Firm survival and innovation:
Knowledge context matters!

Ornella Wanda Maietta[1], Fernanda Mazzotta[2]

[1] CSEF and University of Naples Federico II, maietta@unina.it
[2] DISES, University of Salerno, mazzotta@unisa.it

Abstract

The aim of this paper is to explore the differential effect of innovation on firm survival. 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 multivariate endogenous probit model is applied to simultaneously analyse the determinants of innovation and of subsequent firm survival. Our estimates confirm that process innovation is a determinant of firm survival followed by product innovation, whereas evidence of a more novel type suggests that organisational innovation plays only a weak role. Entrepreneurial general and specific human capital exerts no direct beneficial effect on firm duration. The requirement of proper technological knowledge from the local university has been the driver of firm duration with the highest marginal effect.

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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). Innovativeness also plays a fundamental role for firm survival of entrants, as well as established firms, since entrants innovate to successfully enter the market, and established firms innovate to protect their competitive advantage (Christensen 1997).

To innovate, firms use complementary sources of expertise and 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 and Levinthal 1989; Farace and Mazzotta 2015; Gray 2006). This ability is named the firm's absorptive capacity and is proxied by its R&D investment. Knowledge is also stored within firm workers (Grant 1996), and the human capital of firm founders/entrepreneurs/managers contributes to coordinating and exploiting this knowledge (Colombo and Grilli 2005; Hodgson 1998) in a process of mutual learning between individuals and their organisations according to organisational theory (March 1991).

Firms both learn from internal and external sources of knowledge. The collaboration with external institutions enables a firm to expand its range of expertise and to support the development of new products and processes. However, in order to successfully access new knowledge through collaborations with other firms and institutions, firms must manage the capability to search, find, access and interpret information embodied in external organisations for their own use. This is especially true for small and medium enterprises (SMEs) that generally do not undertake any R&D activities; therefore, in order to determine SMEs' capacity to absorb external knowledge, learning capabilities embodied in their human resources should be considered. The skills, training and experience of SMEs' human capital is their knowledge base, which contributes extensively to the firm's overall capability to absorb external knowledge (Muscio 2007). The theory of industrial districts, the new economic geography (Becattini et al. 2009; Krugman 1991) and the literature on networks and innovation (Lundvall 1992) underline the importance of networks and socio-economic relations in spreading knowledge among firms. Thus, the creation of new knowledge and the adoption of innovations also depend on firm relations with actors of surrounding and delimitated territories such that the nature and the strength of networks around the firm are important (Rogers 2004). The degree of localness of the search process aimed at new knowledge creation may be high for small-sized firms. For these, most of interpersonal job relations are restricted at the provincial level (Chiesi 2007), as a consequence, the local university plays an important role in knowledge transfer through multiple, simultaneous and interrelated channels (research, education and third-mission activities) (Maietta 2015).

The aim of the paper is to assess the differential effect of innovation on firm survival and how firm innovation is explained by entrepreneur and employee human capital and internal and external networks. The latter (such as links with university departments and others partners), being important sources of knowledge and innovation for SMEs, are direct and indirect determinants of firm survival. Among the external networks aimed at knowledge acquisition, particular attention will be devoted to the role played by the main local actors in knowledge production that is the local university and its departments. This intra-university focus is adopted because European universities are structurally characterised by high internal variability.

Different theoretical approaches have analysed the relationship between innovation and survival, evidencing a complex and not-unique structure of the mechanisms linking learning processes and survival. Learning models in the tradition of Jovanovic (1982) emphasise the role of firm efficiency and the effectiveness of market selection in shaping firm survival, whereas the evolutionary stream of literature (Coad 2014) emphasises the effect of firms' different learning processes on efficiency change. The former focus on the short-run market-level selection among incumbent firms and the latter on the long-run selection mechanism operating at firm level through the choice of improved products and processes. Given that the theoretical contributions on firm dynamics are not conclusive on the prevailing mechanism explaining the link between innovation and survival, the question is still open to empirical investigation.

However, whereas a large strand of empirical literature has examined the impact of international trade and foreign investment on firm innovation, survival and productivity (Ferragina and Mazzotta 2014; Lööf et al. 2015), relatively few studies provide any insight into whether innovation input or output influences firm survival. Recent studies explore the relations between innovation output and survival of entrants (Cauchie and Vaillan 2016; Colombelli 2016; Helmers and Rogers 2008; Zhang and Mohnen 2013) and of established firms (Buddelmeyern et al. 2006; Cefis and Marsili 2006; Esteve-Pérez et al. 2014; Giovannetti et al. 2011).

Furthermore, aside from Bates (1990), Blanchflower and Meyer (1994), Blanchflower and Oswald (1998), Evans and Leighton (1989) and van Praag and van Ophem (1995), who assess the impact of human capital on the success or survival of firms run by business owners, no insight is provided in the literature on how the characteristics of entrepreneurs and firm absorptive capacity determine innovation and, through this channel, firm survival. In this article, we draw on these two currently unrelated strands of literature and assess the relationships among kind of innovation (product, process and organisational), human capital, internal and external networks and firm survival. We thus propose the following research questions: "To what extent are entrepreneur and employee human capital, internal and external networks positively related to innovations in SMEs?" and "How do innovations and their determinants influence firm survival?" The differential impact of innovation on survival has been analysed so far by distinguishing between product and process innovation (Cefis and Marsili 2004; Colombelli et al. 2016); however, no one to our knowledge has also analysed the effect of organisational innovation on survival. Analogously, no one thus far has analysed not only the role played by the local academic institution on firm survival, but done so from an intra-university perspective.

The analysis is initially conducted through a survival method that takes into account the evolution of the risk of failure and its determinants (since the method controls for both the occurrence and the timing of exit) once the effect of different kinds of liabilities, evidenced in the literature (Aldrich and Auster 1986; Bruderl and Schussler 1990) and described in the following section, has been captured. However, the endogeneity growth literature suggests that the relationship between innovation and performance may by endogenous (Aghion and Howitt 1992; Grossman and Helpman 1994). To take this into account, we also run an endogenous multivariate probit that simultaneously estimates the probability of introducing product, process and organisational innovations and the probability that the firm observed in 1998-1999 will survive to April 2013.

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

[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.

will help to enhance the entrepreneur's knowledge and contribute to improving the absorptive capability of SMEs.

