The Effects of the Economic Downturn on Innovation: Creative Destruction versus Creative Accumulation

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Abstract

The 2008 financial crisis has, among other things, severely reduced the short-term willingness of companies to invest in innovation. But the reduction in innovation investment has not occurred uniformly. The paper analyses firms' innovation investment before and during the crisis based on Innobarometer 2009 micro data. The results indicate that the economic turmoil has favoured firms leaning towards creative destruction by nurturing the innovations of small firms responsive to new market opportunities.

JEL classification: O12, O30, O52

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1. Introduction

The 2008 financial crisis has, among other things, severely reduced the short-term willingness of companies to invest in innovation. But the reduction in innovation investment has not occurred uniformly. This paper analyses whether or not the economic turmoil has favoured creative destruction nurturing the innovation of new entrants or, on the contrary, has generated a further concentration of activities in the most innovative firms.

Patterns of creative destruction are driven by the behaviour of entrepreneurs who react to new technological opportunities and whose activates can undermine the market positions of incumbent firms and disrupt production and organization in an industry. Patterns of creative accumulation emerge where industries and products are dominated by cumulative learning processes and incremental improvements driven by firms which build on existing competences (Schumpeter, 1911 (1934); Schumpeter, 1942; Von Tunzelmann, 1995). The paper argues that creative destruction and accumulation are two extremes of a spectrum of behaviour that can be observed across firms and industries. Both patterns co-exist and firm behaviour may lean more closely to one or the other. The extent to which firm behaviour leans more towards creative destruction or accumulation depends on many factors related, among other things, to the technology involved in the innovation processes.

The current economic downturn has brought with it a decline in the propensity of firms to invest in innovation (Filippetti and Archibugi, 2009). Historically, there is some evidence suggesting that major innovations bunch together during (or shortly before) recessions. One explanation for the greater occurrence of relatively more major innovations is a change in the underlying technological paradigm (Mensch, 1979; Dosi, 1982; Kleinknecht, 1990). Incremental (as opposed to major) innovations are more frequent during periods of steady economic growth (Freeman et al., 1982).

This paper investigates if innovation investment during the crisis favours investment in response to new technological opportunities by new entrants, or if the opposite is true – that the relatively fewer firms driving innovation processes during the crisis are those with a longstanding track record of technological activities. In other words, does the crisis favour patterns leaning towards creative destruction or accumulation?

Addressing this question is of crucial relevance for current economic policies. The largest single policy instruments are aimed at supporting the volume of R&D activities (e.g. R&D tax credits) and through this creative accumulation. While there is greater heterogeneity in the extent and type of instruments that countries use to encourage innovation behaviour of small, newly established firms.

This paper is using data derived from the *Innobarometer Survey* designed and collected by the European Commission in 2009 (European Commission, 2009). Innobarometer data are collected on a yearly basis since 2001. Each year it covers different topics and the topic of the current 2009 survey is innovation related expenditure including the effects of the economic downturn on innovation related expenditure. In total 5,238 enterprises from the 27 EU Member states, plus Norway and Switzerland responded to the questionnaire. The sample is a random sample stratified by country, enterprise size (5 size bands) and industry (2-digit).

The paper is structured as follows. Section 2 provides the theoretical framework discussing the different dimensions of creative destruction and accumulation. Section 3 introduces the dataset and variables. Section 4 presents the empirical model, while Section 5 concludes.

2. Theoretical framework

Addressing the research question requires conceptualizing of (i) innovation investment during (and before) the crisis, which is then linked to (ii) firm behaviour that is associated with creative destruction on the one hand and creative accumulation on the other hand. The Innobarometer captures whether or not firms increased or decrease investment in innovation related activities as a direct response to the recession as well as investment decisions prior to the crisis.

