INSTITUTE
OF ECONOMICS

Scuola Superiore
Sant'Anna

LEM | Laboratory of Economics and Management

Institute of Economics
Scuola Superiore Sant'Anna

Piazza Martiri della Libertà, 33 - 56127 Pisa, Italy
ph. +39 050 88.33.43
institute.economics@sssup.it

LEM

WORKING PAPER SERIES

Good Times, Bad Times: Innovation and Survival over the Business Cycle

Elena Cefis °
Orietta Marsili *

° University of Bergamo, Italy and Institute of Economics, Scuola Superiore Sant'Anna, Pisa, Italy
* School of Management, University of Bath, UK

2018/02 January 2018
ISSN(ONLINE) 2284-0400

Good Times, Bad Times: Innovation and Survival over the Business Cycle

Elena Cefis
(University of Bergamo and L.E.M., Sant'Anna School of Advanced Studies, Italy)

Orietta Marsili
(School of Management, University of Bath, U.K.)

This version: December 2017

Abstract

High-potential new ventures are a source of economic growth, which policy makers call upon in times of crisis when entrepreneurship is seen as a remedy to economic downturn. Yet at these times new ventures face intensified selection, and survival hinges on heterogeneous capabilities. We examine how the innovative capabilities of new firms created in the Netherlands in 2001-2006, affected their survival likelihood before, during and after the 2007-2008 global financial crisis. We estimate a piecewise exponential model linking survival times, observed in the time period from 2001 to 2015, to longitudinal innovation data from the CIS. Our results show that new ventures innovating within two years from founding benefit of a long-term adaptive survival premium during and after the crisis. This premium and its duration over the stages of the crisis are contingent to the form of innovation: technological innovations entail a more effective and enduring premium, as compared to managerial innovations, which can be even detrimental for survival. Our study has implications for entrepreneurial management, by highlighting how the development of innovative capabilities at founding, lays the foundations for organisational adaptation and resilience in the longer term. Furthermore, our results can inform a policy approach that aims at sheltering from the storm of a financial crisis, those new ventures that do possess the specific and necessary adaptive capabilities, but that are also vulnerable because of the liabilities of newness and smallness. Such an approach could help to maintain alive the process of entrepreneurial experimentation during the crisis, and to boost economic recovery, without dispersing precious resources.

JEL CODE: L11; L25; D21; O32

Keywords: firm survival; environmental jolts; financial crisis; organisational adaptation; technological and non-technological innovation.

Acknowledgments:

The authors thank Alessandro Lucini-Paioni for valuable research assistance, and the participants at: *International ICC Conference: Beyond Technological Innovation and Diffusion.* Univeristy of Berkely, Berkeley, CA, U.S.A., December 11-14, 2016; and CONCORDì 2017 – 10 Years 2007-2017 Conference, *Innovation and Industrial Dynamics: challenges for the next decade*; JRC – European Commission and OECD, Seville, Spain, September 27-29, 2017. The empirical part of this research was carried out at Microdata – Centraal Bureau voor Statistiek (CBS), the Netherlands. The views expressed in this paper are those of the authors and do not necessarily reflect the policies of Statistics Netherlands. Elena Cefis acknowledges financial support from the University of Bergamo (grants ex 60%, n. 60CEFI15 and n. 60CEFI17, Dept. of Management, Economics, and Quantitative Methods).

1. Introduction

Unexpected and disruptive events such as the global financial crisis create an extreme and perilous environment for firms. These events, or environmental jolts, produce a variety of responses by firms, leading to the survival of some and not of others (Meyer, 1982). The scope for a response by firms is bound by their resources, at three levels (Agarwal *et al.*, 2009). First, organisations differ in the resources they directly control. The immediate effect of a financial crisis is to impose tighter liquidity and resource constraints, which lower survival (Clarke *et al.*, 2012). Second, organisations differ in resources they do not directly control, but can access by means of ownership relationships with other organisations. Environmental jolts alter the odds of survival of companies that differ in ownership structure and control: independent firms versus subsidiaries (Bradley *et al.*, 2011a), multinational versus local subsidiaries (Alfaro and Chen, 2012) and family-controlled versus non-family controlled firms (Lins *et al.*, 2013). Third, organisations differ in the ability to leverage and reconfigure resources, either internally or externally controlled, in the effort to adapt to changes in the environment, what has been labelled as adaptive capabilities (Augier and Teece, 2009). These represent a subset of dynamic capabilities (Augier and Teece, 2009) as they relate to the adaptive behaviour of firms in the face of external changes that are sudden and extreme (Grewal and Tansuhaj, 2001; Makkonen *et al.*, 2014).

Earlier studies on survival during environmental jolts illustrate the implications of firm-specific investment decisions and ownership structure (Bradley *et al.*, 2011a; Alfaro and Chen, 2012; Clarke *et al.*, 2012). Less is known about heterogeneous adaptive capabilities. Hence, we ask the question of which type of capabilities act as adaptive capabilities to an external shock, such as the global financial crisis. In particular, we focus on the innovative capabilities of new firms, because they are the most exposed to the clear and present danger of the crisis. Studies on firm survival predating the global financial crisis show that entrepreneurial firms are those that most benefit of an innovation premium for survival (Cefis and Marsili, 2006), which allow them to compensate for the liabilities of newness and smallness (Aldrich and Fiol, 1994). Building on this evidence, we are interested in whether innovation not only provides a survival premium in the good times, but also equip new firms of adaptive capabilities for the bad times. To answer this question, we draw on evolutionary economics (Nelson and Winter, 1982). We propose that new firms that innovate at the time of founding build distinctive and long-lasting adaptive capabilities, which increase their chances of survival to environmental jolts. We also argue that adaptive capabilities vary by type of innovation in a hierarchical order of criticality, comparing technological innovations, in products and processes, to managerial innovations, in organisational and marketing practices (Mol and Birkinshaw, 2009; Battisti and Stoneman, 2010; Ballot *et al.*, 2015).

We observe the survival likelihood over the time period from 2001 to 2015, for a sample of 2329 new firms created in the Netherlands from 2001 to 2006. For this sample, using data from the Community Innovation Survey (CIS), we examine how the innovative capabilities at the time of founding influence the likelihood of survival before, during and after the 2007-2008 financial crisis. We find that product innovation is a primary source of survival during and after the crisis; process innovation has a short-lived positive effect during the crisis; organisational innovation and marketing innovation are ancillary or even detrimental. We conclude that early capabilities in product innovation, more than other types of managerial innovations, are critical for building long-term resilience.

Our study contributes to the understanding of organisational adaptation in relation to the entrepreneurial process. We highlight how organisational adaptation is shaped by founding conditions, by the early ability of new firms to innovate, at a time in which the uncertainty of innovation is compounded with the uncertainty of new venturing. Our study responds to the call made by management scholars and economists to study the impact of the global financial crisis from a micro economic perspective, in contrast to the more diffuse macroeconomic approach (Agarwal *et al.*, 2009; Alfaro and Chen, 2012). Understanding the sources of organisational adaptation is important for firms who need to be prepared and overcome crises that diffuse rapidly in an interconnected and global world, and for policy makers who seek to find remedies to a global crisis (Agarwal *et al.*, 2009). This is critical for new firms, for two reasons. From a management perspective, new firms need to find rapid ways to adapt because of lack of internal slack resources, otherwise available to established firms as buffer to external scarcity (Bradley *et al.*, 2011b). From a policy perspective, new firms may need to be sheltered from a storm that undermines them too soon, before they can acquire legitimacy and the complementary assets necessary to commercialise their innovative ideas (Gans and Stern, 2003). Appreciating how to shelter in the storm can help to maintain alive entrepreneurial experimentation (Rosenberg, 1992; Kerr *et al.*, 2014), which policy makers call upon to boost economic growth and recovery in times of crisis (Stern, 2006; Audretsch *et al.*, 2007). Our results identify which innovative capabilities are crucial to build the necessary adaptive capabilities to overcome the crisis and to successful recover after the recession.

When resources at macro level are scarce, it can be useful to understand which firms have more probability to survive the environmental jolt and concentrate the resources on them instead of dispersing them among all.