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, we clarify the working hypotheses of our analysis. In the next sections, we assess the stylised facts from the previous literature against our data. The multivariate econometric approach is presented in Section 5 and the pattern of firm exit is explored in Section 6, first with a single-equation model and then with a multi-equation model. In the final section, we present some preliminary conclusions. The Appendix reports the univariate and graphical analysis of differences in the survival between groups of firms for variables of interest.

2. Impact of Innovation 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.

Initially, firm survival has been related to R&D investment. The intensity of R&D expenditure increases the survival probability of US manufacturing firms with a stronger effect for firms that do not patent (Hall 1987). In a study of Spanish manufactures, firm

[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).

investment in R&D activities is associated with a lower exit risk; this effect is enhanced by the international dimension of the firm output markets (Perez et al. 2004). For highly innovative industries, a positive relationship between R&D spending and survival is reported by Perez and Castillejo (2004), whereas Ortega-Argiles and Moreno (2005) found that the relationship held only for small firms. A positive non-linear relationship between R&D investment or product innovation and the probability of firm survival is also found in Fontana and Nesta (2009).

Among the studies examining the link between survival and innovation output indicators, Christensen et al. (1998) find that firm product innovation associated with the entrance into new market segments increases the probability of firm survival. A positive relationship between survival and the number of new products introduced in the market has been found (Banbury and Mitchell 1995), whereas firms producing older models show a higher exit risk (Greenstein and Wade 1998). Process innovation is associated with higher survival rates, while product innovation is related to lower survival rates or positively influences firm survival only in combination with process innovation (Baldwin and Gu 2004; Cefis and Marsili 2006), particularly in small firms (Ortega-Argiles and Moreno 2005).

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.

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 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.

The endogenous growth literature demonstrates the simultaneity in the relationship between innovation and performance (Aghion and Howitt 1992; Grossman and Helpman 1994). Innovation is a rival input in the production process and the incentive to innovate is closely linked to the functioning of the institutional framework, since innovators cannot acquire rents from their invention in an unsuitable institutional environment. Building on this foundation, Klette et al. (2000) developed a multi-stage model of firm behaviour in which firm growth is determined by the quality of its own and its competitors' products, and the quality of firm products is improved through innovation. The intensity of the latter is related to the profit margin, which depends on the degree of firm product differentiation. The model suggests that it is important to consider performance and innovation simultaneously.

A large number of empirical studies have examined the determinants of innovation. The development of innovation requires the accumulation of knowledge and financial means; for large firms, R&D laboratories possess the necessary human and financial capital for innovation. Alternatively, for SMEs, entrepreneurship is a key determinant of innovation (Acs et al. 2005; Audretsch 1995); specifically, according to the human capital-entrepreneurship literature, the entrepreneur's human capital attributes (including education, experience, knowledge and skills) are related to entrepreneurial outcomes (Marvel et al. 2016). The entrepreneur's general human capital is considered a transferable stock and is usually measured by education attainment levels or years of education (Chrisman and McMullan 2004; Cooper et al. 1994; Dencker et al. 2009). The specific human capital is defined as a non-transferable stock and usually measured by prior experience and specific training; it may also influence the economic performance of entrepreneurs (Boden and Nucci 2000; Chrisman and McMullan 2004; Dencker et al. 2009).

Other important determinants of firm innovation are subsidies and cooperation with rivals, customers, universities, research institutions and other actors (Lööf et al. 2001; Hashi and Stojčić 2013; Maietta 2015; Maietta et al. 2017). Kemp et al. (2003) find that innovation input is positively influenced by contacts and cooperation with research institutes. Lööf et al. (2001) find that cooperation with domestic rivals and customers is positively related to a firm's higher innovativeness. Klomp et al. (2002) find that interactions between firms, universities and research institutions have a positive effect on the efficiency of the innovation process. More specifically, R&D collaboration with universities/public research labs is a highly significant determinant of process innovation, but only weakly significant for product innovation in traditional sectors (Maietta 2015).

3. Data and Variables

The data derives from the OPIS[4] (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[5] comprises 457 firms, and the descriptive statistics, reported in Table 1, reveal that 48% of firms introduced at least one innovation, whereas 50% survived.

We know the type of innovation (process, product and organisational) and the sources from which the firm acquires new knowledge. Table 1 shows that the percentage of process innovation is higher than the other two kinds of innovation, probably because small firms and the traditional sectors, which prevail in our sample, are mainly characterised by process innovation. Firm exit dates range from the end of 1999 to April 2013.

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 capital used for firm start-up (his/her own or family, banks or subsidies) and market extension (international, national or local[6]).

As for firm size, we adopt a classification based on the number of workers[7] in 1999: 0–9; 10–19; 20–49; 50–99; and over 100. 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[8] such as age, educational level and previous job.

The questionnaire also asks which have been the three main firm partners for each kind of innovation. From Table 1, the most common partners are suppliers of equipment and plants for product and process innovation and consultants/commercial labs for organisational innovation.

The University of Salerno is the most important public research institution in the area. The questionnaire asks which technological knowledge supplied by this academic institution was the firm interested in for its future innovation strategies. The replies refer to the

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

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

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

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

[8] We analyse mainly SMEs in traditional sectors, without distinguishing between management and ownership, since the manager and the owner are almost always the same person.

following scientific disciplines: chemistry, physics, computer science, engineering, business and agricultural economics. Two municipalities host a research centre of the Ministry of Agriculture, and knowledge spillover effects from these labs are captured by a dichotomous variable equal to one if the municipality where the firm is located hosts one of these two labs.

To take into account the effects of agglomerations economies, indicators suggested in the literature (Colombelli 2016) have also been used. These are the distance of each municipality from the main administrative city in the NUTS2 region[9], Naples, and the population density of the municipality where the firm is located. A dichotomous variable equal to one, if the municipality is located in an industrial district, captures whether the firm is part of a production chain[10].

[Table 1 here]

4. Variable Specification and Expected Signs

Our main variables as described in the literature review of the previous section are innovations, the stock of general and specific human capital of entrepreneurs, and innovation partnerships.

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

Hypothesis 1. The probability of firm survival increases in the presence of innovation and in a differential way according to the kind of innovation.

Hypothesis 2. The owner human capital enhances firm absorptive capabilities and then the probability of firm survival, both for a direct effect and an indirect effect through innovativeness.

