innovate, firms use complementary sources of knowledge. According to the knowledge-based viewpoint, knowledge is a critical input and a primary source of value generating cumulative effects (Grant, 1996). Innovation stems from firm ability to acquire and manage knowledge from the environment (Cohen & Levinthal, 1989; Farace & Mazzotta, 2015; Gray, 2006)). Firms both learn from internal and external sources of knowledge. A channel a channel to spread knowledge is the geographical proximity enables firms to exchange among them tacit information. Moreover, through repeated interactions, spatial agglomeration can also generate new knowledge spillovers and learning-by-interacting among co-located industries (Bathelt, 2010). Many studies debate about the impact of agglomeration economies on measures of productivity (labor productivity and TFP), innovativeness, real wages and employment growth (Beaudry & Schiffauerova, 2009; Ferragina, Anna Maria Nunziante & Erhol Taymaz, 2018; Rosenthal & Strange, 2004).

However, less investigated is the role of agglomeration economies with respect to industrial demography indicators as firm entry and exit. On the one hand, firm-entry has received some attention. The set-up of new establishments or start-up of new entrepreneurial activities has been analysed, for example, by Carlton (1983) and Rosenthal and Strange (2003) and also Glaeser and Kerr 2009, Jofre-Monseny et al. 2011 and Fritsch and Schroeter 2011, also with respect to multinational enterprises (Mariotti et al. 2010), on the other hand, less are the studies on the exit of the firms from the market with only few exceptions (Staber 2001; Carree et al. 2011). The analysis of firm exit/survival has been focused on the role of firm- and sector-specific factors (Evans 1987; Geroski 1995; Yasuda 2005), while location and region-specific ones have been only partly studied.

The studies above generally investigate the effect of agglomeration on the entry and exit of firms, at region, province or city level while *there* are few *studies* based on *firm-level*.. However, this level of observation is essential as geographical differences may be due to location characteristics (e.g.. agglomeration economies) or simply may be caused by differences in business and economic composition. One study which analyse the exit of firms and agglomeration economies at Italian level is that of Ferragina and Mazzotta (2015). The authors apply a multilevel approach that allows them to explicitly model the potential hierarchical nature of the problem using some models that take geographic clustering into account and estimate the ‘‘spatial’’ variability of both exit and our independent variables (Maas and Hox 2004; Snijders and Bosker 2012).

Then in the present paper we would to propose the following research questions: “To what extent are innovativeness and the closeness with innovative firms and then agglomeration positively related to survival in SMEs?”

Our analysis comes in the wake of these seminal studies, and using a sample of Italian manufacturing firms of the Province of Salerno, observed over the period 1998/1999 and 2013 we investigate the effect of Innovation on exit of firm by employing a spatial econometric model to take into account productivity spillovers. To the best of our knowledge, this is the first contribution in the literature assessing the innovation-survival relationship at the firm level which attempts to control for the existence of productivity spillovers by using a spatial econometric approach.

As regards the choice of the spatial model, we have evaluated whether a Spatial Durbin model (SDM) might be more appropriate in analysing the effect of innovation on the probability productivity. Indeed, SDM is an appropriate point of departure for the choice of the spatial specification to be used (LeSage and Pace, 2009; Elhorst, 2010). In the SDM, both the spatially lagged dependent variable and the spatially lagged independent variables are included in the specification. Following suggestions by Elhorst (2010), tests are carried out to compare the SDM with the spatial autoregressive model (SAR), which only includes the spatially lagged dependent variable, and the spatial error model (SEM), which only considers the spatial correlation in the error term. The data derive from an ad hoc survey, named OPIS, on SMEs in the province of Salerno in southern Italy, which provides very detailed information on the topic under study.

The analysis of survival and innovation in SMEs in the traditional sector is particularly important in Italy, where 95% of firms are concentrated in the so-called made-in-Italy[1] sectors and have fewer than 10 employees (the highest percentage in the EU[2]). The results of our analysis provide support for policy makers to implement development policies that will help to enhance the innovativeness at local level and to contribute to improving the absorptive capability of SMEs and then more survive.

The paper is organised as follows. In Section 2, we review the literature on firm survival and highlight the stylised facts proposed in previous studies. In Section 3, we present our firm-level dataset, and in Section 4………….. In the final section, we present some preliminary conclusions. The online Appendix reports ………………

[1] ICE, the Italian Agency for international trade, which promotes Italian firm internationalisation.
[2] Statistics Archive of Active Firms (ASIA) and European Commission SBA 2012.

2. Impact of Innovation and local proximity on Firm Survival: Theoretical and Empirical Literature Review

Firm performance is commonly measured through firm survival, together with growth (i.e., increase in employment or sales over time). Notwithstanding the limitations of the survival approach[3], the importance of firm duration for the growth and competitiveness of a country is recognised in the literature (Bartelsman et al. 2005; Haltiwanger et al. 2004). Firms that are able to successfully innovate are also able to establish and maintain a competitive advantage in the market and then to survive (Wagner 1990).

The positive role on firm survival of variously defined innovations is confirmed by many studies, even if theoretical considerations suggest that innovativeness might have either a positive or a negative effect on a firm's survival prospects. For example, radical innovations are subject to fundamental uncertainty and therefore may increase the probability of firm death, particularly in highly uncertain environments or following important institutional or policy changes (Samuelsson and Davidsson, 2009; Hyytinen et al. 2015). Other studies are more ambiguous, finding either a negative relationship, or none or a mixture (Audretsch and Lehmann 2005; Wagner 1990). Bayus and Agarwal (2006) stress the role of a firm's technological trajectory: a higher probability of survival for an innovative start-up is observed only once the firm is established. Being an independent start-up may represent a cost in earlier stages of development when the trajectory is less clear. Audretsch (1995) underlines that innovative industries have higher neo-natal death rates than less innovative ones, but for firms surviving beyond the first few years, survival is higher in innovative industries.

About innovation, particularly widespread is the problem of the higher cost of innovation which appears to be too elevated for some companies, therefore many companies prefer proceed to imitative behaviour rather than introducing their own effective innovations. Then become relevant the diffusion of knowledge and the "geography of innovation" literature, which concentrates on measuring localized spillovers from R&D spending (Griliches, 1979; Breschi and Malerba, 2001; Bottazzi and Peri, 2003; Audretsch and Feldman, 2004). Within this literature, the private technology of individual firms spills over to other firms and becomes public knowledge increasing

[3] It is a widespread but inaccurate caricature that survival is implicitly 'good' while closure is necessarily 'bad'. The growing literature on exit has recently emphasized the distinction between voluntary entrepreneurial exit, closure and failure (see Bates 2005; Coad 2014; DeTienne et al. 2015; Headd 2003; Khelil 2016; Wennberg et al. 2016).

the productivity of all firms. Rosenthal and Strange (2001) and Ellison et al. (2010) consider the importance of input sharing, matching, and knowledge spillovers for manufacturing firms at various levels of geographic disaggregation, and other studies have found that knowledge spillovers tend to vanish rapidly as distance increases (Audretsch and Feldman, 1996; Keller, 2002). The concentration generates dynamic processes of knowledge creation, learning, innovation and knowledge transfer (diffusion and synergies). As a result, the cluster becomes a center of accumulated competence across a range of related industries and across various stages of production (De Propris and Driffield, 2006).

In a wide contest, the literature on agglomeration economies effects is extensive and dates back to a few seminal papers (Marshall, 1920; Glaeser et al. 1992; Porter, 1998; Jacobs, 1969; Audretsch and Feldman, 1996) which describe the positive effects related to technology transfers and to pro competitive forces (increased competition, reallocation of resources towards more productive firms, productivity improvements of incumbent firms).