2. Background and hypotheses

From an evolutionary perspective, organisational survival is the outcome of the processes of selection and learning in an environment characterised by limited carrying capacity and heterogeneous resources (Nelson and Winter, 1982; Barnett *et al.*, 1994). An asymmetric distribution of resources endowments will define the relative position of competing organisations along some dimension of economic performance (e.g. productivity, profitability) or fitness (Nelson and Winter, 1982). The positional advantage that derives from the control of heterogeneous resources will shield an organisation from the process of natural selection, enhancing its survival likelihood (Barnett *et al.*, 1994). In this respect, the resource-based view (RBV) of the firm highlights that in order to produce a sustained competitive (i.e. positional) advantage, and therefore survive in the longer term, firm resources need to be valuable, rare, imperfectly imitable, and not substitutable (Barney, 1991). While selection operates on existing asymmetries, over time the relative positions of individual firms along the distribution of productivity or fitness levels, change per effect of adaptation and learning (Nelson and Winter, 1982). Hence, survival likelihood is explained as the combined outcome of the intensity of market interactions, operating as a mechanism of natural selection, and the heterogeneous rates of firm learning (Dosi *et al.*, 1995)

Consistent with an evolutionary perspective, innovation influences firm survival, because innovative outcomes enhance the competitive position or fitness of firms (Banbury and Mitchell, 1995; Cefis and Marsili, 2005; Colombelli *et al.*, 2016), while, conversely, innovative investments may impose greater risks and uncertainty in outcomes (Buddelmeyer *et al.*, 2009; Fernandes and Paunov, 2015). There is evidence that having introduced an innovation enhances the probability of firm survival persistently over time, years after the innovation has taken place (Cefis and Marsili, 2006). Innovation is a valuable and appropriable resource that generates a sustained positional advantage for the firm in a competitive context (Barney, 1991). Innovation is also a capability, because firms learn how to recognise and exploit commercially novel opportunities and how to solve problems, as they engage in the process of introducing novel products, processes or practices (Nelson and Winter, 1982). This cumulatively built knowledge, which include skills, competences and practices is stored in routines (Nelson and Winter, 1982) and generates persistence in innovative capabilities and outcomes (Cefis, 2003). Such a learning process enhances organisation flexibility and adaptability to future changes either internally or externally to the firm. Hence, innovation as a resource and a capability, contributes to create both a positional advantage through selection, and an adaptive advantage through learning. While the overall import of innovation for survival is well established in the literature, little is known about these two distinctive mechanisms and sources of survival.

The financial crisis of 2007-2008 is an example of an environmental jolt and offers an experimental setting (Meyer, 1982) that can help disentangling the positional and adaptive components in the effect of innovation on firm survival. An example of this type of approach relaying on environmental jolts has been applied to study how the structure of ownership and control of resources influence firm survival. Specifically, the differentials in survival likelihood before, during and after an environmental jolt are considered as indicative of distinct positional and adaptive advantages, which originate in alternative structures of resources ownership (Bradley *et al.*, 2011a). The underlying argument is that organisations taken by surprise by an environmental jolt need to learn fast, and the conditions (e.g. the resources ownership structure) that enable the flexibility and adaptability necessary for survival during and after the shock, are different from the conditions sustaining a competitive advantage before the shock.

We extend this line of reasoning to innovation as a resource and a capability of the firm. We begin with the consideration, in line with the argument made by Bradley *et al.* (2011a: , that in the face of an environmental jolt adaptive capabilities become imperative and more important than positional advantages. Earlier studies based on evidence preceding the financial crisis (Cefis and Marsili, 2005), show that innovation enhances survival likelihood. On this basis, we assume that innovators benefit of a *positional premium for surviva*l in 'good times', under the ordered functioning of competitive forces and the selective pressure of a relatively predictable environment (before the occurrence of an environmental jolt). We then propose that innovators also benefit of an additional *adaptive premium for survival* for the 'bad times' to come, when the selective pressure unexpectedly intensifies and the environment suddenly becomes extreme (during and after an environmental jolt).

In order to isolate the above effect more clearly, we focus on the concept of innovative entrepreneurship, which can be defined as the intersection between the process of innovation and the process of organisational creation. Innovative entrepreneurship combines two sources of uncertainty, one associated with the partly random nature of the innovation process, which involves experimentation and learning by trials and errors (Nelson and Winter, 1982), and the other associated with the process of creating new organisations when resources need to be leveraged in presence of information asymmetries (Amit *et al.*, 1998) and lack of legitimacy (Aldrich and Fiol, 1994). These sources of uncertainty are mutually reinforcing in innovative new companies. The uncertainty and possible disagreement on the value of an innovative idea due to its novelty, can amplify the information asymmetries existing externally in the factors markets, between an entrepreneur and those who own or control resources, thus reinforcing uncertainty in the process of assembling the resources for setting up a new venture (Dew *et al.*, 2004). As a consequence, new companies seeking to innovate when they are born, experience unique and more precarious challenges in comparison to established companies innovating on a routine basis (Winter, 1984). The situation of uncertainty of on multiple levels that new innovative firms have been exposed to and handled at a critical stage of their lifecycle, may not be dissimilar to the uncertainty caused by an external shock. Because learning takes place in similarly uncertain settings, it is plausible to assume that the experience of true uncertainty in one situation helps building flexibility and adaptability to true uncertainty in another. On this basis, we assume that innovative capabilities, especially when developed early on in the organisation life cycle, create adaptive capabilities to future shocks. In other words, adaptive capabilities are most likely to be found in innovative new firms.

Furthermore, the benefits of adaptive capabilities in the face of an environmental jolt are possibly more substantial for new firms than for established firms. New firms are more likely to be in 'clear and present danger' at the onset of an environmental jolt, because of their liabilities of newness and smallness, whereas their longer-lived counterparts benefit from a position of legitimacy and more affluent resources bases (Aldrich and Fiol, 1994). At the very fundamental level, a financial crisis exacerbates the financial constraints new ventures experience for the most part, when compared to established companies less reliant on external funds (Cowling *et al.*, 2012).

For the above reasons, we chose to study cohorts of new companies created before the financial crisis, and compare the differentials in their survival likelihood, before, during and after the shock, in relation to whether they innovate or not at founding. In this setting, we thus expect to observe (i) that innovation at the time of founding helps new firms to survive after entry, and (ii) that starting an organisation with an innovation has a greater impact on survival during and after the financial crisis than it does for survival before the crisis. Because observed in correspondence of an environmental jolt, we interpret such a differential effect before, during and after the jolt, as the expression of an *adaptive survival premium*, which adds to an underlying *positional survival premium* of innovative capabilities at founding. In sum, we formulate the following hypotheses.

Hypothesis 1. Innovative capabilities at founding increase the survival likelihood of new firms, before, during and after an environmental jolt

Hypothesis 2. The effect of innovative capabilities at founding, is greater for the survival likelihood during and after an environmental jolt than for survival before the jolt.

Innovation takes place in different forms, and their impact on survival can differ, being more or less consequential. In the literature on firm survival, there has been a focus on the implications of product and process innovations and the underlying R&D investments. It has also been shown that companies with capabilities in both process innovation and product innovation benefit of an additional premium for survival because of possible complementarities between different forms of innovation (Cefis and Marsili, 2005). In addition to product and process innovations, also labelled as 'technological innovations' (Battisti and Stoneman, 2010), the field of innovation studies has increasingly dedicated attention to other forms of 'non-technological innovations' or managerial innovations (Mol and Birkinshaw, 2009). This in the attempt to gain a more comprehensive understanding of innovation in services as well as in manufacturing, together with a more refined and systematic measurement of innovation in its multiple dimensions (Wengel *et al.*, 2000). The category of non-technological or managerial innovations, includes changes in organisational and marketing practices. Non-technological innovations and technological innovations are interrelated, especially in sectors like services (Tether and Tajar, 2008). As a consequence, the introduction of organisational and marketing innovations by firms often occurs in combination and in support to product and process innovations, enabling the exploitation of synergies and complementarities of some type (Battisti and Stoneman, 2010), with positive outcomes on the overall innovative performance of firms (Schubert, 2010; Ballot *et al.*, 2015). Extending the evidence indicating that managerial innovations contribute to the overall innovative performance of firms, and the observation that product and process innovations both enhance survival, we assume that likewise managerial innovations positively influence survival.

Hypothesis 3. Innovative capabilities at founding, which lead to the introduction of innovations in either products, processes, organisation and marketing practices, increase the survival likelihood of new firms, before, during and after an environmental jolt.