[9] The distance is calculated using the latitude and longitude located with the address of each firm.

[10] Information on a firm's networks is also captured by consortium participation, relationships with other firms as well as its surrounding environment, sense of belonging to the territory and whether the firm acts as a subcontractor. None of the variables accordingly defined was significant.

Hypothesis 3. The probability of firm survival increases if the firm has relationships with partners who transfer proper technological knowledge, both for a direct effect and for an indirect effect through innovativeness.

The dependent variables of this study are *Survivor* plus *Product innovation*, *Process innovation* and *Organisational innovation*. Initially, we investigate firm survival a single-equation model in order to identify the role of the innovations and of the knowledge context on firm survival. Next, we estimate a multi-equation model, as the three innovation variables are potentially endogenous. A univariate and graphical analysis is also conducted in the Appendix.

The key covariates for the firm survival equation are the three innovation-related variables, the dummies for the technological knowledge in which the firm is interested for its future innovation strategies and the entrepreneur (general and specific) human capital indicators. The former is captured by owner years of education and the latter by owner age, proxy of experience. The key covariates for the innovation equations are the dummies for the innovation partnerships and the entrepreneur human capital indicators.

As control variables for the firm survival equation, we include the principal factors suggested as determinants of firm survival. Following the hypotheses primarily drawn from the resource-based theory of the firm, the industrial organisation and the organisational ecology (Geroski 1995), firm-survival chances are positively related to firm age, size and capital endowment[11] (Fackler et al. 2013).

We also control for product market extension, employee characteristics (skills, training and involvement in management), firm age and foundation, location characteristics (municipality density, distance from Naples, district presence, and Ministry of Agriculture lab presence), macro-sectors and sectors. The control variables of the innovation equations are the following: *R&D intensity*, *Skilled employees*, *Firm age*, *Firm founded by the previous generation*, *Level of product processing*, *Employee involvement in firm management*, *Employee training*, plus firm size dummies, location characteristics variables, and macro-sector and sector dummies.

[11] Capital endowment is proxied by dummies related to the source of financing used for firm start-up.

5. Econometric Approach

There is no doubt that the nonparametric models have greater flexibility and protect from the dangers of misspecification. However, the parametric models can yield gains in parsimony and statistical efficiency if the model is correctly specified, and in this way, we can assess the effects of covariates on survival. 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.

Conditional probability models are also usually applied to estimate the probability of failure conditional on a range of firm characteristics (Balcaen and Ooghe 2006; Dencker et al. 2009; Helmers and Rogers 2010).

The econometric model proposed in this study consists of four simultaneous equations related to the following binary dependent variables: (the existence of) product innovation, process innovation, organisational innovation and firm survival. The three innovation variables are potentially endogenous dichotomous variables since they may have a causal effect on firm survival. However, all these variables are also inter-related due to both observed and unobserved variables. The equations for the innovation variables are modelled as treatment equations. The firm survival equation is the structural or outcome equation with the innovation decisions variables as explanatory factors, given that we hypothesise simultaneity in the relationship between innovation and performance (firm survival). Simultaneity does not mean that the events described by the first three equations occur at the same time of the event described by the fourth equation, but that already present observed and/or unobserved variables (i.e., entrepreneurial skills), which explain innovation choice, may also explain future firm survival. Furthermore, since firms which realise successful innovations are also more likely to survive, this model allows one to take into account the resulting selection bias and endogeneity problems.

The dependent variables are jointly described by a multivariate probit model. The model follows a four-equation structure in which the estimation results of the first, second and third equations are used as regressors in the fourth equation, as follows:

$$\begin{cases} y_{1i}^{*} = \mathbf{x}_{1i}'\boldsymbol{\beta}_1 + \epsilon_{1i} \\ y_{2i}^{*} = \mathbf{x}_{2i}'\boldsymbol{\beta}_2 + \epsilon_{2i} \\ y_{3i}^{*} = \mathbf{x}_{3i}'\boldsymbol{\beta}_3 + \epsilon_{3i} \\ y_{4i}^{*} = \gamma_{14}\, y_{1i}^{*} + \gamma_{24}\, y_{2i}^{*} + \gamma_{34}\, y_{3i}^{*} + \mathbf{x}_{4i}'\boldsymbol{\beta}_4 + \epsilon_{4i} \end{cases} \tag{1}$$

The four latent variables are defined as follows: y_1* is product innovation; y_2* is process innovation; y_3* is organisational innovation; y_4* is firm survival; $\mathbf{x}_{ki}$ are vectors of exogenous variables, which influence those probabilities for firm i; $\boldsymbol{\beta}_k$ (k = 1,.., 4) are parameter vectors; γ_{j4} (j=1,.., 3) are scalar parameters which describe a structural relation between y_j and y_4 and therefore allow for causal interpretations; and ε_{ki} are error terms, which are assumed to be jointly normal with the unknown correlation coefficient, ρ_{kl} (k, l = 1,.., 4). The latter measures how far the unobserved factors influence y_k and y_l, if ρ_{lk}=0 cannot be rejected; this implies that the equations need not to estimated as a system and can be estimated separately.

The latent variables y_{ki}* are not observed; however, the binary variables, y_{ki}, are observed, and these are linked to the former according to the following rule:

$$\begin{cases} y_{ki} = 1, & \text{if } y_{ki}^{*} > 0; \\ y_{ki} = 0 & \text{otherwise; } k = 1, \ldots, 4 \end{cases} \tag{2}$$

The coefficient ρ_{j4} can be interpreted as the degree of endogeneity of y_j to u_4 where j = 1, 2, 3 (Monfardini and Radice 2008). The resulting multivariate probit model can be described as an instrumental variable framework for categorical variables and can be estimated using the simulated maximum likelihood method.

Even if identification is, in principle, by “functional form,” then the exclusion variables are not needed for estimation; researchers usually introduce a variable in the treatment equation (in this case the treatment equations are three, each for any kind of innovation) that is not present in the outcome equation “to improve identification” (Greene 2013). We used the innovation partner dummies that are different for each type of innovation; we also include further variables in the fourth equation (*Bank financing to start*; *Subsidies to start*; *Market extension;* the technological knowledge requirement dummies).

Multicollinearity among the regressors has been assessed by computing the variance inflation factor (VIF) and no evidence of a problem in any model was found[12].

6. Results of the Econometric Analysis

6.*1. Cox's regression model*

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.

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).