The concepts creative destruction and creative accumulation are multidimensional and the remainder of this section discusses how the two concepts are operationalized. Figure 1 summarises the key facets relevant for both concepts divided into four dimensions: (i) characteristics of the innovating firms, (ii) the different market structures that support innovation, (iii) the characteristics of the key technologies from which innovations are derived, and (iv) the type of knowledge, learning and innovations involved. In Figure 1 the two concepts – creative destruction and accumulation – are seen to be at two polar ends with respect to the four dimensions. For example, innovation by creative destruction is characterised through the activities of small firms, while the opposite – relevance of large firms – is associated with innovation as creative accumulation. The reader should bear in mind that these are seen as the polar ends of a continuum (or four continuums: one at each level). This paper uses multiple measures to capture each level of analysis individually. The relevant measures are introduced in Section 3. The aim of the paper is to see if the innovation behaviour of the firms leans closer to creative destruction or accumulation during the depression with respect to the period before the depression.

Figure 1

Characteristics of different innovation drivers under creative destruction and creative accumulation

Dimensions	*Creative destruction*	*Creative accumulation*
Characteristics of the innovating firms	Small firms, new entrants are at the core of the innovation process	Innovations are driven by large, incumbent firms that seek new solutions through formal research
Characteristics of the market structure	Low barriers to entry into markets and low levels of concentration	Barriers to entry are high due to relative importance of appropriation and cumulativeness of knowledge and high costs of innovation
Characteristics of the key technologies	New technologies around which a large number of opportunities arise	Technological advancement based on path dependent technological trajectories
Type of knowledge and	Path-breaking innovations,	High relevance of past

innovation	with a greater relevance of applied knowledge.	innovations and accumulated knowledge (formal R&D) leading to a large number of more incremental innovations

2.1 Characteristics of the innovating firms

An important concept in connection with creative destruction at the firm level in Figure 1 is entrepreneurship or entrepreneurial behaviour (Schumpeter, 1911 (1934). Key driving forces are attributed to the (sudden) insights of individuals (Usher, 1954). Innovation is associated with small firms because flexibility and responsiveness are important. This type of innovation behaviour may for example be found in spin-offs from established companies. The development of the ideas to new products, services or processes is likely to favour external collaborations/strategic alliances as such set-ups help to overcome possible resource and capability issues within new and comparatively small firms.

In creative accumulation insight is replaced with research as the key source of innovation. This suggests innovations are largely developed by large firms and with internal R&D laboratories. Creative accumulation also leans towards collaboration of large corporations with the research base – research carried out by universities, public and private research institutes. Embedding externally or jointly generated generic research in turning it into a new product or service requires the necessary absorptive capacity, i.e. own capabilities and research competencies inside the firms (Cohen and Levinthal, 1990).

Another fundamental distinction at the firm level is the relative importance new firms as opposed to incumbents as drivers of innovation in the creative destruction and creative accumulation models. Incumbents may be at a disadvantage compared to newly established firms in bringing about technological discontinuities and path-breaking innovation. As Tushman and Anderson (1986) suggest existing firms may face a lack of competence in the case in which technological discontinuities required new capabilities and skills. This is referred to as 'competence-destroying discontinuities' (see also Henderson and Clark, 1990). Similarly, Leonard-Barton (1992) argues that each firm builds a knowledge set based on core capabilities, systems and values. Core competencies may turn into core rigidities in the sense that they can create inertia to change and innovate which is driven from outside the core competencies.

March (1991) and Levinthal and March (1993) investigate the issue from an organizational and learning perspective, suggesting that the capability of incumbents to survive is linked to their capacity to put forward effective processes of organizational adaptation. That firms are able to exploit current knowledge while at the same time exploring future technologies (see also Tushman et al., 2004). Finally, Christensen and Rosenbloom (Christensen and Rosenbloom, 1995; Christensen, 1997) emphasize the fact that the advantage of the "attackers" with respect to the incumbents relies on the fact that the latter's business is nested within a value network which they define as the context within which a firm competes and solves customers'

problems. In case of innovations which change the structure of the relevant value network, large firms fail to keep up not for a lack of technological competences but rather because they get stuck with their old context and customers.[2]

In conclusion the two stylized models creative destruction and creative accumulation suggest that on the one hand small and newly established firms due to higher flexibility and responsiveness are more likely to introduce path-breaking innovations during technological discontinuities, while large established firms on the other hand are more likely to bring about frequent and incremental innovations along technological trajectories based on accumulated knowledge.