Next, we consider whether the different nature of technological and non-technological innovations has a differential effect on survival likelihood. While it is recognised that technological and non-technological innovations are interrelated, the former is considered to have a more prominent role than the latter. Organisational and marketing innovations are viewed as less demanding or 'soft' because they involve relational rather than technological changes (Tether and Tajar, 2008). They play a role that is functional in support to the success and commercialisation of technological innovations (Schubert, 2010). Furthermore, the performance benefits of engaging in a variety of innovation forms at the same time may not be straightforward. For example, the pursuit of organisational innovation, simultaneously to product and process innovations, appears to reduce the benefits of the presence of complementarities between product and process innovation. Specifically, performing product and process innovations, without organisational innovation, is a better strategy than carrying out the three innovation forms concurrently (Ballot *et al.*, 2015). Thus, the benefits of performing more than one form of innovation can be outbalanced by the costs and complexity of introducing multiple forms of innovation. The net effect depends on contingency factors, such the characteristics of firms, in particular their size (Ballot *et al.*, 2015). Furthermore, when comparing the outcomes of all possible combinations of the three innovation forms (product, process and organisational), introducing only organisational innovation has the lowest effect on the economic performance of firms (Ballot *et al.*, 2015). Overall, earlier studies are indicative of the existence of a hierarchical order among innovation forms with managerial innovations having a role that is ancillary to technological innovations. Managerial innovations can support or complement product and process innovations, but appear to be somewhat less impactful on their own.

The hierarchical order in innovation forms may be even more stringent for new firms, which are typically small firms, and therefore lack of resources on the scale needed to deal with complex and diverse innovation projects (Nooteboom, 1994). It is also plausible to assume that in the face of an environmental jolt the adaptability of an organisation, its survival skills in an extreme environment, will ultimately depend on primary rather than ancillary capabilities. Given a ranking in innovation forms, technological rather than non-technological innovative capabilities will be the essential survival kit for new firms. Accordingly, we expect that while organisational and marketing innovative capabilities at founding increase the likelihood of new firm survival (Hypothesis 3), during and after an environmental jolt, such effect is smaller than what contributed by product and process innovations.

Hypothesis 4. The effect of innovative capabilities at founding on the survival likelihood of new firms, during and after an environmental jolt, is greater for product and process innovations as compared to organisational and marketing innovations.

Finally, we consider the possibility that the duration and not only the intensity of the effect of innovative capabilities at founding on the survival likelihood, differs by type of innovation. We focus on technological innovations, as primary sources of a premium for survival originating at the time of new firm creation (Hypothesis 4). We then assume that while firms may seek to revert to their capabilities to change processes in order to reduce costs and improve efficiencies, as immediate response the resources scarcity induced by an external shock, the benefits are short lived. For a full and durable recovery, firms may need to draw on their capabilities to introduce novel products, which differentiate them from competitors openly in the marketplace. Accordingly, we expect that product innovation capabilities at founding increase the survival likelihood, during and after an environmental jolt. Conversely, the benefits of process innovation capabilities at founding for the survival likelihood of new firms tend to concentrate during, but not after, an environmental jolt.

Hypothesis 5. The persistence of the effect of innovative capabilities at founding on the survival likelihood of new firms is greater for product than for process innovations.

3. Research Design

3.1 Data description and construction of the sample

In Europe, the period of economic crisis that started in 2007 took a course that has seen distinct stages of decline and partial recovery, through the global financial crisis and the Eurozone debt crisis. In order to analyse how the conditions for survival of new ventures changed across the different stages of this long period of economic crisis, we identify three different time segments in our data: (i) the pre-crisis period from 2001 to 2006, (ii) the global financial crisis in 2007-2010, (iii) the recovery period in 2011-2015. For the analysis, we employ a number of micro-datasets for Dutch companies, collected and managed by the Netherlands Central Statistics Office (CBS).

Sample. For the construction of our sample we started by identifying the population of new ventures over the period of interest from the General Business Register (or ABR according to the Dutch initials). The ABR includes all the companies that are registered for fiscal purposes in the Netherlands, and therefore offers a comprehensive list of the whole population of firms active in the country. For these firms, the ABR reports the date in month a firm is first included in the register and the dates in which a firm experiences critical events that change its ownership structure. In the ABR, these events are identified by type of change as births, deaths, acquisitions, disinvestments, restructuring, and mergers. When an event occurs, it is thus possible to know both its typology and the date. Using the date of firms' first inclusion in the register we were able to found a population of new ventures in 2001-2006.

Our purpose is to analyse how the innovative capabilities of new ventures created before the onset of the economic crisis, subsequently influenced the likelihood of survival during the crises and partial recoveries. For this reason, we select from the initial population the set of new ventures created in the pre-crisis period, 2001-2006, for which innovation data was available. This was possible by using the three waves of the Community Innovation Survey that were carried out over the period: the CIS 3.5, CIS 4 and CIS 2006. Because each CIS survey provides innovation data over the three years preceding the year of administration, we select the two most recent birth cohorts within the period covered by each survey. Accordingly, for the CIS 3.5 (covering data for 2000-2002) we choose the birth cohorts of 2001 and 2002, for the CIS 4 (2002-2004) the birth cohorts of 2003 and 2004, and for the CIS 2006 (2004-2006) the birth cohorts of 2005 and 2006. Because in the Netherlands the CIS was carried out every two years, instead of every four as in most EU countries, this time framework enables us to have innovation data that fully cover the time period of observation, from 2001 to 2006, and that are close to the year of start-up, either in the same or one year after start-up, for each birth cohort over such time period. In other words, our sample includes new ventures that could have been innovative from onset or could have become innovative within maximum two years from start-up.

Another consideration is that the CIS sample is a stratified random sample drawn from the ABR (from which our population of new ventures is selected) and constructed to include firms with at least 10 employees. Because of our focus on newly created firms, the matching with the CIS sample implies that only new ventures with at least 10 employees at the time of observation, are included in the final sample. Accordingly, our final sample is composed of newly created companies that have overcome the first hurdle for survival immediately after birth and have demonstrated high potential for future growth: we can qualify them as high-potential new ventures. This final sample consists of 2329 new firms divided by year as follows: 325 in 2001; 278 in 2002; 309 in 2003; 401 in 2004; 449 in 2005; and 667 in 2006.

3.2 Variables

Our dependent variable is the new venture's probability of exit the market conditional on their survival averaged across the entire period from the date of entry in the market (the first possible date is January 2001) to December 2015 on the basis of the yearly files of the ABR in 2001-2015. To compare the likelihood of exit of innovative new ventures as compared to non-innovative new ventures, we use a number of dummy variables that identify the introduction of new products (goods and services) and new processes. Innovation strategies are further distinguished in the introduction of organisational and marketing innovation. For each birth cohort selected in the period prior to the financial crisis (2001-2006) the innovation data are gathered from the wave of the CIS that is the closest to cover either the same year or the year immediately following the company entry (see previous paragraph for precise coupling). With this sequence of CIS waves and birth cohorts we are able to obtain innovation data that do not overlap over time, while fully covering the time period of interest.

We use the four types of innovation as introduced in the CIS questionnaire, which, in turns adopts the OSLO Manual definitions of product innovation, process innovation, organisational innovation and marketing innovation (OECD/Eurostat, 2005).

*"A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics." (OECD/Eurostat, 2005: 48)*

*"A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software." (OECD/Eurostat, 2005: 49)*

*"A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing." (OECD/Eurostat, 2005: 49)*

*"An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations." (OECD/Eurostat, 2005: 51)*

Boundaries between the types of innovation are sometimes blurred, for example there could be borderline cases between process innovation and organisational innovation and some innovations may include elements of both types. While both process and organisational innovations aim at lowering costs by increasing efficiencies, the former achieves this through the introduction of new equipment and techniques, the latter through new practices for organising people and work (OECD/Eurostat, 2005). Product innovation and marketing innovations share the purpose of increasing sales and market shares by better addressing existing customers' needs or opening up new markets. These two types can coexist when changing existing products, by means of product innovations that alter the functionality and use of the product, and by means of marketing innovations that significantly modify appearance, form or packaging (OECD/Eurostat, 2005). We can assume that these types are concurrent (as revealed by a certain covariance between the categories) to a certain degree, but at the same time we want to explore to what extent each of them offers a distinct survival premium.