[Table 2 here]

Table 2 reports the estimates of Cox's regression model for two specifications of the regressors: Model 1 and Model 2: the latter distinguishes between kinds of innovation

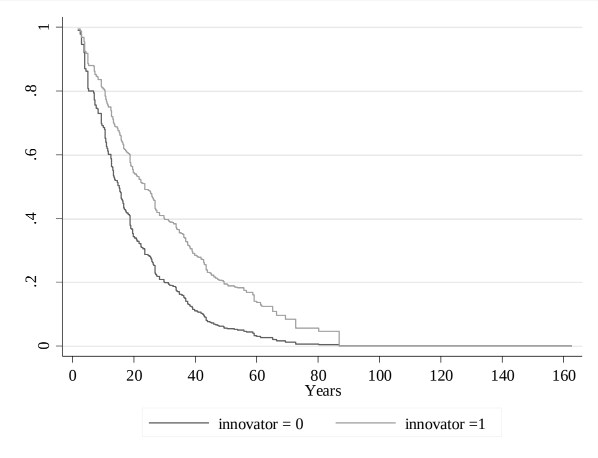
[12] The mean VIF is equal to: 1.57 for equation 1, 1.59 for equation 2, 1.57 for equation 3 and 1.89 for equation 4. The VIF for each variable is below 10 in all equations.

whereas the former does not. Negative coefficient or less-than-one risk ratios imply that the hazard rate decreases and the corresponding probability of survival increases.

The risk of exit decreases by 43% if the firm is an innovator (Figure 1). Looking at the different innovations, process innovation is highly significant, followed by product innovation, whereas organisational innovation is only weakly significant even if the decrease in exit risk associated with its adoption is higher (Figure 2, panel c).

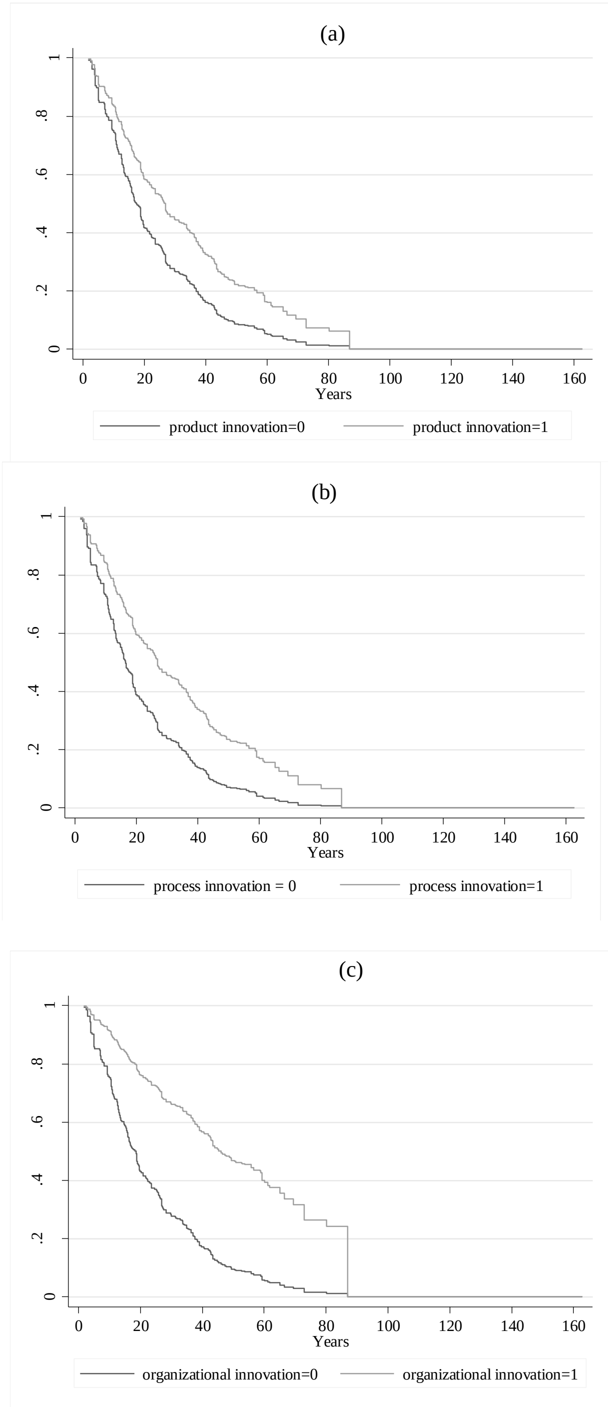
Large firms exhibit a higher risk of failure. The risk of exit decreases if the employer provides training for his employees but increases if the employees are involved in firm management. The dummy related to the requirement of technological knowledge in the agricultural economics area at the University of Salerno is associated with a higher hazard rate[13].

Figure 1. Survival function by innovator



[13] Standard errors are missing (whereas the hazard ratio is zero) for the dummy related to the requirement of technological knowledge in chemistry being collinear with the dead/censor variable.

Figure 2. Survival function by kind of innovation



6.2 Multivariate probit regression

The multivariate four-equation framework of the endogenous multivariate probit is supported by the high significance of the likelihood ratio test, conducted on the hypothesis that the ρs are jointly null.

The correlation coefficients, reported in Table 3, show that the only highly significant correlation is that between the process innovation and the firm survival equations, in that firm survival is negatively correlated through unobserved variables with process innovation. One possible explanation for this negative association is that new-to-the-world innovation may increase the probability of firm exit. We do not control for innovation newness; this aspect, therefore, is captured by the residuals. The inherently risky nature of radical innovation seems more pronounced for process innovation.

[Table 3 here]

The marginal effects of the multivariate probit regressions are reported in Table 4. The standard errors of the coefficients have been clustered around the municipality in which the firm is located.

[Table 4 here]

Almost all the determinants of firm survival, already identified in the previous Cox regressions, are confirmed. Among these, process and product innovation are highly significant, whereas organisational innovation is only weakly significant. Hypothesis 1 is verified since process innovation presents a higher marginal effect than product and organisational innovation, the latter being less important for firm survival.

Hypothesis 2 is not confirmed, since owner general human capital exerts no direct effect on firm survival and a negative one on process innovation; analogously, owner-specific human capital, proxied by owner age[14], exerts a detrimental effect on firm survival, meaning that younger and less experienced entrepreneurs run their business better. However, it is likely that some effect of owner human capital is already caught by other variables, such as the choice of innovation partners and of employee training. This latter exerts a highly significant and positive effect on firm duration.