2.2 Characteristics of the market structure

In his work on creative accumulation Schumpeter (1942) put forward suggested that large firms and conditions of monopolistic competition[3] are more affective in bringing about technical progress. He writes: "*What we have got to accept is that [the large-scale establishment or unit of control] has come to be the most powerful engine of […] progress and in particular of the long-run expansion […]. In this respect, perfect competition is not only impossible but inferior, and has no title to being set up as a model of ideal efficiency"* (Schumpeter, 1942 p. 106). Other scholars lately explored this issue (Galbraith, 1952; Sylos Labini, 1962; for a review see Scherer, 1992; and Cohen, 1995).

Nelson and Winter (1982) suggest that the market structure in a specific industry, the degree of concentration and rate of entry, is influenced by the level that technological opportunities arise and the ease with which innovations can be protected from imitation (i.e. the appropriability conditions). High technological opportunities together with a low degree of appropriability cause less concentration in an industry and vice versa. The former being associated with creative destruction and the latter with creative accumulation.

2.3 Characteristics of the key technologies

Patterns of creative destruction and creative accumulation overlap or as associated with technological regimes (Freeman et al., 1982; Malerba and Orsenigo, 1994, 1996; Breschi et al., 2000). Klevorick et al. (1995) define technological opportunities along the following three dimensions: (i) advancements in scientific and technical understandings; (ii) technological advancements originated in other industries; and

[2] However, others have stressed that incumbents might have a stronger capacity to resist and adapt even to major changes. To this end, Pavitt (1997, 1999) suggests that large firms "know more than they do", that is their competences are spread over a wider range of fields than those associated with their core products and that they have learnt how to assimilate new fields of knowledge through their internal competences in order to manage technological discontinuities. Methé et al. (1996) present empirical evidence showing that established firms often are sources of major innovations in telecommunications and medical instruments. In a similar vein Iansiti and Levien (2004) suggest that despite the many predictions about incumbent failures, technological transitions in the computer industry were survived by the overwhelming majority of incumbents. Despite the presence of this counter-evidence, the main interpretation presented in the theoretical background for the sake of the simplicity of the theoretical framework, while we shall take up this point later in the discussion.

[3] The monopolistic structure Schumpeter envisages is about the competition between large firms which is closer to the oligopolistic competition than to a monopoly.

(iii) within-industry feedbacks from technology. Their evidence suggests that differences in the degree and the source of technological opportunities account for difference in R&D expenditure and technological advances across industries.

Technological opportunities are often associated with the productivity of R&D. The higher the technological opportunities, the higher the expected return of a unit of R&D expenditure (under a given the level of appropriability).[4] Within this perspective, high levels of new technological opportunities favour creative destruction because the presence of technological opportunities increases the expected return of insight and idea generation of entrepreneurs and new firms. On the other hand, industries characterized by low technological opportunities are less attractive for new entrants and potential innovators. Consequently, low technological opportunities are associated to the creative accumulation model.

2.4 Type of knowledge and innovation

Creative destruction is associated with path-breaking innovations and radically new solutions which break with traditional solutions. Key driving forces are new insights followed up by entrepreneurs. Creative accumulation on the other hand is associated with frequent, but more incremental type of innovations, based on past innovation activities of incumbent firms. These two patterns are linked to differences in the type of knowledge.

Malerba and Orsenigo (1994) and Breschi et al. (2000) link cumulative learning processes and the nature of knowledge feeding into the innovative processes to patterns of creative destruction and accumulation. Knowledge bases refer to (i) generic knowledge – situated in formal R&D labs, universities etc – and (ii) applied knowledge which is seen as closer to commercialisation processes and is situated within firms (i.e. to a lesser extent involves formal research). It is the generic knowledge and formal research which is more relevant in the creative accumulation process, because it is the large, established firms that have the internal and financial resources to carry out in-house R&D and the competencies to turn generic knowledge developed outside the firms, e.g. in universities, and feed them into the development of new products and services.

Cumulativeness means that firms innovation activities are driven by past innovation activities. Cumulativeness is therefore high when the firm is established and can build on a history of innovation success, and where there is a tradition of research inside the firm. Cumulativeness is linked with creative accumulation.