A number of control variables are included in the model to account for inter-firm heterogeneity in the likelihood of failure, by using data from the ABR. As a determinant of post-entry survival, we measure firm size as the number of employees (transformed in logarithms because of skewness) in the year of new firm creation and also in the last year of existence in case of closure. We also account for differences between new firms that are created as independent entities and those that are subsidiaries of existing companies. Finally, we consider the variety of sectoral conditions that impact on new firm survival by introducing a set of dummies that group industries into eight categories, which includes firms in agriculture, mining, manufacturing, energy, water management, knowledge-intensive services, less knowledge intensive services, and other service. We exclude from the analysis the following sectors: construction, energy and public administration because they are respectively too pro-cycle, too heterogeneous, and not constituted by private firms.

Table 1 reports the exit and survival rates of the six cohorts of new ventures in our sample. At the end of our period of observation, only one third of the new ventures have survived: the average survival rate across birth cohorts is about 33%, with a minimum of about 27% for the 2002 cohort and a maximum of about 39% for the 2006 cohort. When considering the exit rates per year, the values observed per each birth cohort (Table 2) as well as the averages calculated across birth cohorts (Figure 1) confirm that new venture mortality picked during the global financial crisis, with the average exit raising to 15.6% in 2008 and reaching 20.7% in 2010.

-- Insert Tables 1 and 2, and Figure 1 about here --

3.3 Methodology

In order to test our hypothesis, we implemented a piece-wise exponential hazard model because we recognize that the "macro" (or systemic) conditions for operating in the market have been significantly different across periods that lies in our observation period 2001 – 2015. The financial crisis of 2007-2010 is an example of an environmental jolt and offers an experimental setting that can help disentangling the positional and adaptive components in the effect of innovation on firm survival.

These differences in the conditions underlying the survival of firms are taken into consideration when modelling firms' survival by assuming that the baseline hazard rate differs across the time periods, while it is held constant within each time period (Jenkins, 2005).

Following Rodríguez (2005), let's consider a proportional hazard model of the form

$$\lambda_i(t|\mathbf{x}_i) = \lambda_0(t)exp\{\mathbf{x}_\mathbf{i}'\boldsymbol{\beta}\}$$

imposing mild assumptions on the baseline hazard $\lambda_0(t)$.

Consider partitioning the observation period into j intervals, specifying the cut-points as follows: i) pre-crisis period 2001-06; ii) global financial crisis 2007-10; iii) recovering period 2011-15. We define the $j-th$ interval as $[\tau_{j-1}, \tau_j)$, where τ is the time indicator. Our *j-th* intervals extend: i) from January 2001 to December 2006; ii) from January 2007 to December 2010; iii) from January 2011 to December 2015 and our τ the time indicator varies between 1 and 3.

It can be assumed that the baseline hazard is constant within each interval, so that

$\lambda_0(t) = \lambda_j \; for \; t \in [\tau_{j-1}, \tau_j)$.

We can therefore model the baseline hazard using j parameters $\lambda_1, \dots, \lambda_j$. Each parameter represents the risk of the reference group inside a particular time period (Rodrıguez, 2005). We have chosen the *j-th* periods observing the average exit rates reported in Fig.1a, that shows clearly where the exit rates, and, consequently, the hazard rate changes.

Let us now consider the proportional hazard model previously defined and assume that the baseline hazard is constant in each interval (piece-wise constant). We can rewrite the model as

$$\lambda_{ij} = \lambda_j \; exp\{x_i'\beta\}$$

where λ_{ij} is the hazard of subject *i* in the time period j, and λ_j is the baseline hazard of such time period and $exp\{x_i'\beta\}$ is the relative risk for the subject *i*, at any given time, compared to the baseline and given the covariates' values x_i'.

Taking the logs, it yields the additive log-linear model

$$log\lambda_{ij} = a_j + x_i'\beta$$

where $a_j = log\lambda_j$. This is the standard log-linear model where the time periods are considered as regressors. In our case a_j is equal to "Time-period 1 (tp1)" for the pre-crisis period, "Time-period 2 (tp2)" for the crisis period, and "Time-period 3 (tp3)" for the recovery period.

We have extended this model to include time-varying covariates and time-dependent effects resulting in different model specifications, namely from model (1) in Table 3 to model (14) in Table 4.

4. Results

4.1 Univariate Analysis

Figure 2 reports the survival functions for each cohort separately, estimated using the Kaplan-Meier estimator. The K-M is a non-parametric estimator of the survival function also known as the product-limit estimator and takes into account right-censored observations as in our case.

-- Insert Figure 2 about here --

Figure 2 reports the estimated survival function where the survival unit is the year and the *x*-axis reports the number of years (the first two digits) and the months (the last two digits) of survival. The plots appear as step-functions with discontinuities, with drops when failures are observed. In all the plots, it is quite evident the drop that correspond to the first international financial crisis, while the second crisis is a bit less evident. Regardless of the cohort, the survival functions show that after 10 – 15 years (depending of the cohort we consider) and two severe crises, the survived firms represent approximately the 25% - 30% of the starting cohort, and after 10 years the probability of surviving seems to stabilize around that level. In other words, 1 out of 3 (in cohorts more resilient) or 4 (in the others) of our high-potential new ventures survive after 10 years. Usually economic and policy institutions at different level identify these firms as an important driver for economic growth especially during recession times. Consequently, it could be useful to be able to understand what are those with higher probability to survive the environmental jolts.

4.2 Multivariate analysis

Table 3 and 4 report the coefficients of the piece-wise exponential hazard models estimated over the period from 2001 to 2015. We start with a comparison of the coefficients of the time dummies that identifies the three time periods of interest in our survival analysis: before, during and after the 2007-2008 crisis, which we assume to represent an environmental jolt. These coefficients allow to estimate the baseline hazard rate for each time period, assuming the other covariates are all simultaneously zero and that the exponential transformation is considered.

The estimates of the effects of the time periods on the hazard rate or (conditional) failure rate[1] are consistent throughout the 14 models specifications in significance, sign and magnitude. We can notice that the pre-crisis period has a baseline hazard rate equal to 4 % on average (through all the 14 models). Vice versa, in the crises period the baseline hazard rate increases to 13%, while the recovery period sees a reduction of the hazard rate to 6%, larger than the crisis period but higher than the pre-crisis period. The significance level of those coefficients is particular high and always consistent with a $p<0.01$. These results show that the different time-periods have different effects on firms' exit rate and therefore on their survival, and that the variations across time periods are consistent with the definition of an environmental jolt. The survival chances are most favourable before the jolt, they worsen remarkably during the jolt, and partially recover after the jolt, without nevertheless returning to the pre-jolt values. This pattern thus confirms our basis assumption that the 2007-2008 crisis has been actually an environmental jolt that firms had to face in order to survive.

Our first interest is in establishing the influence on the survival likelihood of particular kinds of innovative capabilities, those that new firms demonstrate at the time of founding (*Hypothesis 1*). Within this overall category, we also distinguish innovative capabilities by the form of innovation (*Hypothesis 3*). Table 3 reports the estimates for various specifications of the model. In all of them, the independent variables are not interacted with the time regressors. This formulation implies that the effects of the independent variables are averaged across the three time periods: before, during and after the crisis.

-- Insert Table 3 about here --

The estimates of the innovation dummy in Models (1) and (2) in Table 3 indicate that innovative new ventures created before the financial crisis experienced lower mortality rates than non-innovative new ventures, on average across the three time periods. We therefore find support for *Hypothesis 1*. Innovative capabilities at founding have a positive and long-lasting effect on the survival likelihood of firms, years after they have been created. The survival time ranges from a minimum value of one year after funding, to 14 years after founding (for a firm created in 2001 and surviving until 2015).

[1] The hazard rate is also called a "(conditional) failure rate" since the denominator (i.e., the population survivors) converts the expression into a conditional rate, given survival past time: $h(t)= f(t) / 1-F(t)$ where $1-F(t)$ is the population survivors. We will refer to the hazard rate in the text also as exit rate (instead of failure rate) to highlight that we do observe firms' exits of the markets that do not always coincide with firms' failure.

Models (3) and (4) include each type of technological innovations separately. In these model formulations, the effect is slightly higher for product innovation (with a coefficient of -0.181 and $p < 0.01$) than for process innovation (with a coefficient of -0.143 and $p<0.01$). When considering both types of innovation within the same model formulation (Model 5), it appears that the effect is largely driven by the influence of product innovation: the coefficient of product innovation is equal to -0.148 with $p<0.05$, while the coefficient of process innovation is not anymore significant. Thus, for technological innovations, we find that the capability to introduce new products at founding has a more prominent role for reducing new venture mortality over time, than the capability to introduce process innovation at founding.