The theory on agglomeration economies and spillover effects mainly identifies two types of externalities: localization (or specialization) economies and diversification economies. The localization economies may rise from industry specialization available to the local firms within the same sector (the Marshall- Arrow-Romer or MAR externalities) and by the emergence of the intra-industry transmission of knowledge (Glaeser et al. 1992) as firms learn from other firms in the same industry (Porter 1998). These economies explain the development of industrial districts (ID). Unlike localization economies, however, Jacobs (1969) economies indicate that the diversity of industries and knowledge spillovers across geographically close industries promote innovation and growth via inter-industry knowledge spillovers (Acs et al., 2007). The latter reflects external economies passed to enterprises as a result of the large-scale operation of the agglomeration, independent of the industry structure. For instance, relatively more densely populated areas are more likely to house universities, industry research laboratories and other knowledge generating facilities.

The theory on agglomeration economies also argues that positive knowledge spillovers are more likely to occur if firms are located in the same area, as geographical proximity encourages the diffusion of ideas and technology due to the concentration of customers and suppliers, labour market pooling, worker mobility, and informal contacts (Greenstone et al. 2010). Technology transfers (intra and inter industry knowledge spillovers) may occur via vertical linkages (along the supply chain) and horizontal linkages (collaboration among firms, imitation, concentration of customers and suppliers workers mobility; informal contacts).

In Italy there is a wide literature on the so called ‘‘district effect’’, trying to quantify the Marshallian advantages[4] (Alfred Marshall, 1919; 1920; Becattini 1975; 1978; 1979) as opposed to the role of ‘‘urban effects’’ associated to externalities of the Jacobian type. Quite mixed results are shown. Di Giacinto et al. (2012) detect stable productivity advantages of firms located in urban areas and a weakening of the advantages traditionally associated to Italian industrial districts, a weakening confirmed by other studies (CENSIS 2010; Iuzzolino and Micucci 2011; Bugamelli et al. 2012; Alampi et al. 2012). On the other hand, Buccellato and Santoni (2013), for the 2001–2010 period, carry out a detailed analysis of TFP productivity externalities in the Italian manufacturing industry, both within and between sectors, showing that the productivity premiums arising from increased productivity of neighbouring firms in a district are higher if compared to the premiums due to an increased degree of urbanization of the territory. Moreover, the paper by Accetturo et al. (2013) confirms that agglomeration effects explain local productivity premiums of Italian firms more than firms' selection effects[5].

Firm or market characteristics, such as a relatively small initial start-up age and size, a single-product innovation, scale economies and capital intensity, may also be determinants of failure for new businesses.

New firms face a high probability of exit (the liability of newness). Exit rates are expected to decrease with firm age, but the relationship is not linear (Dunne et al. 1989; Mata and Portugal 1994) the probability of exit is initially low, increases to a certain point and decreases afterwards (referred to as the liability of adolescence) (Bruderl and Schussler 1990). Mortality risk can increase with firm age (Aldrich and Auster 1986), since structural inertia tends to be more pronounced in older organisations. Strong inertial force can constrain an organisation's ability to respond to environmental changes and therefore increase the mortality risk of old organisations due to a changing environment (the liability of obsolescence). However, even in stable environments, the accumulation of rules and routines in older organisations can decrease their efficiency and increase their mortality risk (the liability of senescence). Furthermore, young firms, which are more exposed to the risk of exit, benefit more from innovation to survive in the long term (Cefis and Marsili 2006).

The probability of survival increases with firm size (the liability of smallness). Large firms are more likely to have output levels close to their industry minimum efficient scale, and thus are less likely

[4] They were one of the driving forces of Italian economic development after the Second World War (Amatori et al. 2013; Becattini and Coltorti 2004; Brusco and Paba 1997)

[5] A theory that suggests that larger markets attract more firms and make the competition tougher, thus leading less productive firms to exit from the market in a process of Darwinian selection of firms (Accetturo et al, 2018).

to be vulnerable than are small firms (Audretsch and Mahmood 1995). Second, large firms are usually more diversified than small ones; this reduces their risk of exit, since adverse conditions in one market can be offset by better conditions in others. Third, in the firm and industry dynamics literature, firm size and age represent the efficiency differences arising from differences in experience, managerial abilities, production technology and firm organisation. Fourth, large firms may find it easier to raise capital, may face better tax conditions and may be in a better position to recruit qualified workers and more skilled and talented managers. On the other hand, consistent with theories of industry evolution (Agarwal 1998; Audretsch 1995) and of strategic niches (Caves and Porter 1977; Porter 1979), according to which firms remain small because they occupy product niches that are not easily accessible or profitable for large firms, most studies find that size increases the likelihood of survival in the most technologically advanced industries, but not in traditional sectors.

Other firm characteristics, such as export intensity, may influence firm survival. Recent models of heterogeneous firms and international trade (Bernard et al. 2003; Melitz 2003) predict that exporters are less likely to fail than non-exporters. In these models the relationship between exports and survival is driven by the relatively high productivity of exporters. Hence, the higher the firm's exporting intensity, the lower its probability of exit.

Finally, These analyses have prompted further recent studies on Italy on agglomeration economies adopting spatial methodologies both at regional and at firm level. Moreno et al. (2005), Marrocu et al. (2013), Antonelli et al. (2011), Dettori et al. (2012) apply spatial econometrics techniques to model innovation spillovers at the regional level. This literature is in the wake of Anselin et al. (1997) study which revisited Jaffe's work (1986) applying for the first time spatial econometrics techniques to innovation models (see also Autant-Bernard and LeSage 2011). Within this approach, Lamieri and Sangalli (2013) found a relevant impact of patents on total factor productivity (TFP) of Italian manufacturing firms using a spatial autoregressive model (SARAR). Cardamone (2016), also adopting a spatial autoregressive specification, shows that the productivity of each firm is affected by the productivity of nearby firms and that the indirect effect of innovation is stronger than the direct one. Further analysis on Italy has shown that productivity spillovers at industry level also matter. Carboni (2013a, b) used spatial econometric techniques to investigate the importance of sectoral proximity in promoting R&D investment and collaboration among Italian manufacturing firms. The results of the spatial two stage least square estimation suggest that in their R&D decision firms benefit from spillovers originating from neighboring industries.

Several empirical contributions have provided evidence about the positive role of R&D activities at the firm level (e.g., Hall and Mairesse, 1995; Harhoff, 1998; Aiello et al, 2005). However, in order to adequately evaluate the effect of R&D on productivity, productivity spillovers should also be taken into account. Indeed, productivity spillovers could arise because of such factors as face-to-face contacts, worker mobility and R&D cooperation between firms (Baltagi et al, 2012).

At the regional level, a number of studies have employed spatial econometric tools in order to take productivity spillovers into account when evaluating the effect of innovative efforts (e.g., Antonelli et al, 2011, Dettori et al, 2012; LeSage and Fischer, 2009). As regards firm-level analyses, Baltagi et al (2012) recently assessed the effect of intangible assets on the productivity of Chinese chemical firms by considering the spatial correlation of the error term across firms. Moreover, Lamieri and Sangalli (2013) evaluated the impact of patents on the total factor productivity (TFP) of Italian manufacturing firms by allowing for spatial dependence in both TFP and error terms across firms. In both contributions, results show that productivity spillovers matter. Ferragina and Mazzotta (2015) analysis of the relationship between agglomeration economies and firm exit taking in account the multidimensional spatial structure and also understanding how local economies differently affect firms with different levels of global activities, taking into account the great heterogeneity that exists between firms that perform international Foreign Direct Investiment (FDI) and domestic firms that are unable to engage in this type of internationalization. domestic firms not involved in FDI are not able to benefit from the social capital that spills over from industrial districts, while foreign multinationals show a higher persistence in terms of survival in such contexts.