Large and, to a lesser extent, small firms had problems surviving, confirming that size does not increase the likelihood of survival in traditional sectors. A firm size between 20 and 100 workers seems to be optimal for firm duration. Older firms or firms with employee involvement in management are also more likely to exit. The behaviour of both firm age and the dummy for a firm founded by a previous generation confirm the theoretical prescription about the liabilities of ageing (obsolescence and senescence).

[14] We also tested other variables, proxies of the entrepreneur-specific human capital, such as the dummies for previous job (as an entrepreneur in another firm, an employee or a self-employed individual), but none was significant.

Among the technological knowledge supplied by the University of Salerno in which the firm was interested for its future innovation strategies, the chemistry requirement[15] positively impacts firm survival. This result is not surprising, since the chemistry field received the highest average grade per research output given by the Italian performance-based research funding system (VQR) to the University of Salerno scientific areas during 2004-2010 (ANVUR 2013), and the second highest grade per research output during 2001-2003 (MIUR 2007). During the 2004-2010 period, the number of chemistry patents was 11 out a total of 21 for the University of Salerno. On the other hand, the requirement of knowledge in the field of agricultural economics[16], which received a very low VQR grade (ANVUR 2013), is negatively associated with survival. Furthermore, in the years analysed, the agricultural policy regime shifted from protectionism to a market-based approach and to a completely new structural policy aimed at promoting the economic self-sufficiency of rural communities.

Hypothesis 3 is confirmed, since partnerships with universities/research labs, consultants/commercial labs, suppliers of equipment and plants and contractors exert an indirect effect on firm survival enhancing process and product innovation. Furthermore, the direct effect of the choice of proper innovation partners on firm survival is very strong, as suggested by the high marginal effect of the chemistry requirement dummy: the identification of future proper technical knowledge from the local university seems to have been a strong driver of firm survival.

Among the technology trajectories, innovative industries confirm higher death rates, since the dummy for science-based firms is negative but only weakly significant. No sectoral specificity emerges.

Looking at the innovation determinants, it is possible to observe that the codified absorptive capacity, captured by *R&D intensity* and *Skilled employees*, does not generally explain firm innovativeness, as expected. Variables related to employee training, location characteristics and innovation partners are significant but follow a differential pattern, according to the kind of innovation. Firms with over 100 workers did not innovate. These results suggest a high localness of the search strategies aimed at new knowledge creation.

[15] Expressed by very small firms (with less than 10 workers) of the food, drink and tobacco sectors without previous experience of collaboration with universities but with high owner general human capital.

[16] Expressed by small and medium firms (with $10 \leq$ workers ≤ 50) of the food, drink and tobacco sectors.

7. Conclusions

The aim of this paper was to explore the differential effect of innovation, owner human capital and networks on firm survival. We analysed the effect of product, process and organisational innovations on a representative sample of manufacturing firms, located in southern Italy, primarily represented by SMEs of the traditional sectors. A multivariate endogenous probit model was applied to simultaneously analyse the determinants of innovation and of subsequent firm survival. Our estimates confirm that the degree of localness of the search process aimed at new knowledge creation is high in the examined case study.

The requirement of technological knowledge for future innovations at the local university in the scientific field with the highest average grade per research output (given by the Italian performance-based research funding system) is the determinant of firm survival with the highest marginal impact, followed by process innovation. Entrepreneur general and specific human capital exerts no direct beneficial effect on firm duration, whereas employee training exerts a highly significant and positive one.

The liability of smallness is not particularly pronounced, suggesting that SMEs may be crucial to the promotion of the economic self-sufficiency of communities with a similar economic structure.

When the degree of localness of the search process aimed at new knowledge creation is high, the mechanism of national public research funding may have important consequences on local firm dynamics. The results obtained in this study underline that it is possible to find areas of academic excellence in local universities, even within second- and third-tier-level institutions, while at the same time within good universities there may be areas of poor quality for industrial research. From the firm perspective, trustworthy third parties, such as regional development agencies, should guide the choice of local university partners by spreading information about the national research evaluation at the departmental level, particularly during years of important sectoral policy regime change.

Table 1. Descriptive statistics of the variables

Variables	Meas. Unit	Mean	St. Dev.
Survivor dummy		0.502	0.500
Innovator dummy		0.479	0.029
Product innovation dummy		0.223	0.024
Process innovation dummy		0.316	0.026
Organisational innovation dummy		0.065	0.016
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
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
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	0.064
Skilled employees	%	4.630	0.755
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		0.494	0.029
Owner general human capital	years of educ.	11.614	0.201
Owner age	years	43.290	0.710
Own or family capital financing (0= no his/her own or family, 1=his/her own or family, 2=his/her own and family)		0.912	0.016
Bank financing to start dummy		0.039	0.010
Subsidies to start dummy		0.043	0.010
Market extension (1=local, 2=national, 3=international)		1.424	0.040
Level of product processing (1= intermediate products, 2= final products)		1.603	0.703
Firm age	years	21.540	1.238
Dummy for firm founded by the previous generation		0.686	0.028
Employee involvement in firm management (0= no, 1=low, 2= medium, 3=high)		1.024	0.068
Dummy for employee training		0.312	0.027
Dummy for distance from Naples < 150 km		0.946	0.015
Dummy for district		0.287	0.026
Dummy for Ministry of Agriculture research lab in the municipality		0.053	0.016
Municipality density	1000 inh./ km^2	1201.972	60.259
Dummy for chemistry requirement		0.006	0.004
Dummy for physics requirement		0.014	0.008

Dummy for computer science skill requirement	0.005	0.003
Dummy for engineering requirement	0.076	0.014
Dummy for business requirement	0.092	0.015
Dummy for agricultural economics requirement	0.027	0.010
Dummy for science-based macro-sector	0.058	0.018
Dummy for scale-intensive macro-sector	0.116	0.018
Dummy for specialised supplier macro-sector	0.233	0.021
Dummy for supplier-dominated macro-sector	0.592	0.028
Food, drink and tobacco industries dummy	0.224	0.025
Textiles and leather industries dummy	0.120	0.016
Wood and metal products industries dummy	0.242	0.029
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	0.060	0.008
Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.033	0.006
Manufacturers of products based on non-metallic minerals dummy	0.078	0.012
Manufacturers of mechanical products dummy	0.243	0.027