We then evaluate the role of managerial innovations by adding organisational innovation in Model 6 and marketing innovation in Model (7). Specifically, in the most comprehensive formulation of Model (7), with all four types of innovation, the estimated coefficients reveal the strongest effect for product innovation (- 0.180 with $p < 0.05$), and not statistically significant effects for process and organisational innovations. Somewhat surprisingly the effect of marketing innovation is to increase the mortality rates of new ventures although with a coefficient (equal to 0.148) which is only marginally statistically significant ($p < 0.10$).

Overall the results only partly support *Hypothesis 2*. While they confirm that capabilities in product innovation at founding increase the survival likelihood of new firms over time, consistent with *Hypothesis 2*, other forms of innovative capabilities, in processes and organisational practices, do not significantly alter the chances of survival, on average over time. Contrary to our hypothesis, marketing innovation at founding appears to lower survival.

The previous results refer to the average effects of the explanatory across the three time periods of interest. The distinct time periods have an effect on the intercept of the model by differentiating the baseline hazard rate, but do not affect the coefficients of the explanatory variables. The next step is to allow those coefficients to vary with time periods, in order to assess how the financial crisis impacts on the relationship between survival and innovative capabilities. The aim is to establish whether there is a differential response of the survival likelihood to innovative capabilities at founding (in the first or in the second year of a firm's life), when survival is observed at different time periods: before, during and after the shock. For this purpose, Table 4 reports the estimates of the model which includes the interaction terms between the innovation variables and the dychotomic variables corresponding to the three time periods, in various formulations.

-- Insert Table 4 about here --

Model (8) shows the impact of being an innovator at founding, independent of the type of innovation, when the effect is differentiated over the three period. Here we observe that the coefficient of the interaction term between the *Innovator* variable and the time period is negative and most statistically significant during the shock (time period 2), it is positive and less statistically significant before the shock (time period 1), and is not statistically significant after the shock (time period 3). These results indicate that the most beneficial effect of innovation at founding is experienced for survival during the environmental jolt (consistent with *Hypothesis 2*), although the effect is relatively short lived and fades away in the recovery stage. Surprisingly innovation at founding increases the hazard rate before the jolt. A possible explanation is that the time period before the jolt is the closest to the time of creation of the firms, and that innovations pose risks for newly created firms. Hence, the adaptive survival premium comes to play for those firms that have overcome such initial risk.

In order to better qualify the previous result, in which the coefficient of the *Innovator* variable reflects the aggregate effect of different types of innovation, we distinguish the model formulation by type of innovation (Models 9 to 14). For technological innovations, we find that innovation at founding especially lowers the hazard rate during the crisis, for both products (-0.282) in Model (9), and processes (-0.359) in Model (11), with no statistically significant effects on the other time periods. For organisational innovation, in Model (12), we observe again that this type of innovation lowers the hazard rates during the crisis (-0.208) but increases the hazard rates before the crisis (0.345). Finally, for marketing innovation, in Model (13), we find a positive significant effect on exit rates (0.235) before the crisis. Overall, these results suggest that the adaptive survival premium observed during the crisis originates from innovations at founding in product, process, and organisation. In contrast, the enhanced risk of exit observed before the crisis, and at an early stage of a firm’s life cycle, is attributable to the effects of managerial innovations at founding, in organisation and to a lesser extent in marketing. In sum, these results support *Hypothesis 4*: innovative capabilities at founding in product and process innovation appear to play a more prominent role in enhancing the likelihood of survival, than capabilities in managerial innovations, especially in the period during the environmental jolt (while none of the innovation forms has statistically significant effect on survival after the jolt).

The above pattern remains broadly consistent when all the innovation forms are simultaneously included, and interacted with the time regressors, in the complete Model (14). This formulation, which accounts for the fact that firms may introduce multiple forms of innovation at once, brings to light more clearly how the effects vary over time, during the crisis and in the recovery stage. What is most interesting is the change in the significance of the effects during the recovery period for product and process innovations. Product innovation at founding has the longest lasting effect in reducing the exit rate, starting during the crisis (-0.182) and extending even more noticeably in the recovery period (-0.323). In contrast, process innovation lowers the hazard rate even more effectively than product innovation during the crisis (-0.271), but the effect is short-lived. In fact, process innovation has now the effect of increasing the hazard rate in the stage of recovery (0.282). The estimates of the complete model (14) reinforce support for *Hypothesis 4*, as discussed in the earlier analysis of the separate models. They also offer support for *Hypothesis 5*, of a more persistent adaptive survival premium from product innovation than process innovation.

As for the control variables, we observe a negative and statistically significant coefficient (with $p < 0.01$) across all the model specifications (Table 3 and 4) of firms' size at the moment of the exit (or of the censoring), regardless the entry size that is always not significant. On the one side, this confirms the well-known fact that exit rates of new ventures decline with company size. On the other side, this emphasise that firms' growth is what really matters in the end in order to reduce firms' exit rate also during distress times (Coad *et al.*, 2013)). Instead, somewhat surprisingly, new ventures that are subsidiaries of established companies at the moment of the exit (or of the censoring) display exit rates that are higher than independent new ventures: the estimated coefficient is positive, statistically significant (with $p < 0.01$) with a magnitude constant (around 0.834) across all the versions of the model. A possible explanation is that in times of crisis entrepreneurs are more resilient and continue to stay in business even when profitability would suggest the contrary. Entrepreneurs may have stronger personal attachment to the company and lack of alternative opportunities, and therefore they are willing to accept a lower threshold of performance before taking the decision to close the business (Gimeno *et al.*, 1997). In contrast, the exit costs for a subsidiary of an established firm are lower and closure may represent the most immediate response of the parent firm to the shock.

5. Conclusion and Discussion

The results of our study show that the introduction of innovative products early in the life cycle of new firms drives their survival in times of crisis. Other forms of innovations have a more differentiated effect. While process innovation provides an advantage during distress times, the introduction of more far reaching innovations that involve organisational practices, may be less effective, or as in the case of marketing innovations, can be even detrimental for survival. Besides, process innovations (efficiency rather than experimentation) insure against closure in the short run (during distress time), but in the long run (during the recovery period) does not help the firm to survive. Among all innovation forms at the time of founding, only the introduction of product innovations reduces the exit rate in the long run. Hence, new firms innovating in products benefit of a unique and long-lasting survival premium.

Our first conclusion is that innovative capabilities at founding can act as adaptive capabilities. Innovative capabilities that emerge early in the life cycle of firms equip them with a survival premium when they need to deal with sudden changes in the environment, years later. Innovative capabilities at founding increase resilience both in the face of an environmental jolt, and during recovery. By highlight how founding conditions imprint organisational adaption to (future) changes in the environment, our results confirm and qualify the role of founding conditions for the survival of new firms (Geroski *et al.*, 2010). We show that the specific conditions in which new firms are created, in good times, continue to shape later on, in bad times, those heterogeneous resources and capabilities they draw upon to respond to an external shock like the financial crisis (Agarwal *et al.*, 2009).

Second, we suggest that not all innovative capabilities are adaptive capabilities, but this depends on the form of innovation. In fact, early capabilities in marketing innovation are associated with greater risks of failure during an environmental jolt. Other forms, such as organisational innovations appear to be too risky for newly created firms; only once new firms have overcome their first few years of activity, capabilities in organisational innovation can help them to be more resilient and adapt to sudden changes in the environment. This variety of patterns across innovation forms as sources of adaptation and resilience, is consistent with the notion that the performance effects of managerial innovations may not be as strong and direct as those of product and process innovation (Ballot *et al.*, 2015).

Finally, our results indicate that adaptive capabilities have different persistence and reach. Adaptive capabilities, generated by technological innovations, differ in the way their impact prolongs over time, depending on whether they involve product or process innovation. Product innovation is associated with adaptive capabilities which persist and even strengthen during and after the environment jolt. Process innovation has a more short-lived impact increasing the ability of firms to adapt and survive during an environmental jolt, but at the same time increasing the risk of exit after the jolt. This contrasting pattern confirms and qualifies the role of entrepreneurial experimentation for economic growth and prosperity (Stern, 2006). It proves that recovery from a shock, such as the financial crisis, depends on the resilience of entrepreneurial firms, which early in life develop capabilities in product innovations focusing on experimentation. Relying on efficiency and cost-saving improvements can help new and young firms to survive the onset of a financial crisis, but puts them in danger in the longer term.