And finally Ferragina and Nunziante (2018) employ a spatial econometric approach (spatial autoregressive and spatial error models) by using the geographical coordinates at firm level on Italian manufacturing firms for 2007 and 2010 (AIDA data) and focus on Made in Italy LLS of Textile. They found strong productivity spillovers at spatial level and a relevant impact of innovation on firm productivity. However, no analysis directly analyzes the link between innovation, agglomeration and survival of firms. Only one exception is the analysis by Cardamone (2014; 2016), using a sample of Italian manufacturing firms over the period 2004–2006 provided by the Xth UniCredit-Capitalia survey (2008), have analysed the role of R&D in firm productivity (TFP) by using a spatial autoregressive model. In so doing, she has allowed the productivity of each firm to be affected by the productivity of nearby firms. Results show that R&D significantly affects Italian firm productivity and that productivity spillovers across firms matter. Moreover, productivity is found to be positively affected by intrasectoral R&D spillovers, while intersectoral R&D spillovers do not have a significant effect.

In view of the arguments developed so far, it is possible to set out the working hypotheses underlying the present analysis.

Hypothesis 1. Firms survival increase if firms are innovative;

Hypothesis 2. Firms survival increase if closer firms survive and if closer firms are innovative (external knowledge);

Hypothesis 3. Firms survival increase if increase the worker productivity (educational level and training) (internal knowledge);

Hypothesis 4. Firms survival increase the closer they are to strategic university department, Science and Technology Park (PST) and research laboratory of the Ministry of Agriculture *(MIPAA)* in the municipality.

3. Data and Variables

The data derives from the OPIS[6] (Permanent Observatory on Firms in Salerno Province) database, an ad hoc survey of a sample of 462 manufacturing firms from the province of Salerno, a NUTS3 area located in the Campania region. The sample is statistically representative of that economic system at the territorial and sectoral levels (Amendola et al. 2013; Coppola et al. 1999). Face-to-face interviews occurred in 1998/1999.

The final sample[7] comprises 457 firms, and the descriptive statistics, reported in following Table 1 and table A1 in the appendix, reveal that 48% of firms introduced at least one innovation, whereas 50% survive.

We know the type of innovation (process, product and organizational) and the sources from which the firm acquires new knowledge. Table 1 shows the percentage of the surviving firms given that firms are innovative the percentage is 62%, and +22 percentage point (p.p) than not innovative firms. Firm exit dates range from the end of 1999 to April 2013.

Table 1 Innovative and Surviving Firms from 1999 to 2013

VARIABLES	%
Innovative Firms	48.4
Survival Firms	50.3
Survival Firms|Innovative	61.8

[6] The project was carried out by CELPE, University of Salerno, and funded by the Sichelgaita Foundation in Salerno.

[7] Without missing values for the variables used in this study.

Survival Firms|Not Innovative	39.6

The survey provides useful information at firm level, such as the number of employees, their education level, their training and their involvement in firm management; firm legal form, economic sector, source of start-up capital (his/her own or family financing, banks or subsidies) and market extension (local[8], national or international). As for firm size, we adopt a classification based on the number of workers[9] in 1999: less than 10, 10–19, 20–49 and at least 50. Each firm was assigned to a sector of activity based on a two-digit level of the ATECO code. The survey also includes characteristics of the entrepreneur[10] such as age and educational level.

The questionnaire asks to indicate the three main innovation-specific partners. From Table A1 in the appendix the most common partners are suppliers of equipment and plants for product and process innovations and consultants/commercial labs for organizational innovation. The questionnaire asks which technological knowledge supplied by the University of Salerno, which is the most important public research institution in the province, was the firm interested in for its future innovation strategies. The departments of the University of Salerno most involved in third-mission activities are chemistry, computer science, and engineering (ANVUR 2013); during the 2004–2010 period, there were more patent activities in the chemistry department (11 patents out a total of 21 for the University of Salerno) and more contract research in the engineering and computer science departments, whereas spin-off creation was equally frequent in the chemistry and engineering departments (two out a total of six for the University of Salerno). The chemistry department performed better from the point of view of research output quality, receiving the highest average grade per research output during 2004–2010 given by the Italian performance-based research funding system to the scientific areas of the University of Salerno (ANVUR 2013). Two municipalities host a research laboratory of the Ministry of Agriculture (MIPAAF) and one hosts a technology scientific centre (Parco scientifico e tecnologico, Science and Technology Park, PST) [11]; knowledge spillovers from these centres are captured by a dichotomous variable equal to one if the municipality where the firm is located hosts the technology scientific centre (Dummy for PST in the

[8] Local market is defined by the province of Salerno, the Campania region or southern Italy.

[9] Some firms have only one worker, which is the owner. For this reason, size is defined by the number of workers minus the owner.

[10] The manager and the owner are almost always the same person in SMEs in traditional sectors.

[11] The Istituto Sperimentale per l'Orticoltura (Experimental Institute for horticulture) is located in Pontecagnano Faiano, the Istituto Sperimentale per il Tabacco (Experimental Institute for the cultivation and transformation of tobacco) in Scafati and the Science and Technology Park in Salerno.

municipality) plus a dichotomous variable equal to one if the municipality hosts one of the MIPAAF labs (Dummy for MIPAAF lab in the municipality).

To take into account the effects of agglomerations economies, indicators suggested in the literature (Colombelli 2016) were been used. These were the distance of each municipality from the main administrative city in the NUTS2 region[12], Naples, and a dichotomous variable equal to one if the municipality is located in an industrial district was also used.

The principal variables that we consider for control the effect of agglomeration is directly a distance matrix $W = w_{ij}$ or *nxn* spatial weight matrix composed by w_{ij} .

W describes the spatial arrangement of the n units and each entry w_{ij} of W is greater than zero if units i and j can be considered as neighbours. We used as sources of locational information the location in Cartesian space then we used latitude and longitude to compute distances among units[13]. In order to exclude self-neighbours, the diagonal elements w_{ij} are conventionally set equal to zero.

4. Econometric Approach

For analyse the survival of the firms taking in account the agglomeration, we firstly consider a probability to exit and we consider those models belong to the growing family of econometrics methods that deals with observations showing some kind of spatial or network dependence. Then Spatial binary-choice regression models are used to analyse sample data that are associated with specific locations in space and that represent binary outcomes (in our case to be alive). We deal with spatial regression models of the following form (the notations follow LeSage and Pace, 2009):

$$y = \rho W y + X\beta + \gamma W x + \mu \quad [1]$$

$$\mu = \lambda W \mu + \varepsilon$$

$$\varepsilon \sim N(0, \sigma^2 I_n)$$

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[12] The distance is computed using the latitude and longitude related to the firm address.