This section developed four dimensions of creative destruction and creative accumulation: the characteristics of the innovating firms, the market structure, the key technology, and the knowledge and innovation involved. The following section explains how these dimensions are operationalized, i.e. how creative destruction and accumulation, as well as innovation activity before and during the crisis, are measured using the Innobarometer data.

[4] Additionally the level of the demand and the level of the technology are considered fixed. Here, the emphasis is on the role played by the appropriability.

3. The data

The data derives from the *Innobarometer Survey 2009* designed and collected by the European Commission (European Commission, 2009). Innobarometer is conducted on a yearly basis since 2001. Each year it emphasises a different issue, which is reflected in the questionnaire items. The focus of the current 2009 survey is innovation related expenditure including the effects of the economic downturn on innovation related expenditure. In total 5,238 enterprises from the 27 EU Member states, plus Norway and Switzerland responded to the questionnaire. The sample is a random sample stratified by country, enterprise size (5 size bands) and industry (2-digit).

3.1 The dependent variables

The dependent variable is a direct measure of innovation related investment in response to the economic downturn. The following question is analysed: *"In the last six months has your company taken one of the following actions [increased, decreased or maintained the innovation spending] as a direct result of the economic downturn?"*. The variable is called INVEST_2. It takes a value of 1 for decrease, 2 for maintain and 3 for increase in innovation investment.

We juxtapose the dependent variable above with the investment decisions prior to the economic downturn using the following question: "*Compared to 2006, has the amount spent by your firm on all innovation activities in 2008 increased, decreased, or stayed approximately the same (adjust for inflation)?"*. The relevant variable is called INVEST_1. Table I compares the investment patterns across INVEST_2 and INVEST_1, and, therefore, identifies the propensity of firms to increase or decrease innovation expenditure before and during the recession.

Table 1

Investment in innovation related activities before and after the economic downturn

	INVEST_1 (before the crisis)		INVEST_2 (during the crisis)	
	N	*%*	*N*	*%*
	(1)	(2)	(3)	(4)
Increase	1,985	37.93	453	8.65
Decrease	472	9.02	1,231	23.52
Maintain	2,207	42.17	2,961	56.57
No innovative activities	328	6.27	457	8.73
D/K	242	4.62	132	2.52
Total	**5,234**	**100**	**5,234**	**100**

Source: *Innobarometer 2009: own calculations.*

Table I column 2 shows that 37.9% of enterprises declared that they increased innovation investment prior to the crisis (INVEST_1). This compares to only 8.7% of companies that declared that they increased investment in innovation as a direct result of the economic downturn (INVEST_2; column 4). The drop in the propensity to increase investment is mirrored in the propensity to decrease innovation investment.

9.0% of firms decreased their expenditures before the recession, and 23.5% decreased investment during the recession.

Table 1 also shows that the largest share of firms – both before and during the crisis – maintained the level of innovation investment. Our discussions focus (albeit not exclusively) on explaining the behaviour of the 37.9% and 8.7% of firms that increased innovation investment before the crisis and in response the crisis because the aim of the paper is to determine where the innovation potential – and with it new sources of growth lie, and if these differ from the patterns under economic growth.

3.2 The independent variables

The independent variables are designed to capture patterns leaning towards creative destruction and accumulation as developed in the framework in Section 2 summarised in Figure 1. Table 2 provides in the first column the variable names and in the second column the description of the variables. The final two columns indicate if the variable is assumed to be positively or negatively correlated with the concepts creative destruction and accumulation respectively.

Table 2

Overview of the independent variables – variable name and description – broken down into the four dimensions of creative destruction and accumulation

Variable name	*Variable description*	*Creative destruction*	*Creative accumulation*
Characteristics of the innovating firms			
NEW	Firm was established after 1st January 2001	+	-
SIZE1	20-49 employees (base group)	+	-
SIZE2	50-249 employees	+	-
SIZE3	250-499 employees	-	+
SIZE4	500 or more employees	-	+
INTRD	Firm had expenditures on in-house research & development since 2006	-	+
EXTRD	Firm had expenditures on research and development performed for the company by other enterprises or by research organisations since 2006	-	+
Characteristics of the market structure			
APPR	Firm applied for a patent or registered a design since 2006	-	+
CMPT	Increased pressure from competitors had a positive effect on innovation in your company since 2006	+	-
INTMKT	Firm operates in international markets	-	+
Characteristics of the key technologies			
TECHOPP	Emergence of new technologies to be exploited had a positive effect on innovation since 2006	+	-
MKTOPP	New opportunities to enter new markets had a positive effect on innovation since 2006	+	-
Type of knowledge and innovation			
BASIC	Firm has strategic relationship in support of innovation with research institutes and educational institutions since 2006	-	+
APPLIED	Firm has strategic relationship in support of innovation with customers, suppliers or competitors since 2006	+	-