Our study focuses on a specific type of adaptive capabilities, which are the innovative capabilities of new firms in the first or second year of life. Accordingly, it shows how organisational adaptation is shaped by capabilities imprinted early in a firm's life cycle. However, given initial capabilities, firms respond to a situation of crisis by changing their innovation strategies and behaviour over time. In the face of the financial crisis, firms have altered their investment decisions in R&D (Amore, 2015), and in innovative activities more broadly defined, with some firms investing less and others more in response to the crisis (Archibugi *et al.*, 2013). Taking this into account, our study could be extended by incorporating changes in adaptive capabilities, which originate from the innovative investments and activities company undertake in response to an environmental jolt.

From a policy perspective, the most worrying threat of a financial crisis is to halt that process of entrepreneurial experimentation which is seen as essential to promote economic growth and to boost the system out of a recession (Audretsch *et al.*, 2007). As earlier studies reveal, the global financial crisis has caused firms to shrink their overall investments in innovation (Archibugi *et al.*, 2013), to stop ongoing innovation projects (Paunov, 2012), and to revise their plans for technology spending (Campello *et al.*, 2010). Our results are important in the light of this evidence and policy concerns. Policy interventions aimed at actively encouraging corporate investments in innovation, as a way to sustain entrepreneurial experimentation, are costly and uncertain in outcomes. Our results point out that firms with innovative capabilities at start are able to navigate the crisis more successfully, and to compete persistently in the phase of recovery, and this outcome is independent of their investment decisions during and after the crisis. Furthermore, our results identify the type of innovative capabilities that are most effective for building the adaptive capabilities necessary to overcome and pull out of the crisis. Yet, new ventures that do have these necessary adaptive capabilities are also fragile in the face of a financial crisis, because of the liabilities of newness and smallness, which undermine survival in the aftermath of a sudden and disruptive shock. A policy approach that shelters these firms from the storm of a financial crisis, could help to maintain alive the process of entrepreneurial experimentation during the crisis, and to boost economic recovery, without dispersing precious resources.

References

Agarwal, R., J. B. Barney, N. J. Foss and P. G. Klein (2009), 'Heterogeneous resources and the financial crisis: implications of strategic management theory', *Strategic Organization*, **7** (4): 467-484.

Aldrich, H. and C. Fiol (1994), 'Fools rush in? The institutional context of industry creation', *Academy of management review*, **19** (4): 645-670.

Alfaro, L. and M. X. Chen (2012), 'Surviving the global financial crisis: foreign ownership and establishment performance', *American Economic Journal: Economic Policy*, **4** (3): 30-55.

Amit, R., J. Brander and C. Zott (1998), 'Why do venture capital firms exist? theory and canadian evidence', *Journal of Business Venturing*, **13** (6): 441-466.

Amore, M. (2015), 'Companies learning to innovate in recessions', *Research Policy*, **44** (8): 1574-1583.

Archibugi, D., A. Filippetti and F.-M. Policy (2013), 'Economic crisis and innovation: Is destruction prevailing over accumulation?', *Research Policy*, **42**: 303-314.

Audretsch, D. B., I. Grilo and A. R. Thurik (2007), 'Explaining entrepreneurship and the role of policy: a framework', *Edward Elgar Publishing*: 1-17.

Augier, M. and D. J. Teece (2009), 'Dynamic Capabilities and the Role of Managers in Business Strategy and Economic Performance', *Organization Science*, **20** (2): 410-421.

Ballot, G., F. Fakhfakh, F. Galia and A. Salter (2015), 'The fateful triangle: Complementarities in performance between product, process and organizational innovation in France and the UK', *Research Policy*, **44** (1): 217-232.

Banbury, C. M. and W. Mitchell (1995), 'The effect of introducing important incremental innovations on market share and business survival', *Strategic Management Journal*, **16** (S1): 161-182.

Barnett, W. P., H. R. Greve and D. Y. Park (1994), 'An Evolutionary Model of Organizational Performance', *Strategic Management Journal*, **15** (S1): 11-28.

Barney, J. (1991), 'Firm resources and sustained competitive advantage', *Journal of Management*, **17** (1): 99-120.

Battisti, G. and P. Stoneman (2010), 'How Innovative are UK Firms? Evidence from the Fourth UK Community Innovation Survey on Synergies between Technological and Organizational Innovations', *British Journal of Management*, **21** (1): 187-206.

Bradley, S. W., H. Aldrich, D. A. Shepherd and J. Wiklund (2011a), 'Resources, environmental change, and survival: asymmetric paths of young independent and subsidiary organizations', *Strategic Management Journal*, **32** (5): 486-509.

Bradley, S. W., D. A. Shepherd and J. Wiklund (2011b), 'The Importance of Slack for New Organizations Facing ‘Tough’ Environments', *Journal of Management Studies*, **48** (5): 1071-1097.

Buddelmeyer, H., P. H. Jensen and E. Webster (2009), 'Innovation and the determinants of company survival', *Oxford Economic Papers*, **62** (2): 261-285.

Campello, M., J. R. Graham and C. R. Harvey (2010), 'The real effects of financial constraints: Evidence from a financial crisis', *Journal of financial Economics*, **97** (3): 470-487.

Cefis, E. (2003), 'Is there persistence in innovative activities?', *International Journal of Industrial Organization*, **21** (4): 489-515.

Cefis, E. and O. Marsili (2005), 'A matter of life and death: innovation and firm survival', *Industrial and Corporate Change*, **14** (6): 1167-1192.

Cefis, E. and O. Marsili (2006), 'Survivor: The role of innovation in firms’ survival', *Research Policy*, **35** (5): 626-641.

Clarke, G., R. Cull and G. Kisunko (2012), 'External finance and firm survival in the aftermath of the crisis: Evidence from Eastern Europe and Central Asia', *Journal of Comparative Economics*, **40** (3): 372-392.

Coad, A., J. Frankish, R. G. Roberts and D. J. Storey (2013), 'Growth paths and survival chances: An application of Gambler's Ruin theory', *Journal of Business Venturing*, **28** (5): 615-632.

Colombelli, A., J. Krafft and M. Vivarelli (2016), 'To be born is not enough: the key role of innovative start-ups', *Small Business Economics*, **47** (2): 277-291.

Cowling, M., W. Liu and A. Ledger (2012), 'Small business financing in the UK before and during the current financial crisis', *International Small Business Journal*, **30** (7): 778-800.

Dew, N., S. R. Velamuri and S. Venkataraman (2004), 'Dispersed knowledge and an entrepreneurial theory of the firm', *Journal of Business Venturing*, **19** (5): 659-679.

Dosi, G., O. Marsili, L. Orsenigo and R. Salvatore (1995), 'Learning, market selection and the evolution of industrial structures', *Small Business Economics*, **7** (6): 411-436.

Fernandes, A. M. and C. Paunov (2015), 'The Risks of Innovation: Are Innovating Firms Less Likely to Die?', *Review of Economics and Statistics*, **97** (3): 638-653.

Gans, J. S. and S. Stern (2003), 'The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs', *Research Policy*, **32** (2): 333-350.

Geroski, P. A., J. Mata and P. Portugal (2010), 'Founding conditions and the survival of new firms', *Strategic Management Journal*, **31** (5): 510-529.

Gimeno, J., T. B. Folta, A. C. Cooper and C. Y. Woo (1997), 'Survival of the Fittest? Entrepreneurial Human Capital and the Persistence of Underperforming Firms', *Administrative Science Quarterly*, **42** (4): 750.

Grewal, R. and P. Tansuhaj (2001), 'Building organizational capabilities for managing economic crisis: The role of market orientation and strategic flexibility', *Journal of marketing*, **65** (April): 67-80.

Jenkins, S. P. (2005), 'Survival analysis', *Unpublished manuscript, Institute for Social and Economic Research, University of Essex, Colchester, UK*.

Kerr, W. R., R. Nanda and M. Rhodes-Kropf (2014), 'Entrepreneurship as Experimentation', *Journal of Economic Perspectives*, **28** (3): 25-48.

Lins, K. V., P. Volpin and H. F. Wagner (2013), 'Does Family Control Matter? International Evidence from the 2008–2009 Financial Crisis', *Review of Financial Studies*, **26** (10): 2583-2619.