[13] Alternatively the knowledge of the size and shape of observational units allows the definition of contiguity measures, e.g., one can determine which units are neighbours in the sense that they share common borders. Thus, the former source points towards the construction of spatial distance matrices while the latter is used to build spatial contiguity matrices. It is worth noting that the aforementioned sources of locational information are not necessarily different. For instance, a spatial contiguity matrix can be constructed by defining units as contiguous when they lie within a certain distance; on the other hand by computing the coordinates of the centroid of each observational unit, approximated spatial distance matrices can be obtained using the distances between centroids. More details are available in LeSage and Pace (2009).

where (y) represents an *nx1* vector of binary dependent variables is the dependent variable of this study then in this case we define (y) an exit dummy (1/0), **X** an *nxk* matrix of independent variables, I_n is the identity matrix of size n and β (*kx1* vector), ρ, γ and λ (scalar in [-1; 1]) are parameters to be estimated. The *nxn* matrices W is the spatial weight matrices and contain the information on the spatial relationship between observations.

Spatial weight matrices are usually constructed as a function of the distance between observations or other contiguity measures (shared borders, shared department, etc.). In this case we consider a contiguity matrix, typically w_{ij} is higher if observations i and j are contiguous, while w_{ij} go to 0 otherwise .

We built a W matrix of reciprocal influences between firms based on their geographical distance. The computation of W is based on a distance matrix which is a quadratic n x n matrix (where n is the number of firms in the sample: 457), with zero diagonal elements. The generic elements w_{ij} are referred to as ''spatial weights'', measuring the strength of the relationship between a firm i and a neighbour firm j.

Geographical distance in kilometres d_{ij} (between a firms i and a generic neighbouring firm j) were computed using the latitude and longitude to compute distances (d_{ij}) among units knowing precisely the addresses of the companies. Then we have the *Distance matrix D*, symmetric and by convention, the diagonal is set to be zero. Consequently we calculate the invers of each reciprocal distances $v_{ij} = \frac{1}{d_{ij}}$, typically v_{ij} is higher if observations i and j are contiguous,). Finally W is obtained by row-standardizing is the spatial weight matrices.[14] i.e $w_{ij} = \frac{v_{ij}}{\sum_j v_{ij}}$ constructed in terms of contiguity

The key covariates (X) for the firm survival equation were the innovation dummy (1/0); the dummies for the technological knowledge supplied by the University of Salerno in which the firm was interested for its future innovation strategies; and the entrepreneur (general and specific) human capital as captured by the owner's level of education, the owner's age as a proxy of experience, and the dummies for the owner's previous position (as an employee, a student or unemployed, a self-employed individual, or an entrepreneur in another firm).

[14] This distance is compute with Stata command "geodist" which computes geodetic distances, i.e. the length of the shortest curve between two points along the surface of a mathematical model of the earth. In the probit models the W matrix is computed with R spdep a collection of functions to create spatial weights matrix (Bivand, Hauke, and Kossowski 2013; Bivand and Piras 2015). For LM and robust LM tests on spatial dependence the reference is Pisati (2001).A commonly used spatial weights matrix is constructed by a contiguity matrix, whose elements w_{ij}take value 1 if two regions i and j share the same border and 0 otherwise.

As control variables for the firm survival equation, we included the principal factors suggested as determinants of firm survival: firm age, size, and start-up capital. We also controlled for employees characteristics such as training and involvement in management, market extension, type of product processing, whether the firm was founded by the previous generation, location characteristics (municipality density, distance from Naples, district presence, and MIPAAF or technological scientific laboratory presence), macro-sectors, and sectors.

The model in Eq. [1] is often referred as spatial autoregressive model with spatial autoregressive disturbances (which reflect the dependence in the disturbance process) and spatial lag of the explanatory model when all the parameters ρ, γ and λ respectively spatial lag parameter, spatial lag of explanatory and spatial error parameter[15], are different from zero. In this way we can control separate motivations for regression models which include spatial processes and the same motivation justify also the importance of taking in account the spatial autoregressive process:

$\rho \neq 0,\ \lambda = 0\ ,\ \gamma =\ 0 \rightarrow SAR$: *Spatial Autoregressive regression model* which is particular useful for quantify spatial spill overs link to our *y* (the survival of firms *i* rely on survival of neighbouring firms)

$\rho = 0,\ \lambda \neq 0,\ \gamma =\ 0 \rightarrow SEM$*: Spatial Error Model* when it's worth fully control a spatial heterogeneity motivation and the spatial effect can be view as error dependence and modelled as a separate intercept for each unit.

$\rho = 0,\ \lambda = 0,\ \gamma \neq\ 0 \rightarrow SLX$: *Spatial Lag of X model ,* when the spatial motivation derive from omitted unobservable explanatory factors.

$\rho \neq 0,\ \lambda = 0,\ \gamma \neq\ 0 \rightarrow SDM$: *Spatial Durbin model,* when the spatial motivation derive from a spillower effect and also an omitted unobservable explanatory factors, and which include spatial lag of the dependent variable Wy, as well as the explanatory variable vector *x*

Given the binaries' of the dependent variable (a dummy for the exit or the survival of the firms) we have to consider the spatial probit model and we performed it using R "Spatialprobit" library.

In this analysis we present the results for the SAR and SDM for the probit to survive

Moreover we try to performed Spatial Lag of model *SLX* using a survival parametric models to control the effect of a particular explanatory variable *x,* the innovation (INNOVATION).

[15] Spatial lag, since it represents a linear combination of values of the variables considered (Y, X and μ)

For considering the agglomeration in these models (Cox and Weibull Parametric Models) we include a spatial average of a neighbouring characteristic and in the specific we consider innovation (1/0) and we have *W*Innovation* as a covariate and that could play a direct role in determining the survival *y* of the firms:

Spatial Lag of X model (defined SLX, LeSage and Pace, 209 p. 30) and we used Cox and Weibull Parametric regression survival-time models to estimate the *hazard function*:

$$h(t,X) = h0(t)\lambda,$$

$$\text{where } \lambda \equiv \exp(X\beta), \text{ or}$$

$$\log[h(t\,X] = \log[h0(t)] + X\beta$$

$$X = (X \quad , Innovation, W * Innovation)$$

$$s = X \quad \beta_1 + Innovation\beta_2 + W * Innovation\beta_3 + \varepsilon$$

where (*s*) represents an *nx1* vector of life duration is the dependent variable, **X** an *nxk* matrix of independent variables and β_1 (*kx1* vector) and produce the effect of the characteristics on the survival of the firms, β_2 is the sestimated effect of the innovation introducet by each firms on their survival, The *nxn* matrices W is the spatial weight matrices and contain the information on the spatial relationship between observations.

A popular regression model for the analysis of survival data is Cox's regression model (Cefis and Marsili 2006; Colombelli et al. 2016). This is a semi-parametric model making fewer assumptions than typical parametric methods and therefore is the most practical and well-known statistical model with which to investigate the relationship between predictors and the time-to-event through the hazard function. In this model, there was no need for the researcher to assume a particular survival distribution for the data. The only assumption of the model concerns the proportional hazards and for this reason it is also called the Cox proportional hazards regression. Moreover, to take into account the unobserved heterogeneity we estimate also a Weibull model with and without the frailty (Lancaster, 1990; Jenkins, 2005).

Firstly we used Cox's partial likelihood model allows derivation of estimates of the slope coefficients placing not restrictions at all on the shape of the baseline hazard. The only assumption made in Cox's regression model is about the proportional hazards. We checked the assumption of proportionality both for all variables jointly and for each variable using the tests based on Schoenfeld's residuals (Schoenfeld 1980). The null hypothesis that the hazard rates are proportional cannot be rejected, for each of the covariates, and the global test, at a 1% significance level. Morevover, for take in account of the frailty (unobserved heterogeneity) we show also the results of the Weibull's regression model with and without the frailty.