Table 2. The Cox regression coefficients

Variables	Hazard ratio Model 1		Model 2	
Innovator	0.571	***		
Product innovation			0.615	**
Process innovation			0.549	***
Organisational innovation			0.323	*
Dummy for 10 ≤ workers < 20	1.254		1.256	
Dummy for 20 ≤ workers < 50	0.863		1.044	
Dummy for 50 ≤ workers < 100	1.051		1.051	
Dummy for≥100 workers	4.128	***	4.388	***
Owner general human capital	0.936	**	0.942	**
Owner age	1.010		1.010	
Market extension	1.177		1.176	
Bank financing to start	1.048		1.230	
Subsidies to start	0.920		0.919	
Firm founded by the previous generation	1.354		1.352	
Employee involvement in firm management	1.181	**	1.190	**
Employee training	0.502	***	0.538	**
Dummy for distance from Naples < 150 km	1.460		1.600	
Dummy for district	0.863		0.862	
Dummy for Ministry of Agriculture research labs in the municipality	1.257		1.591	
Municipality density	1.000		1.000	
Dummy for physics requirement	1.434		1.341	
Dummy for computer science skill requirement	0.253		0.235	
Dummy for engineering requirement	1.243		1.129	
Dummy for business requirement	1.079		1.032	
Dummy for agr. economics requirement	5.503	**	8.782	***
Dummy for science-based macro-sector	2.747	*	3.049	**
Dummy for scale-intensive macro-sector	1.285		1.321	
Dummy for specialised supplier macro-sector	0.970		0.978	
Food, drink and tobacco industries dummy	1.127		1.099	
Textiles and leather industries dummy	1.573		1.515	
Wood and metal products industries dummy	1.652	*	1.573	
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	1.942	*	1.878	*
Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	1.375		1.425	
Manufacturers of products based on non-metallic minerals dummy	1.773	*	1.816	*

*, **, *** stand for significant at 10%, 5% and 1%, respectively

Table 3. Correlation coefficients

rho21	0.050	
rho31	-0.079	
rho41	0.038	
rho32	0.177	
rho42	-0.526	***
rho43	-0.246	

*** stands for significant at 1%

Table 4. Marginal effects of the multivariate probit regression

Variables	dF/dx *Product innovation*	dF/dx *Process innovation*	dF/dx *Organisational innovation*	dF/dx *Survivor*
	dependent variable			
Product innovation dummy				0.179 ***
Process innovation dummy				0.307 ***
Organisational innovation dummy				0.131 *
University/research lab partnership dummy	0.782 ***	0.683 ***		
Consultants/commercial lab partnership dummy	0.791 ***	0.693 ***	0.937 ***	
Supplier of equipment and plants partnership dummy	0.812 ***	0.774 ***	0.022 ***	
Contractor partnership dummy	0.792 ***	0.689 ***	0.010	
Client partnership dummy	0.000 ***	0.000 ***	0.019 ***	
R&D intensity	0.003	0.046 ***	0.002	
Skilled employees	0.000	-0.001	0.001 ***	
Dummy for 10 ≤ workers < 20	0.004	0.202 ***	-0.004	-0.168 ***
Dummy for 20 ≤ workers < 50	0.046	0.203 ***	0.101 **	-0.168
Dummy for 50 ≤ workers < 100	0.031	0.039	-0.024 ***	-0.107
Dummy for≥100 workers	-0.101 ***	-0.208 ***	-0.058 ***	-0.497 ***
Dummy for company	0.004 *	-0.133 ***	0.002	
Owner general human capital	0.007	-0.004 **	0.001	0.014
Owner age	0.002 ***	0.002 *	0.000	-0.001 **
Level of product processing	0.037 **	-0.040 ***	-0.013 *	
Bank financing to start				-0.223 *
Subsidies to start				-0.136
Market extension				0.095
Firm age	0.001	0.000	-0.001 **	-0.003 **
Firm founded by the previous generation	-0.028	-0.085 ***	-0.015	-0.122 **
Employee involvement in firm management	-0.001 *	0.032 **	0.007 ***	-0.065 ***
Employee training	0.006 *	0.030 *	-0.014	0.224 ***
Dummy for distance from Naples < 150 km	-0.056	0.035 *	0.026 ***	-0.089
Dummy for district	0.055 ***	0.037	0.018 *	0.066
Dummy for Ministry of Agriculture research labs in the municipality	0.033	0.037 **	0.054 ***	-0.147
Municipality density	0.027 *	-0.053 ***	-0.018 ***	-0.019
Dummy for chemistry requirement				0.497 ***
Dummy for physics requirement				-0.059
Dummy for computer science skill requirement				0.060
Dummy for engineering requirement				-0.027
Dummy for business requirement				-0.029
Dummy for agr. economics requirement				-0.325 **
Dummy for science-based macro-sector	0.001	-0.094 **	0.034	-0.156 *
Dummy for scale-intensive macro-sector	-0.018	-0.013	-0.004	-0.022 **
Dummy for specialised supplier macro-sector	-0.002	0.033	0.001	-0.173
Food, drink and tobacco industries dummy	-0.048	-0.002	0.003	0.017
Textiles and leather industries dummy	-0.068 **	-0.042	-0.037 ***	-0.149
Wood and metal products industries dummy	-0.072 **	-0.072 **	0.002	-0.093
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	0.013	0.211 ***	-0.023 ***	-0.137
Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.006	0.156 ***	-0.013	-0.125
Manufacturers of products based on non-metallic minerals dummy	0.057	0.011	0.012	-0.126

*, **, *** stand for significant at 10%, 5% and 1%, respectively %

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Appendix

A1. Non-Parametric Analysis of the Survival Function

The multivariate regression analysis allows assessing the effect of each variable on the hazard rate of exiting after the effect of all the other covariates is controlled for. A common procedure in survival analysis (Cefis and Marsili 2006; Colombelli et al. 2016), is also to estimate the survival function S(*t*) using the Kaplan and Meier (1958) estimator. If the data were not censored, the obvious estimate would be the empirical survival, where the estimator is simply the proportion alive at time *t*. Kaplan and Meier extended the estimate to censored data in case of distinct ordered times of death. These researchers proposed a simple frequency non-parametric estimator, which makes no assumptions about the distribution of exit times or how covariates shift the hazard function. The Kaplan and Meier estimate of the survival function is a step function with discontinuities or jumps at the observed death times (Jenkins 2005).