Makkonen, H., M. Pohjola, R. Olkkonen and A. Koponen (2014), 'Dynamic capabilities and firm performance in a financial crisis', *Journal of Business Research*, **67** (1): 2707-2719.

Meyer, A. D. (1982), 'Adapting to environmental jolts', *Administrative Science Quarterly*, **27**: 515-537.

Mol, M. J. and J. Birkinshaw (2009), 'The sources of management innovation: When firms introduce new management practices', *Journal of Business Research*, **62** (12): 1269-1280.

Nelson, R. R. and S. G. Winter (1982), *An evolutionary theory of economic change*: Harvard university press.

Nooteboom, B. (1994), 'Innovation and diffusion in small firms: theory and evidence', *Small Business Economics*, **6** (5): 327-347.

OECD/Eurostat (2005), *Oslo Manual*: OECD Publishing.

Paunov, C. (2012), 'The global crisis and firms' investments in innovation', *Research Policy*, **41**: 24-35.

Rodrıguez, G. (2005), 'Non-parametric estimation in survival models', *WP*, Princenton University.

Rosenberg, N. (1992), 'Economic experiments', *Industrial and Corporate Change*, **1** (1): 181-203.

Schubert, T. (2010), 'Marketing and Organisational Innovations in Entrepreneurial Innovation Processes and their Relation to Market Structure and Firm Characteristics', *Review of Industrial Organization*, **36** (2): 189-212.

Stern, S. (2006), 'Economic experiments: The role of entrepreneurship in economic prosperity', *Melbourne Review: A Journal of Business and Public Policy*, **2** (2): 53.

Tether, B. S. and A. Tajar (2008), 'The organisational-cooperation mode of innovation and its prominence amongst European service firms', *Research Policy*, **37** (4): 720-739.

Wengel, J., G. Lay, A. Nylund, L. Bager-Sjögren, P. Stoneman, N. Bellini, A. Bonaccorsi and P. Shapira (2000), 'Analysis of empirical surveys on organisational innovation and lessons for future community innovation surveys', *Scientific Follow-up of the Community Innovation Survey (CIS) Project CIS*, **98** (191): 483.

Winter, S. G. (1984), 'Schumpeterian competition in alternative technological regimes', *Journal of Economic Behavior & Organization*, **5** (3-4): 287-320.

Table 1: Number of new ventures, exits, survived firms and relatively rates by Cohorts

Cohort year	Cohorts - N	Exit - N	Exit rate	Survival - N	Survival rate
2001	325	224	68.92%	101	31.08%
2002	278	205	73.74%	73	26.26%
2003	309	201	65.05%	108	34.95%
2004	301	187	62.13%	114	37.87%
2005	449	303	67.48%	146	32.52%
2006	667	431	64.62%	236	35.38%
	2329	1551	66.60%	778	33.40%

Table 2: Exit rates each year of observation by cohorts

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cohort 01	0.00%	0.89%	10.48%	8.36%	9.12%	7.63%	14.35%	9.14%	18.99%	5.52%	5.11%	6.15%	6.56%	7.02%
Cohort 02		0.00%	7.27%	10.45%	13.33%	6.73%	10.31%	12.07%	25.49%	7.89%	10.48%	7.45%	3.45%	5.95%
Cohort 03			0.00%	0.00%	30.06%	8.33%	14.35%	7.26%	24.10%	11.11%	3.57%	6.48%	6.93%	4.26%
Cohort 04				1.28%	12.66%	8.92%	13.06%	8.92%	18.56%	6.33%	8.11%	5.88%	1.56%	4.76%
Cohort 05					0.00%	0.22%	19.42%	10.25%	25.93%	8.75%	6.85%	10.29%	6.01%	9.88%
Cohort 06						1.19%	24.77%	8.72%	20.08%	7.56%	6.86%	7.08%	5.79%	4.85%