It is important to notice that our sample from the population of Salerno province's manufacturing firms in 1999 cannot be considered a random sample to examine the determinants of firm survival due to the existence of left-truncated spells. The "selection bias" provoked by the fact that short-duration firms (firms that were born and died before 1999 but, had they been active in 1999, would have been eligible to be included in the OPIS survey) are not included in our sample can be handled using information about the elapsed time between sampling and the end of the follow-up period. In other words, we analyse failures that have occurred by 2013 conditional on surviving in the stock market until 1999 (date of sampling). However, the empirical methodology could take into account this aspect and is capable of accommodating such features and allows obtaining unbiased estimates of the determinants of firm survival. They are also adequate in the presence of right-censored observations (i.e., firms still in the market after 2013). Unfortunately, we only have time-invariant explanatory variables for sample construction. Thus, we are not able to overcome the limitation that arise from considering firm characteristics previous to the beginning of the period analysed or at the time of entry as unique determinants of the probability of firm survival across time (see Mata et al. 1995).

How to interpret the results we have a direct and indirect effect that it possible to calculate for the Spatial Autoregressive regression model and Spatial Durbin model .

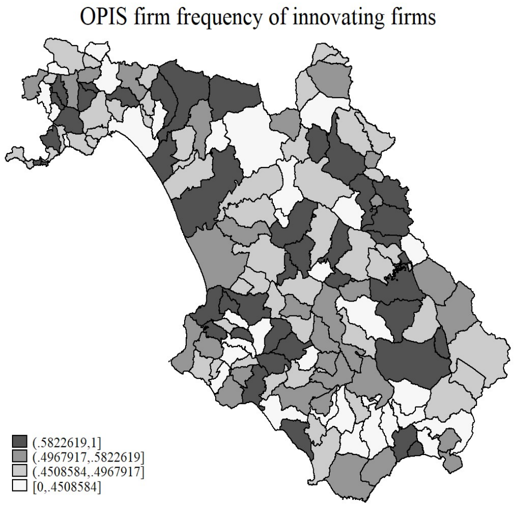
The Average Direct effect – averaged over all n observations providing a summary measure of the impact arising from changes in the ith observation of variable *x*. For example, if firms *i* make an innovation what will be the average impact on the exit probabilities in firm *i* ? This measure will take into account feedback effects that arise from the change in the *ith* firms's innovativeness on innovation of neighboring firms in the system of spatially dependent regions.

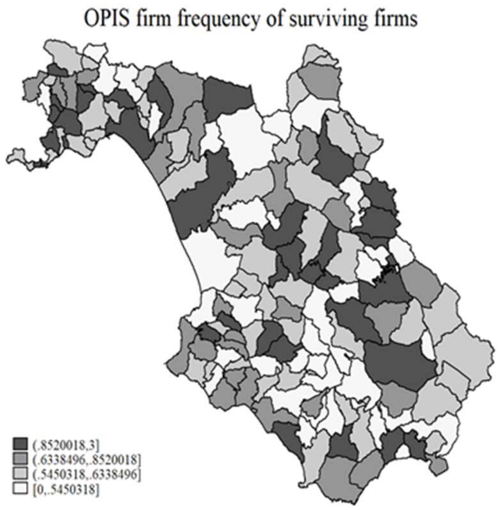
The Average Total effect = Average Direct effect + Average Indirect effect. This scalar summary measure has two interpretations. Interpretation 1), if all firms make an innovation, what will be the average total impact on exit of the particular firm ? This total effect will include both the average direct impact plus the average indirect impact. Interpretation 2) measures the total impact arising from one firm j making an innovation on the probability of exit from the market of all other firms (on average).

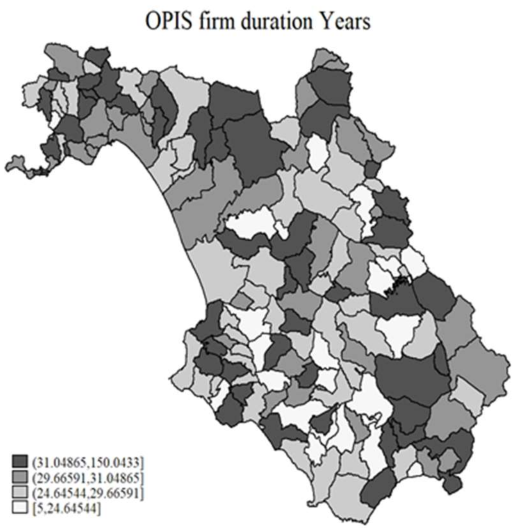
Finally, the Average Indirect effect = Average Total effect – Average Direct effect by definition. As an example, this effect could be used to measure the impact of all other firms making their innovation on the exit probability of an individual firms, again averaged over all firms.

Results

From a preliminary explorative analysis, we present the figures of the Province of Salerno showing the average of survival frequency from the year 1990 to April 2013, life duration and innovativeness (frequencies of innovating firms) by municipality where the firms are located. As we can see there are similar colours in contiguous areas







After we consider some traditional test for control the Global indices of spatial autocorrelation Moran's I and Geary's c, (Table 2) the null hypothesis is no global spatial auto-correlation. Controlling for all the variables considered in the analysis, we can see that we reject the null hypothesis of no global spatial auto-correlation, for innovation variable at 5%, but not for the life duration of the firms

Table 2 Moran's I and Geary's *c Global Spatial Test*

Variables	Moran's I						Geary's c					
	I	E(I)	sd(I)	z	p-value *		c	E(c)	sd(c)	z	p-value *	
Duration in Years	0.008	-0.002	0.011	0.945	0.172		0.894	1	0.109	-0.967	0.167	
Dummy for Innovation	0.023	-0.002	0.015	1.701	0.044	**	0.975	1	0.015	-1.658	0.049	**
Dummy for Owner Low education	0.017	-0.002	0.015	1.286	0.099	*	0.982	1	0.015	-1.161	0.123	
Dummy for Owner High secondaty	0.01	-0.002	0.015	0.789	0.215		0.988	1	0.015	-0.781	0.217	
Dummy for Owner Degree	0.023	-0.002	0.015	1.691	0.045	**	0.966	1	0.021	-1.623	0.052	*
Owner age	0.018	-0.002	0.015	1.387	0.083	*	0.974	1	0.021	-1.24	0.108	
Dummy for owner previous job as an employee	0.042	-0.002	0.015	2.98	0.001	***	0.958	1	0.015	-2.727	0.003	***
Dummy for owner previous job as self-employed	-0.006	-0.002	0.015	-0.282	0.389		0.976	1	0.035	-0.693	0.244	
Dummy for owner previous job as an enterpreneur	0.007	-0.002	0.015	0.64	0.261		0.982	1	0.017	-1.066	0.143	
Dummy for owner previous job as unemployed or housewife	0.009	-0.002	0.014	0.784	0.217		0.998	1	0.067	-0.037	0.485	
Dummy for employee training	0.033	-0.002	0.015	2.384	0.009	***	0.955	1	0.016	-2.843	0.002	***
Employee Involv. Ment Grade	0.061	-0.002	0.015	4.238	0	***	0.948	1	0.016	-3.24	0.001	***
Dummy for chemistry requirement	-0.002	-0.002	0.011	0.036	0.485		1.033	1	0.115	0.288	0.387	
Dummy for physics requirement	-0.004	-0.002	0.013	-0.121	0.452		1.048	1	0.082	0.583	0.28	
Dummy for computer science requirement	-0.004	-0.002	0.012	-0.142	0.444		1.006	1	0.094	0.064	0.475	
Dummy for engineering requirement	0.026	-0.002	0.015	1.906	0.028	**	1.002	1	0.027	0.077	0.469	
Dummy for business requirement	0.087	-0.002	0.015	5.991	0	***	0.942	1	0.025	-2.297	0.011	**
Dummy for agr. economics requirement	-0.006	-0.002	0.014	-0.298	0.383		0.93	1	0.058	-1.211	0.113	
Dummy for <10 workers	0.007	-0.002	0.015	0.598	0.275		0.99	1	0.015	-0.658	0.255	
Dummy for 10 ≤ workers < 20*	-0.013	-0.002	0.015	-0.71	0.239		1.01	1	0.02	0.485	0.314	
Dummy for 20 ≤ workers < 50	0.034	-0.002	0.015	2.463	0.007	***	0.941	1	0.023	-2.603	0.005	***
Dummy for > 50 workers	0.005	-0.002	0.014	0.484	0.314		1.034	1	0.044	0.76	0.223	
Dummy for bank financing	-0.008	-0.002	0.015	-0.416	0.339		0.983	1	0.035	-0.483	0.315	