We set out the sample considering the left truncated (delay entry, enter date 1999) and the origin data that correspond to the date of birth; moreover, we have correct censoring observations that do not complete the spell and others that complete the spell exit from the market; in other words, we have units for which the event of interest has not occurred at the time the data are analysed.

Figure A1 shows the non-parametric estimate of the survival function: 50% of firms survive less than 20 years, with only 12% remaining in operation over 60 years.

Figure A1. Kaplan-Meier survival estimate

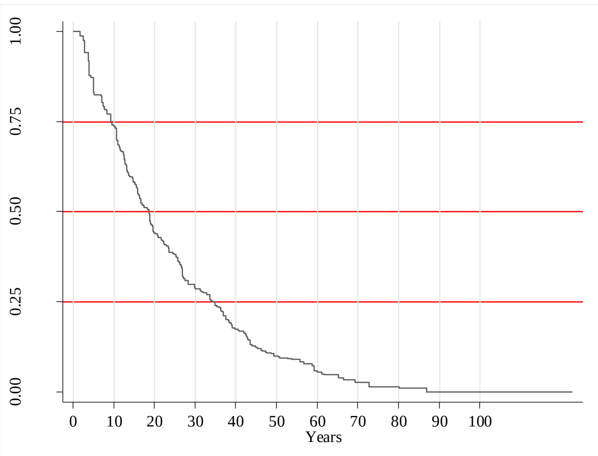
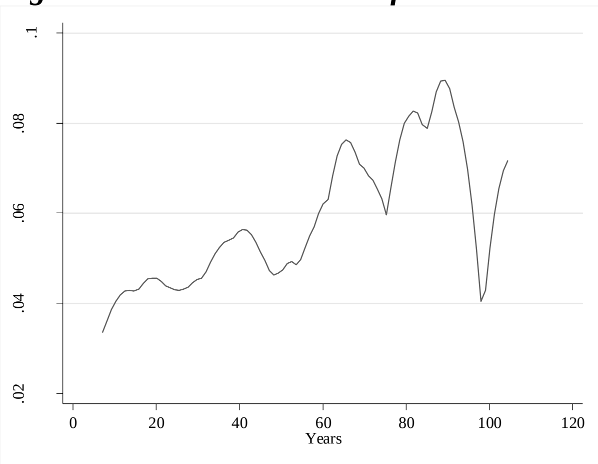


Figure A2 depicts the smoothed hazard rate that shows the evolution of a firm's failure risk. The hazard rate is defined as the probability that a firm exits the market in a moment *t* (conditional upon survival up to that time *t*). There is an increasing trend across age, with three peaks at 40, approximately 65 and over 90 years. The exit rate declines with firm age for intermediate durations (that is, negative duration dependence); this might be due to the presence of individual heterogeneity. The described pattern seems to confirm the evidence that the probability of exit is initially low for entrants, later increases to reach a peak and eventually decreases, then beyond a certain age the risk of firm exit increases with age.

Figure A2. Smoothed hazard function



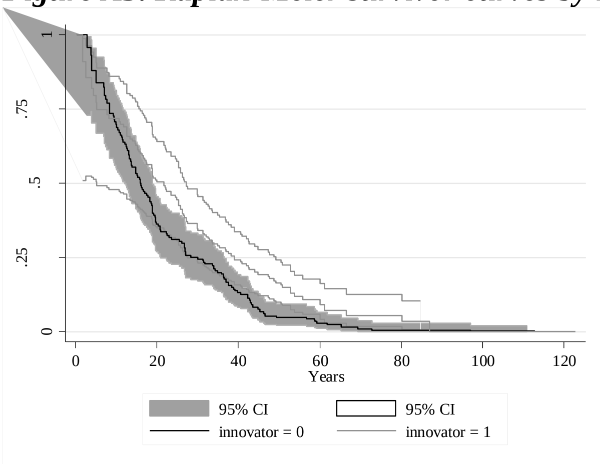
The two commonly used nonparametric tests for comparison of two survival distributions are the generalised Wilcoxon procedure (Breslow 1970; Gehan 1965) and the Log-rank test (Cox 1972; Mantel 1966). Both are based on the ranks of the observations (Lee and Go 1997). The Log-rank test derived proportional hazards and has been shown (Peto 1972) to be the locally most powerful rank-invariant test when there is a single parameter of interest and when censorship is equal. When the hazard ratio is not constant, the generalised Wilcoxon test can be more powerful than the Log-rank test.

The results of Table A1 suggest the existence of remarkable differences in the survival prospects among groups of firms for some variables of interest, such as owner general human capital, innovator and employee training. Thus, higher levels of owner general human capital, employee training and innovator firms endure significantly better survival chances than their counterparts at the 1% level of statistical significance.

The magnitude of these differences can be seen by comparing the last column of Table A1, which includes the median survival times by group obtained by the Kaplan-Meier product limit estimate method.

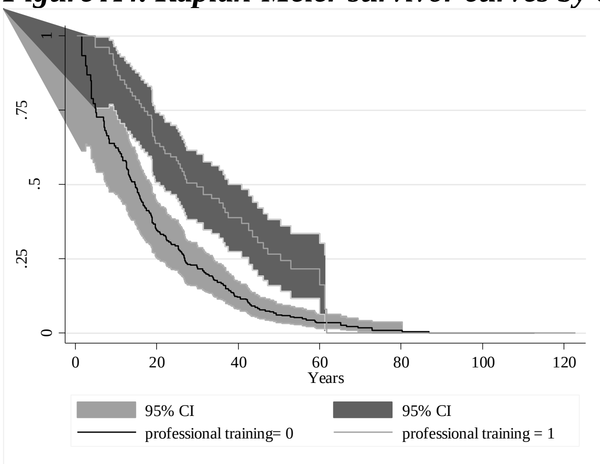
Figures A3-A5 present the Kaplan-Meier survivor curves for groups of firms. They give a brief idea that the presence of innovations, the employee training and a higher owner general human capital are more likely to influence a firm’s later survival.