The first variable listed in Table 2 is named NEW and is coded 1 for all those firms that were newly established after 2001 and 0 otherwise. This variable used as a proxy to identify new entrants, and, therefore, is assumed to be highly, positively correlated with the concept creative destruction while negatively associated with creative accumulation. The second set of variables contains four dummies representing the size of the firm. Small firms (20 to 49 employees) are used as the base comparison group in the regressions. Large size is associated positively with creative accumulation while the reverse is the case for creative destruction. The next two variables capturing the characteristics of the innovative firms are used to measure the importance of research in the innovation process. They are called INTRD and EXTRD and capture if a firm engaged in internal or external R&D (coded 1 and 0 otherwise). As discussed in Section 2, research is seen as positively correlated with creative accumulation and negatively with creative destruction.
Characteristics of the market structure are proxied by three dummy variables, the first of which captures appropriability conditions. The relevant variable is called APPR and is coded 1 if a firm had expenditures in connection with patent applications or design registrations. Appropriability is an important indicator for creative accumulation. There are no direct measures of market concentration or barriers to entry in the Innobarometer. The two variables used in this paper capture the level of competition and exposure to international markets (CMPT and INTMKT). Stronger competition is assumed to be associated with those markets in which there are many small firms and lower entry barriers. With respect to the international market, the assumption is the role played by large, multinational corporations is stronger and that this favours creative accumulation.

With respect to the types of knowledge the paper distinguishes between basic and applied knowledge. Access to basic knowledge is measured by cooperation with universities and research institutes, while applied knowledge is measured by cooperation with other firms. The relevant variables BASIC and APPLIED are coded 1 if the enterprise cooperated with the knowledge base and 0 otherwise.

3.3 Control variables

Three groups of control variables are included in the empirical analysis. The first captures growth in turnover over the three years 2006-2008 before the crisis. The rationale is the following. Past economic performance plays a role in increasing financial resources available for innovation and, thus, may lead to increased innovation activity in the current period. Nonetheless, it is also possible that firms invest in innovation in order to address a drop in sales of their existing goods and services. Growth in turnover is measured using three dummies indicating a growth below 10 percent, between 10 and 50 percent and above 50 percent. We include two digit industry dummies and country dummies in the regressions.

4. The empirical model

The regressions predict investment in innovation based on firm, market, technology and knowledge or innovation characteristics which taken together are used to capture patterns of creative destruction and accumulation. The relationships between innovation investment and the independent variables are assumed to be linear. Because the dependent variable is categorical – decrease, increase or unchanged investment in innovation activities – multinomial logistic regressions are estimated with the category 'unchanged' as the base group. Table 3 reports the results of the multinomial logit model.

Table 3

Regression results predicting an increase or decrease in innovation expenditure during and before the crisis