%												
Dummy for subsidies	0.04	-0.002	0.015	2.846	0.002	***	0.945	1	0.035	-1.559	0.059	*
Locale versus International market	0.013	-0.002	0.015	0.999	0.159		0.994	1	0.027	-0.216	0.415	
National versus International market	-0.008	-0.002	0.015	-0.383	0.351		0.999	1	0.032	-0.019	0.493	
Dummy for firm founded by the previous generation	0.002	-0.002	0.015	0.296	0.384		0.987	1	0.018	-0.753	0.226	
Dummy for PST in the municipality	0.454	-0.002	0.015	30.635	0	***	0.622	1	0.021	-18.383	0	***
Dummy for MIPAAF lab in the municipality	0.247	-0.002	0.015	17.074	0	***	0.729	1	0.037	-7.306	0	***
Dummy for distance from Naples < 150 km	0.339	-0.002	0.015	23.424	0	***	0.453	1	0.04	-13.63	0	***
Dummy for district	0.448	-0.002	0.015	30.145	0	***	0.56	1	0.016	-26.916	0	***
Dummy for science-based macro-sector #	0.045	-0.002	0.014	3.225	0.001	***	0.992	1	0.043	-0.181	0.428	
Dummy for specialised supplier macro-sector	0.01	-0.002	0.015	0.843	0.2		0.99	1	0.022	-0.472	0.318	
Dummy for scale-intensive macro-sector	0.033	-0.002	0.015	2.326	0.01	**	0.965	1	0.016	-2.238	0.013	**
Dummy for traditional macro-sector	0.038	-0.002	0.015	2.706	0.003	***	0.959	1	0.015	-2.727	0.003	***
Dummy for Food, drink and tobacco industries dummy ç	0.016	-0.002	0.015	1.249	0.106		0.943	1	0.021	-2.655	0.004	***
Dummy for Textiles and leather industries dummy	0.047	-0.002	0.015	3.328	0	***	0.967	1	0.02	-1.685	0.046	**
Dummy for Wood and metal products industries dummy	0.021	-0.002	0.015	1.549	0.061	*	0.953	1	0.02	-2.289	0.011	**
Dummy for Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	-0.005	-0.002	0.015	-0.206	0.418		1.029	1	0.023	1.287	0.099	*
Dummy for Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.039	-0.002	0.015	2.77	0.003	***	0.903	1	0.03	-3.279	0.001	***
Dummy for Manufacturers of products based on non-metallic minerals dummy	0.109	-0.002	0.015	7.451	0	***	0.91	1	0.023	-3.969	0	***

Dummy for Manufacturers of mechanical products dummy	0.011	-0.002	0.015	0.881	0.189	1.007	1	0.019	0.36	0.359

The Moran's I test for spatial correlation shows the presence of positive spatial correlation of innovation, with a significance of 5% and it also shows that there is a robust positive spatial autocorrelation of the owner degree and owner previous activities as employees and also if the firms make training for their dependents and if make them to be involved in the production. Maybe we can think that there is a driving force which come from the general and specific formation that can favourite the diffusion of information among the contiguous firms also with the start up of new firms by previous dependent workers which workers after having acquired a training can start an individual business activity. If the firms require for business competence, and if receive financial subsidies. This last maybe is an expected results if financial subsides are devoted to favorit firms localised in particular areas. Finally there are also spatial correlation about all the sectors more significance for chemical and non metallic minerals (ceramics and bricks).

In the following table we present the results of the SAR and SDM model and we show the coefficient and the marginal effect (Tabel 3a and 3b), for these last disentangle the combination of direct and indirect (neighbourhood) influences. From spatial model we can see that the SAR and the SDM model show a coefficient of spatial autocorrelation ρ, which reflects the strength of spatial dependence, not significant (only for the SDM we have a slightly significance). Then the endogenous interaction effects Wy doesn't create strong feedback effects, we can say that it is not possible to identify a spillover effect arising from the fact that each variable has an impact upon a firm's survival and this affects the survival of near

For consider how innovation determining survival from neighboring firms to exert an influence on survival of firm *i*. we accomplish by entering an average of an explanatory variable from neighboring firms, created using the matrix product *W*Innov*. And we can see the innovation decrease the probability of exit in all the probit model, a. The spatial lag of explanatory variable is significant with an high value (- 47 p.p the total effect) showing the innovation in neighbour regions has more effect than compared the effect of own innovativeness of the firms itself.

But Look to the direct and indirect effects is (table 3b) given next . we can see that: the effect of the spatial lag W*Innovation which take in account the feedback of the innovation from neighbouring firms on the "survival" of the firms *i increase the probability to survive* (+47 p.p). Moreover, Innovation has a strong direct and positive effect on the probability to survive of each firms (negative effect on the probability of exit - an innovative firms "decrease" the probability of exit of 11 p.p: percent point). Then the direct impact of innovation is different to the marginal effect of a no spatial probit, the difference between the marginal direct effect estimate of -0.11 and the marginal effect without take in account the spatial effect, -0.1466 represents the feedback effects that arise as a result of impact passing through neighbouring (this difference can be interpreted as an *indirect effect)*, and unfortunately in this case increase the probability of exit for the firms (+3 p.p).