Figure A3. Kaplan-Meier survivor curves by innovator



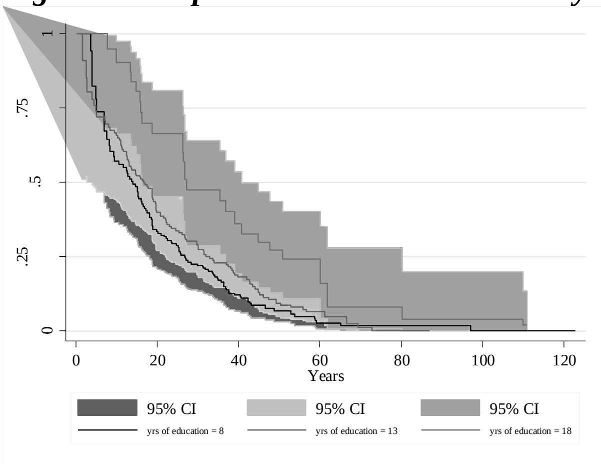
Log – rank 10.99***

Figure A4. Kaplan-Meier survivor curves by employee training



Log-rank test: 15.19***

Figure A5. Kaplan-Meier survivor curves by owner general human capital



Log-rank test: 8.3**

Table A1. Non-parametric tests of equality of survival functions and median duration by explanatory variables

Variables		**Long Rank test**		**Wilxocon test**		**Characteristics**	**Median**
Innovator	chi2(1)	10.99		10.28		Not	15.93
	Pr>chi2	*0.0009*	***	*0.0013*	***	Yes	21.64
Product innovation		4.4		4.21		Not	16.99
		0.036	**	*0.0401*	**	Yes	24.54
Process innovation		9.35		8.18		Not	17.46
		0.0022	***	*0.0042*	***	Yes	16.66
Organisational innovation		6.13		4.29		Not	17.46
		0.0133	**	*0.0382*	**	Yes	48.74
Dummy for workers <10		3		2.57		Not	26.3
		0.0831	*	*0.1087*		Yes	15.72
Dummy for 10 ≤ workers < 20		0.8		2.73		Not	16.6
		0.3709		*0.0983*	*	Yes	26.8
Dummy for 20 ≤ workers < 50		3.31		0.33		Not	17.46
		0.069		*0.5644*		Yes	19.79
Dummy for 50 ≤ workers < 100		0.15		0		Not	17.8
		0.7033		*0.9705*		Yes	16.28
Dummy for≥100 workers		3		0.42		Not	18.17
		0.0832	*	*0.5146*		Yes	26.51
Own capital to start		0.12		0.31		Not	19.65
		0.7241		*0.5767*		Yes	17.46
Family financing to start		0.53		0.84		Not	18.17
		0.4686		*0.3589*		Yes	58.67
Bank financing to start		1.66		1.92		Not	18.17
		0.1974		0.1653		Yes	18.8
Subsidies to start		0		0.01		Not	18.8
		0.9613		*0.9305*		Yes	1.67
Market extension		3.49		7.58		n.a.	13.8
		0.3217		*0.0556*	*	local	16.6
						national	19.15
						international	22.02
Firm founded by the previous generation		0.11		0.15		Not	18.17
		0.7444		*0.6991*		Yes	22.02
Employee involvement in firm management		0.95		2.03		No employment	13.51
		0.8134		*0.5654*		low	29.8
						medium	22.95
						high	19.65
Employee training		15.19		12.7		Not	14.71
		0.0001	***	*0.0004*	***	Yes	29.8
Owner general human capital		8.3		5.74		8	13.99
		0.0158	**	*0.0567*	*	13	16.66
Owner age		143.58		167.29		18	27.21
		0.0203		*0.0004*			

Firm age	105.48		92.72			
	0.0011		*0.0136*			
Dummy for distance from Naples< 150 kms	2.49		1.48		Not	27.27
	0.1146		*0.2235*		Yes	17.8
Dummy for district	0.07		0.19		Not	16.66
	0.7862		*0.6649*		Yes	19.72
Dummy for Ministry of Agriculture research labs in the municipality	3.9		3.62		Not	18.8
	0.0482	*	*0.057*	*	Yes	7.77
Municipality density	187.71		200.06			
	0		*0*	***		
Dummy for chemistry requirement	1.12		0.99		Not	17.8
	0.2902		*0.3187*		Yes	.
Dummy for physics requirement	0.7		0.54		Not	17.51
	0.4037		*0.4626*		Yes	19.65
Dummy for computer science requirement	0.31		0.03		Not	17.51
	0.5803		*0.8542*		Yes	.
Dummy for engeenering requirement	1.62		2.18		Not	16.95
	0.203		*0.14*		Yes	33.71
Dummy for businees requirement	0.49		0.46		Not	18.8
	0.4839		*0.4957*		Yes	7.77
Dummy for agr. economics requirement	1.68		1.41		Not	18.8
	0.1943		*0.2345*		Yes	3.75
Dummy for science-based macro-sector	0.32		0		Not	18.53
	0.5741		*0.9679*		Yes	2.81
Dummy for scale-intensive macro-sector	0.08		0.49		Not	18.8
	0.782		*0.4851*		Yes	12.55
Dummy for specialised supplier macro-sector	2.26		0.84		Not	16.25
	0.1329		*0.3608*		Yes	22.95
Dummy for traditional supplier macro-sector	1.4		1.77		Not	17.8
	0.2363		*0.183*		Yes	18.17
Food, drink and tobacco industries dummy	0.79		1.21		Not	17.51
	0.373		*0.2722*		Yes	22.26
Textiles and leather industries dummy	3.7		4.29		Not	17.8
	0.0545	*	*0.0382*	**	Yes	16.25
Wood and metal products industries dummy	0.84		0.83		Not	17.22
	0.3581		*0.3618*		Yes	22.5
Manufacturers of paper pulp, paper, cardboard and paper products; printing and publishing dummy	0.03		0.01		Not	18.76
	0.8532		*0.9222*		Yes	12.55
Manufacturers of chemical products and synthetic and artificial fibres and rubber dummy	0.94		1.69		Not	17.22
	0.3329		*0.1933*		Yes	26.8
Manufacturers of products based on non-metallic minerals dummy	0		0		Not	18.8
	0.9672		*0.9907*		Yes	1.67
Manufacturers of meccanical and other products dummy	1.54		0.96		Not	16.95
	0.2141		*0.3262*		Yes	18.96

P-values in italics, *, **, *** stand for significant at 10%, 5% and 1%, respectively