	INVEST_1 (before the crisis)		INVEST_2 (during the crisis)	
	Increase	Decrease	Increase	Decrease
	(1)	(2)	(3)	(4)
Characteristics of the innovating firms				
NEW	-0.39**	0.11	-0.25	-0.02
	(0.01)	(0.62)	(0.34)	(0.89)
SIZE1	0.10	-0.10	-0.34**	-0.16
	(0.31)	(0.55)	(0.03)	(0.14)
SIZE2	0.02	-0.10	-0.68***	-0.09
	(0.90)	(0.64)	(0.00)	(0.50)
SIZE3	0.03	-0.03	-0.79***	0.04
	(0.87)	(0.91)	(0.00)	(0.82)
INTRD	0.43***	0.33**	0.25	0.03
	(0.00)	(0.04)	(0.14)	(0.82)
EXTRD	0.23**	-0.01	-0.04	-0.06
	(0.02)	(0.95)	(0.79)	(0.58)
Characteristics of the market structure				
APPR	0.56***	0.38*	0.37**	0.10
	(0.00)	(0.07)	(0.03)	(0.43)
CMPT	0.19*	0.13	0.04	0.19*
	(0.05)	(0.42)	(0.78)	(0.08)
INTMKT	-0.08	0.06	0.20	0.14
	(0.41)	(0.70)	(0.20)	(0.17)
Characteristics of the key technologies				
TECHOPP	0.28***	-0.16	0.02	0.01
	(0.00)	(0.32)	(0.91)	(0.89)
MKTOPP	0.08	-0.19	0.51***	-0.06
	(0.43)	(0.23)	(0.00)	(0.58)
Type of knowledge				
BASIC	0.05	-0.26	0.20	-0.01
	(0.62)	(0.12)	(0.20)	(0.95)
APPLIED	0.54***	0.36**	0.27	0.09
	(0.00)	(0.02)	(0.13)	(0.42)
Control variables				
GROWTH1	0.41***	-0.53***	0.22**	-0.30***
	(0.00)	(0.00)	(0.02)	(0.00)
GROWTH2	0.07	-0.82***	-0.14	-0.41***
	(0.61)	(0.00)	(0.49)	(0.00)
GROWTH3	-0.06	-0.26	-0.45**	-0.19
	(0.63)	(0.37)	(0.01)	(0.21)
Industry dummies	Included	Included	Included	Included
Country dummies	Included	Included	Included	Included
Model fit				
Observations	2,820		2,792	
LR Chi2(130)	644.59***		401.66***	
Log Likelihood	-2,397		-2,267	

Source: *Innobarometer 2009: own calculations.*

Estimation method is Multinomial Logit. The base group is no change in innovation investment compared to the previous period. Standard errors are reported in brackets.

* denotes p<0.10; **p<0.05; ** p<0.01.

Table 3 Column 1 provides the estimates of the propensity to increase investment into innovation compared with unchanged investment prior to the recession; Column 2

compares decrease in investment with unchanged investment prior to the recession. The estimates of Columns 3 and 4 assess the propensity to increase, decrease investment in innovation – the base comparison group is no change in investment – during the crisis.

Before the crisis (Column 1) the following variables have a positive association with increased investment – INTRD, EXTRD, TECHOPP, CMPT, APPR, APPLIED – while NEW has a negative association. Thus, before the crisis increase in innovation investment is driven by variables leaning towards creative accumulation as formal research, strong appropriability conditions and established firms are more likely to increase investment. Two indicators used to measure behaviour of creative destruction are, too, relevant. These are the level of technological opportunities and cooperation with other firms (APPLIED).

Column 2 of Table 3 contains estimates predicting a decline (as opposed to unchanged) investment in innovation prior to the crisis. Three variables significantly predict decline in investment – INTRD, APPR and APPLIED. In the first instances, this could appear counter intuitive; however, it is those firms which are innovative *per se* that adjust investment upwards or downwards compared with firms that do not change innovation expenditures. Added to this, the firms that decreased investment prior to crisis are less likely to have experienced a growth in turnover.

The discussion now turns to Columns 3 and 4 which contains the coefficients estimating the propensity to invest during the crisis. The variables predicting an increase in investment are MKTOPP which ash the strongest effect (beta=0.51; $p<0.01$), APPR and SIZE. Compared with Column 1 (before the crisis) formal R&D whether internal or acquired is not positively associated with increased investment. In terms of opportunities, the relevance shifts from technological to market openings; and while newly established firms are not (more or) less likely to increase investment as was the case before the crisis. In Column 4 predicting a decrease in investment during the crisis, the only variable predicting a drop in investment is CMPT which was used as a proxy for the market concentration.

In conclusions there are two key points that derive from the analysis in Table 3. Firstly, there is now exact demarcation between creative destruction on the one hand and accumulation on the other. Secondly, there is some support that increased investment in innovation is more strongly associated with patterns leaning towards the creative accumulation type, compared with during the crisis, where there is some indication that creative destruction type behaviour is associated with increased investment.