Table 3a No spatial probit, SAR and SDM probit spatial autoregressive models: Coefficient, Y=1=exit

	No Spatial Probit		Spatial Probit SAR		Spatial Probit SDM	
	Coefficient		Coefficient		Coefficient	
W*Innovator dummy					-1.7670	**
Innovator dummy	-0.36945	***	-0.3846	**	-0.4055	**
Dummy for 10 ≤ workers < 20*	0.002318		-0.0010		0.0195	
Dummy for 20 ≤ workers < 50	-0.04423		-0.0698		-0.0108	
Dummy for > 50 workers	0.113627		0.1415		0.1445	
Dummy for firm founded by the current owner	-0.20043		-0.1913		-0.2027	
Dummy for Owner Low education	0.052776		0.0563		0.0605	
Dummy for Owner High secondary	-0.2935		-0.3192		-0.2957	
Owner age	-0.02353		-0.0244		-0.0264	
Owner age^2	0.00033		0.0003		0.0004	
Dummy for owner previous job as an employee	0.011098		0.0064		-0.0236	
Dummy for owner previous job as self-employed	0.191084		0.2182		0.1661	
Dummy for owner previous job as an enterpreneur	0.108147		0.1065		0.1453	
Dummy for owner previous job as a housewife	0.315797		0.3217		0.2896	
Dummy for intermediate products $	-0.09518		-0.1097		-0.0604	
Locale versus International market	0.204128		0.1960		0.1556	
National versus International market	0.702787		0.7346		0.6641	
Employee Involv. Ment Grade	0.079746		0.0827		0.0914	
Dummy for employee training	-0.58459	***	-0.5971	***	-0.6325	***
Dummy for PST in the municipality	0.010495		-0.0125		0.1041	
Dummy for MIPAAF lab in the municipality	0.614864	**	0.6981	*	0.7258	*
Dummy for bank financing %	0.279557		0.2823		0.3156	
Population Density at Municipal level	7.44E-05		0.0001		0.0001	
Dummy for agricultural economics department requirement	0.36466		0.3918		0.4071	
Dummy for Food, drink and tobacco industries dummy	-0.23606		-0.2346		-0.2957	
Dummy for Textiles and leather industries dummy	0.247981		0.2490		0.2102	
Dummy for Wood and metal products industries dummy	0.188147		0.1902		0.2097	
Dummy for Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	0.202364		0.2251		0.1744	
Dummy for Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.175898		0.1898		0.1720	
Dummy for Manufacturers of products based on non-metallic minerals dummy	0.192941		0.1878		0.2358	
rho			-0.1903		-0.3018	*
Loh likelihoood	-291.7					

Table 3b SAR and SDM probit spatial autoregressive models: Total, Direct and Indirect Marginal effects on the probability of exit

	SDM Spatial model			SAR Spatial model			No spatial probi model
	Total Marginal Effect	Direct marginal effect	Indirect marginal effect	Total Marginal Effect	Direct marginal effect	Indirect marginal effect	Marginal Effect f
W*Innovator dummy	-0.4666 ***						
Innovator dummy	-0.1068 **	-0.1384 ***	0.0318 *	-0.1130 ***	-0.1318 **	0.0216	-0.1466 **
Dummy for 10 ≤ workers < 20*	0.0054	0.0066	-0.0012	-0.0007	-0.0003	-0.0004	0.0009
Dummy for 20 ≤ workers < 50	-0.0031	-0.0037	0.0005	-0.0209	-0.0239	0.0036	-0.0176
Dummy for > 50 workers	0.0380	0.0495	-0.0116	0.0406	0.0483	-0.0089	0.0453
Dummy for firm founded by the current owner	-0.0535	-0.0692	0.0158	-0.0562 *	-0.0656 *	0.0108	-0.0798
Dummy for Owner Low education	0.0163	0.0206	-0.0043	0.0169	0.0192	-0.0028	0.0211
Dummy for Owner High secondary	-0.0784	-0.1008	0.0225	-0.0931	-0.1096 *	0.0188	-0.1159
Owner age	-0.0070	-0.0090	0.0020	-0.0072	-0.0084 *	0.0013	-0.0094
Owner age^2	0.0001	0.0001 *	0.0000	0.0001 *	0.0001 **	0.0000	0.0001
Dummy for owner previous job as an employee	-0.0064	-0.0080	0.0016	0.0014	0.0022	-0.0009	0.0044
Dummy for owner previous job as self-employed	0.0432	0.0568	-0.0137	0.0634	0.0749	-0.0131	0.0759
Dummy for owner previous job as an enterpreneur	0.0382	0.0496	-0.0115	0.0311	0.0365	-0.0063	0.0431
Dummy for owner previous job as a housewife	0.0753	0.0987	-0.0236	0.0934	0.1103	-0.0193	0.1243
Dummy for intermediate products $	-0.0158	-0.0206	0.0049	-0.0326	-0.0377	0.0059	-0.0379
Locale versus International market	0.0420	0.0532	-0.0113	0.0578	0.0670	-0.0108	0.0809
National versus International market	0.1765	0.2267	-0.0505	0.2172 *	0.2518 *	-0.0401	0.2634
Employee Involv. Ment Grade	0.0241	0.0312	-0.0071	0.0244 *	0.0284 *	-0.0045	0.0318
Dummy for employee training	-0.1674 ***	-0.2159 ***	0.0488 **	-0.1759 ***	-0.2047 ***	0.0333 *	-0.2286 ***
Dummy for PST in the municipality	0.0272	0.0356	-0.0084	-0.0037	-0.0042	0.0006	0.0042
Dummy for MIPAAF lab in the municipality	0.1917 *	0.2478 **	-0.0564	0.2052 ***	0.2395 **	-0.0394	0.2333 **
Dummy for bank financing %	0.0842	0.1076	-0.0235	0.0838	0.0969	-0.0152	0.1105
Population Density at Municipal level	0.0000	0.0000	0.0000	0.0000 *	0.0000 *	0.0000	0.0000
Dummy for agricultural economics department requirement	0.1077	0.1387	-0.0312	0.1143	0.1343	-0.0228	0.1428
Dummy for Food, drink and tobacco industries dummy	-0.0782	-0.1008	0.0228	-0.0689	-0.0803	0.0131	-0.0935
Dummy for Textiles and leather industries dummy	0.0561	0.0718	-0.0158	0.0740	0.0853	-0.0132	0.0985
Dummy for Wood and metal products industries dummy	0.0558	0.0716	-0.0159	0.0568	0.0653	-0.0099	0.0749
Dummy for Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	0.0461	0.0595	-0.0135	0.0669	0.0771	-0.0119	0.0804
Dummy for Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.0458	0.0587	-0.0130	0.0564	0.0652	-0.0102	0.0700
Dummy for Manufacturers of products based on non-metallic minerals dummy	0.0624	0.0805	-0.0182	0.0558	0.0644	-0.0100	0.0767
RHO	-0.3018 .			-0.1903			

Table 4 reports the estimates of Weibull's (with and without control for frailty) and Cox's regression models. Less-than-one risk ratios imply that the hazard rate decreases and the corresponding probability of survival increases.[16]

The risk of exit decreases by 44-47% if the firm made an innovation and of 90% if the other closer firms made an innovation. Training of the employee always consistently reduce the risk of exit, internal knowledge is still important in this contest.

Instead increases the risk of exit if the there is a MIPAAF lab in the municipality this evidence a weakness of agricultural areas

[16] The likelihood ratio test on frailty accepted it [Likelihood-ratio test of theta=0: chibar2(01) = 1.93 Prob>=chibar2 = 0.082] then it should be more efficient the estimation with frailty