Fig. 1: Average exit rate across cohorts

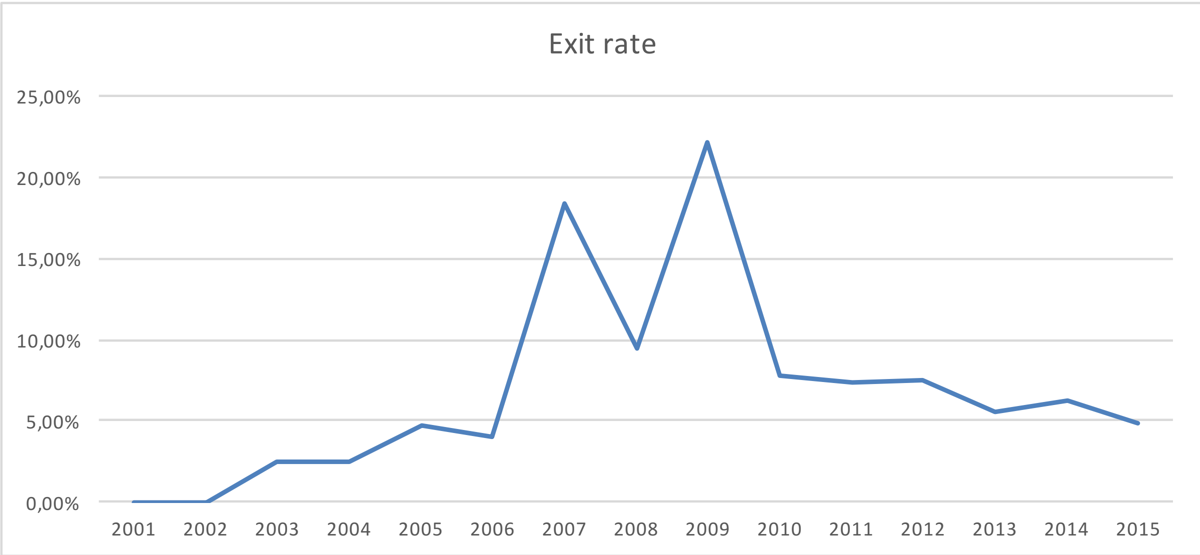

Fig. 2: Kaplan-Meier survival functions by cohort

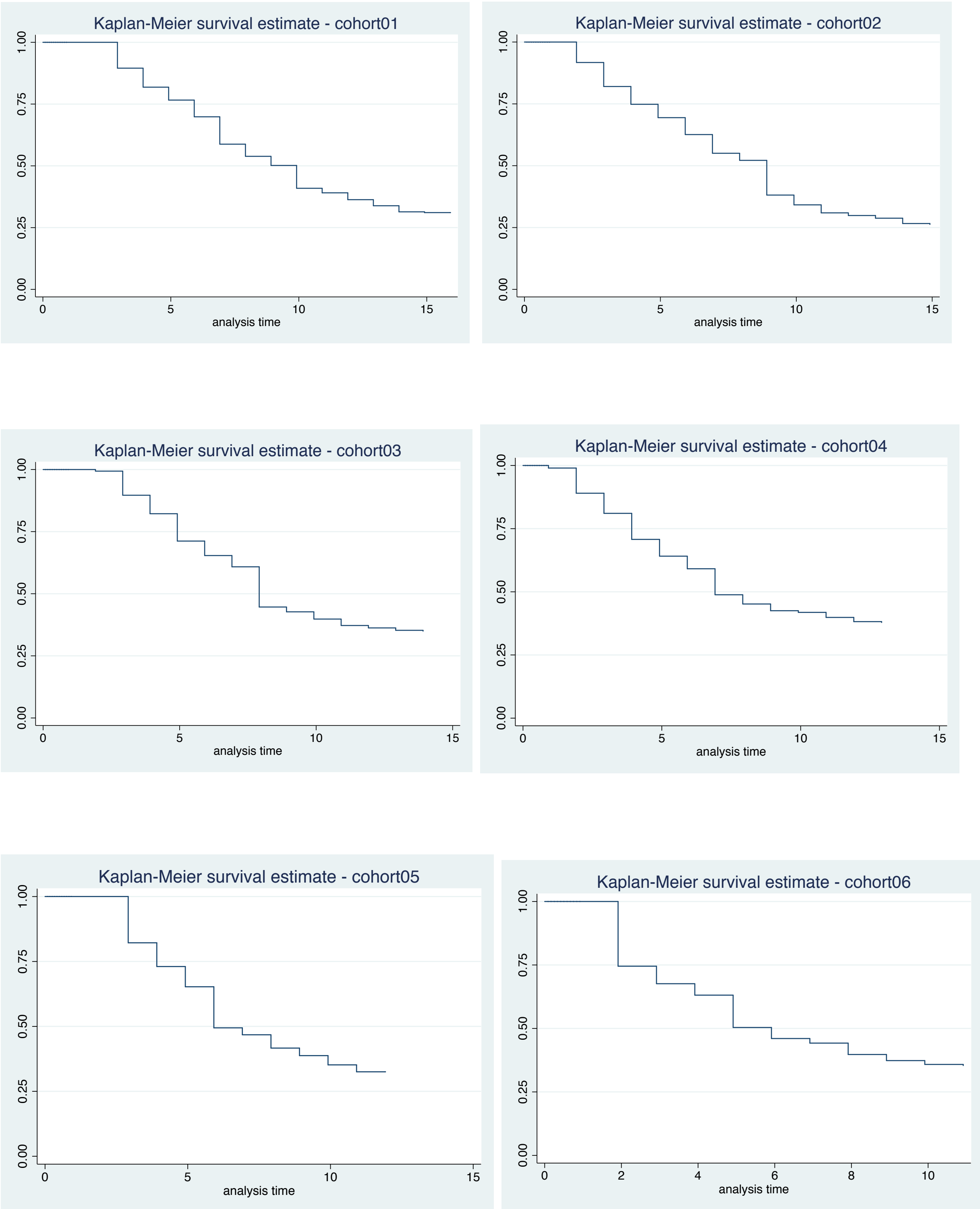

Table 3: Piecewise exponential model of hazard rates including period specific effects

Dep. Variable: hazard rate

VARIABLES	Mod1	Mod2	Mod3	Mod4	Mod5	Mod6	Mod7
Time-period 1	-3.163***	-3.157***	-3.133***	-3.184***	-3.148***	-3.148***	-3.181***
	(0.458)	(0.459)	(0.459)	(0.459)	(0.459)	(0.459)	(0.460)
Time-period 2	-2.006***	-2.001***	-1.978***	-2.029***	-1.992***	-1.992***	-2.023***
	(0.457)	(0.458)	(0.458)	(0.458)	(0.458)	(0.458)	(0.458)
Time-period 3	-2.707***	-2.701***	-2.675***	-2.729***	-2.689***	-2.689***	-2.719***
	(0.460)	(0.461)	(0.461)	(0.461)	(0.461)	(0.461)	(0.461)
Size [entry]		-0.00448	-0.00723	-0.00602	-0.00555	-0.00580	-0.00551
		(0.0247)	(0.0246)	(0.0246)	(0.0247)	(0.0247)	(0.0247)
Size [exit]	-0.0999***	-0.0973***	-0.0961***	-0.0976***	-0.0954***	-0.0954***	-0.0974***
	(0.0152)	(0.0207)	(0.0207)	(0.0207)	(0.0207)	(0.0207)	(0.0208)
Group [exit]	0.833***	0.834***	0.831***	0.834***	0.834***	0.833***	0.833***
	(0.0547)	(0.0549)	(0.0548)	(0.0549)	(0.0549)	(0.0549)	(0.0549)
Innovator	-0.128**	-0.127**					
	(0.0541)	(0.0544)					
Product Inn.			-0.181***		-0.148**	-0.149**	-0.180**
			(0.0635)		(0.0709)	(0.0714)	(0.0734)
Process Inn.				-0.143**	-0.0747	-0.0763	-0.0846
				(0.0649)	(0.0725)	(0.0739)	(0.0740)
Organizational Inn.						0.00679	-0.0226
						(0.0574)	(0.0596)
Marketing Inn.							0.148*
							(0.0776)
Cohort & Sector dummies included							
Observations	5445	5445	5445	5445	5445	5445	5445
chi2	7554,00	7554,00	7552,00	7555,00	7550	7550	7547
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00
log-likelihood	1221	1221	1223	1221	1223	1223	1225

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 4: Piecewise exponential model of hazard rates with time periods interaction effects

Dep. Variable: hazard rate

VARIABLES	Mod8	Mod9	Mod10	Mod11	Mod12	Mod13	Mod14
Time-period 1 (tp1)	-3.363***	-3.217***	-3.231***	-3.229***	-3.323***	-3.237***	-3.353***
	(0.464)	(0.461)	(0.460)	(0.461)	(0.462)	(0.460)	(0.463)
Time-period 2 (tp2)	-1.938***	-1.964***	-1.958***	-1.931***	-1.940***	-2.041***	-1.927***
	(0.458)	(0.458)	(0.458)	(0.459)	(0.458)	(0.458)	(0.459)
Time-period 3 (tp3)	-2.797***	-2.682***	-2.771***	-2.717***	-2.743***	-2.716***	-2.753***
	(0.465)	(0.462)	(0.462)	(0.463)	(0.463)	(0.461)	(0.464)
Size [entry]	-0.00451	-0.00794	-0.00659	-0.00635	-0.00825	-0.0111	-0.00612
	(0.0246)	(0.0246)	(0.0245)	(0.0246)	(0.0246)	(0.0244)	(0.0247)
Size [exit]	-0.0973***	-0.0957***	-0.0972***	-0.0952***	-0.1000***	-0.102***	-0.0972***
	(0.0207)	(0.0207)	(0.0206)	(0.0207)	(0.0206)	(0.0206)	(0.0208)
Group	0.836***	0.833***	0.832***	0.834***	0.831***	0.828***	0.834***
	(0.0549)	(0.0549)	(0.0549)	(0.0549)	(0.0549)	(0.0548)	(0.0550)
Innovator x tp1	0.226*						
	(0.120)						
Innovator x tp2	-0.281***						
	(0.0677)						
Innovator x tp3	0.0244						
	(0.118)						
Product Inn x tp1		0.130		0.0434			-0.0489
		(0.133)		(0.156)			(0.162)
Product Inn x tp2		-0.282***		-0.152*			-0.182*
		(0.0819)		(0.0908)			(0.0943)
Product Inn x tp3		-0.185		-0.340**			-0.323**
		(0.132)		(0.153)			(0.158)
Process Inn x tp1			0.195	0.163			0.0776
			(0.136)	(0.160)			(0.163)
Process Inn x tp2			-0.359***	-0.291***			-0.271***
			(0.0863)	(0.0958)			(0.0978)
Process Inn x tp3			0.127	0.298**			0.282*
			(0.129)	(0.150)			(0.154)
Organiz Inn x tp1					0.345***		0.302**
					(0.118)		(0.132)
Organiz Inn x tp2					-0.208***		-0.171**
					(0.0707)		(0.0772)
Organiz Inn x tp3					0.0706		0.0881
					(0.118)		(0.130)
Marketing Inn x tp1						0.235*	0.0785
						(0.139)	(0.156)
Marketing Inn x tp2						0.0335	0.255**
						(0.0909)	(0.101)
Marketing Inn x tp3						-0.138	-0.137
						(0.167)	(0.182)
Cohort & Sector dummies included							
Observations	5445	5445	5445	5445	5445	5445	5445
chi2	4736	4734	4746	4743	4728	4724	4725
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00
log-likelihood	2870	2868	2869	2870	2872	2871	2882

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix

Tab. 3: Descriptive Statistics: Mean and Standard Deviation; Correlation Matrix

	Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8
1	Size (exit)	3,98	1,7	1							
2	Group (exit)	0,51	0,5	0.1875*	1						
3	Innovator	0,53	0,5	0.2203*	0.1030*	1					
4	Product Inn.	0,26	0,44	0.1559*	0.0525*	0.5576*	1				
5	Process Inn.	0,23	0,42	0.1750*	0.0953*	0.5145*	0.5071*	1			
6	Organizational Inn.	0,38	0,49	0.1860*	0.1119*	0.7387*	0.3244*	0.3279*	1		
7	Marketing Inn.	0,16	0,37	0.1324*	0.0647*	0.4196*	0.3561*	0.2840*	0.3749*	1	
8	Size (entry)	4,21	1,5	0.7518*	0.2054*	0.2336*	0.1446*	0.1810*	0.2157*	0.1253*	1
9	Group (entry)	0,63	0,48	0.2487*	0.5095*	0.1462*	0.0946*	0.0956*	0.1400*	0.0751*	0.2617*

* Significant at 5% level.