5. Discussion of the results

In relation with the theoretical framework summarised in Figure 1, the results presented in this paper suggest that there is no clear-cut mechanism driving innovation that can be mapped exactly onto the two models – creative destruction and accumulation. This is true before and during the crisis. Nonetheless, the results suggest that firms that increase innovation investment before the recession more

closely resemble patterns of creative accumulation; while during the crisis some indication of creative destruction is found.

Before the economic downturn innovation investment of firms is driven by (i) established firms; (ii) firms that are engaged in formal research activities both internally and bought-in; (iii) favour strong appropriability conditions indicated by patent applications and design registrations; and (iv) firms that experienced growth in turnover which led to a self-reinforcing mechanism success-breeds-success described by Schumpeter (1942) and Nelson and Winter (1982).

Both patterns of creative destruction and accumulation are likely to exist at the same time and the four dimensions – firm, market, technology, and knowledge characteristics – will not necessarily form a perfect fit at the individual firm level. Thus, it is not surprising to find some variables that suggest the presence of creative destruction before the crisis and vice versa. Technological opportunities have a positive impact on investment prior to the crisis. This pattern is consistent with the idea that during expansion periods (i.e. before the crisis) firms on the whole explore more risky solutions along new technological opportunities. Moreover, cooperation with universities and research institutes is not linked to increased investment in innovation – neither before nor during the crisis. However, cooperation with other firms, the indicator for access to applied knowledge associated with creative destruction more so than with creative accumulation, is positively associated with investment in innovation before the crisis.

During the economic downturn innovation is driven by (i) smaller firms compared with large firms; (ii) firms that explore new market opportunity; and (iii) favour appropriation (albeit to a lesser extent than prior to the crisis). It is worth emphasizing that the age of the firm is not relevant in predicting increased innovation investment, while it has a negative association with investment beforehand.

In conclusion, there has been an important change in the drivers of innovation as a result of the economic downturn. The relative importance of behaviours leaning towards creative destruction and creative accumulation is changing from accumulation to destruction in the snap shot of the business cycles that the Innobarometer makes it possible to observe.

6. Conclusions

The crisis is not very likely to lead to a further concentration of innovation within the most innovative firms, and instead may offer a window of opportunity for some small firms able to respond to new market opportunities. While neither a clear pattern of creative destruction nor creative accumulation is found during and before the crisis, patterns leaning more strongly towards one or the other are observed (creative accumulation before the crisis and creative destruction during the crisis). The extent to which this is true is likely to vary along the development of a specific industry (Gort and Klepper, 1982; Utterback, 1996; Mazzuccato and Semmler, 1999), and across industries (Malerba and Orsenigo, 1994; Breschi et al., 2000).

The paper shows that a creative destruction vs. creative accumulation balance differs not only across industry and along the development within a single industry, but also with respect to the business cycle. The fact that, during a period of sustained growth, firms' behaviour lean towards accumulative patterns of innovation could not be taken for granted. During periods of sustained growth firms have access to greater financial resources and thus might be seen more likely to explore radical and risky solutions. Similarly, it can be conceivably maintained that during a depression large established firms are better equipped to manage a situation of fall in demand and lack of financial supply. The paper recognizes and finds that both patterns of innovation co-exist, but that during the depression firms' innovation behaviour is closer to creative destruction compared with before the crisis.

While the Innobarometer survey offers a unique opportunity to shed light onto the impact of the recent economic downturn on innovation, the analyses presented here are also constrained by the data and the statistical models. For once, the results are confined to Europe, and exclude the largest economy the US, as well as regions outside the EU. The data offer information on two time periods, which allows comparing patterns before and during the crisis, but does not allow for panel estimations. Future work should focus on accessing data which allows for estimates based on longer time periods and the inclusion of more countries.

The paper reveals important implication for policies aimed at increasing innovation within countries during economic recessions. In particular the paper suggests that innovation policy instruments directed at small, start-up firms has potential to increase innovation investment during recession. Governments can foster innovation by increased transparency in information directed at new market openings. There is some indication that patent applications and design registration are relevant in increased investment into innovation.

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