Table 4 SLX model Cox and Weibull survival model: Hazard ratio

	Spatial Weibull frailty model		Spatial Weibull non-frailty model		Spatial Cox model		Weibull non-frailty model		Weibull model		Cox model	
	Hazard ratio		Hazard ratio		Hazard ratio		Hazard ratio		Hazard ratio		Hazard ratio	
W*Innovator dummy	0.100	***	0.096	***	0.099	***						
Innovator dummy	0.533	***	0.542	***	0.568	***	0.415	***	0.537	***	0.559	***
Dummy for 10 ≤ workers < 20*	1.150		1.065		1.150		1.227		1.032		1.117	
Dummy for 20 ≤ workers < 50	0.654		0.747		0.681		0.499		0.712		0.656	
Dummy for > 50 workers	1.093		1.197		1.161		2.512		1.103		1.034	
Dummy for firm founded by the current owner	0.687		0.727		0.723		0.527		0.726		0.712	
Dummy for Owner Low education	1.052		1.015		1.039		1.100		0.954		0.982	
Dummy for Owner High secondary	0.461	**	0.488	**	0.484	**	0.508		0.446	**	0.456	**
Owner age	0.997		0.999		0.998		0.966		0.996		0.996	
Owner age^2	1.000		1.000		1.000		1.001		1.000		1.000	
Dummy for owner previous job as an employee	1.059		1.078	*	1.011		0.991		1.088		1.003	
Dummy for owner previous job as self-employed	1.972	*	2.101		1.791	*	1.767		2.028	**	1.692	*
Dummy for owner previous job as an enterpreneur	1.410		1.495		1.368		1.122		1.359		1.232	
Dummy for owner previous job as a housewife	1.540		1.576		1.466		1.828		1.727		1.550	
Dummy for intermediate products $	0.748		0.793		0.817		0.667		0.743		0.760	
Locale versus International market	1.700		1.596		1.462		2.870		1.574		1.416	
National versus International market	3.183	*	2.941	*	2.250		4.720	*	2.784	*	2.101	
Employee Involv. Ment Grade	1.135		1.125		1.144		1.154		1.107		1.134	
Dummy for employee training	0.450	***	0.472	***	0.462	***	0.378	**	0.505	***	0.487	***
Dummy for PST in the municipality	1.194		1.163		1.244		1.068		1.000		1.056	
Dummy for MIPAAF lab in the municipality	1.558		1.518		1.475		2.486		1.437		1.392	
Dummy for bank financing %	1.252		1.327		1.162		1.434		1.257		1.095	
Population Density at Municipal level	1.000	**	1.000	**	1.000	*	1.000		1.000	*	1.000	
Dummy for agricultural economics department requirement	6.851	*	3.220	*	6.727	***	15.160	**	2.899		6.465	
Dummy for Food, drink and tobacco industries dummy	0.621		0.660		0.688		0.467		0.691		0.717	
Dummy for Textiles and leather industries dummy	1.122		1.089		1.145		1.252		1.072		1.136	
Dummy for Wood and metal products industries dummy	1.200		1.205		1.290		1.163		1.156		1.214	
Dummy for Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	1.322		1.228		1.370		1.578		1.257		1.394	
Dummy for Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	1.074		1.065		1.040		0.882		1.008		0.984	
Dummy for Manufacturers of products based on non-metallic minerals dummy	1.402		1.366		1.532		1.339		1.164		1.302	
_cons	0.042		0.068	**	0.042	**	0.008	***	0.028	***	0.008	***
ln_p	0.159		0.050				0.365*		0.031			
ln_the	-2.755*						-1.196**					
ll	-3482.607		-3498.2		-952.954		-3579.278		-3655.99		-960.392	
N. obs	457		457		457		457		457		457	

7. Conclusions

How then interpret the opposite results on survival of the firms between the negative indirect effect of the innovation variables and the positive effect from the spatially lagged explanatory variable innovation that estimate a total marginal effect of -0.47 from the SDM model? Maybe the indirect effect of the innovation take in account the feedback on survival of a characteristics as the innovation from neighbouring firms on firm *i (*positive spatially lagged innovation effect*)* together with the opposite or null feedback effect (negative spatially lagged survival effect) from changes in survival in neighbouring firms that arise from a change originating in firms *i* .

Appendix A

Table A1. Descriptive statistics of the variables

Variables	Means Unit	Mean	St.dev
Survivor dummy		0.500	0.501
Innovator dummy		0.479	0.500
Product innovation dummy		0.223	0.417
Process innovation dummy		0.315	0.465
Organisational innovation dummy		0.065	0.247
University/research lab partnership for product innovation dummy		0.013	0.113
Consultant/commercial lab partnership for product innovation dummy		0.041	0.199
Supplier of equipment/plants partnership for product innovation dummy		0.071	0.258
Contractor partnership for product innovation dummy		0.026	0.159
Client partnership for product innovation dummy		0.035	0.183
Other firm partnership for product innovation dummy		0.013	0.114
Public institution partnership for product innovation dummy		0007	0.008
University/research lab partnership for process innovation dummy		0.011	0.104
Consultant/commercial lab partnership for process innovation dummy		0.054	0.226
Supplier of equipment/plants partnership for process innovation dummy		0.199	0.400
Contractor partnership for process innovation dummy		0.026	0.159
Client partnership for process innovation dummy		0.037	0.188
Other firm partnership for product innovation dummy		0.002	0.147
Public institution partnership for product innovation dummy		0.002	0.047
Consultant/commercial lab partnership for organisational innovation dummy		0.024	0.153
Supplier of equipment and plants partnership for organisational innovation dummy		0.019	0.138
Contractor partnership for organisational innovation dummy		0.004	0.066
Client partnership for organisational innovation dummy		0.009	0.093
R&D intensity	%	0.163	1.852
Skilled employees	%	12.716	12.089
Dummy f or < 10 workers		0.724	0.024
Dummy for 10 ≤ workers < 20		0.146	0.019
Dummy for 20 ≤ workers < 50		0.088	0.014
Dummy for 50 ≤ workers < 100		0.032	0.010
Dummy for≥100 workers		0.010	0.004
Dummy for company		0.506	0.493

Owner general human capital	years	11.614	0.201
Owner age	years	43.315	10.496
Dummy for final products		0.773	0.419
Dummy for intermediate products		0.110	0.313
Dummy for intermediate and final products		0.117	0.322
Dummy for own financing		0.879	0.327
Dummy for family financing		0.043	0.203
Dummy for bank financing		0.039	0.193
Dummy for subsidies		0.042	0.202
Market extension (1=local, 2=national, 3=international)		1.424	0.040
Firm age	years	21.537	26.171
Dummy for firm founded by the previous generation		0.254	0.436
Employee involvement in firm management (0= no, 1=low, 2= medium, 3=high)		1.022	1.141
Dummy for employee training		0.312	0.464
Dummy for PST in the municipality		0.141	0.348
Dummy for distance from Naples < 150 km		0.946	0.227
Dummy for district		0.287	0.453
Dummy for MIPAAF lab in the municipality		0.053	0.224
Municipality density	th inh./ km^2	1201.972	60.259
Mean municipal income per capita in 1998	th €	15.144	2.959
Mean municipal income per capita in 2007	th €	20.721	3.218
Annual rate of municipal mean income per capita growth in 1987-1998	%	1.644	1.476
Annual rate of municipal mean income per capita growth in 1998-2007	%	4.129	0.920
Annual rate of municipal mean income per capita growth in 2007-2013	%	5.954	0.829
Dummy for physics requirement		0.014	0.116
Dummy for computer science skill requirement		0.005	0.070
Dummy for engineering requirement		0.076	0.266
Dummy for business requirement		0.092	0.290
Dummy for agricultural economics requirement		0.027	0.163
Dummy for science-based macro-sector		0.058	0.235
Dummy for specialised supplier macro-sector		0.116	0.321
Dummy for scale-intensive macro-sector		0.233	0.423
Dummy for supplier-dominated macro-sector		0.592	0.492
Dummy for Food, drink and tobacco industries		0.224	0.417
Dummy for Textiles and leather industries		0.120	0.326
Dummy for Wood and metal products industries		0.242	0.429
Dummy for Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing		0.060	0.237
Dummy for Manufacturers of chemical products and synthetic and artificial fibres and rubber		0.033	0.178
Dummy for Manufacturers of products based on non-metallic minerals		0.078	0.268
Dummy for Manufacturers of mechanical products		0.244	0.430

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