Chapter 17
In Times of Economic Crisis: Innovation With, or Without, R&D Activities? An Analysis of Spanish Companies

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Abstract Analysis of non-R&D innovators—firms that successfully innovate without conducting R&D activities in-house—is an emerging topic in the innovation literature. Surprisingly, little is known about how they differ from R&D innovators. This paper's goal is to understand those differences and their persistence in times of economic crisis. From analysing 2011 CIS data, results suggest that for non-R&D innovators: (a) the innovation process has been persistent across different time periods, and that, therefore, firms have innovated whatever the environmental economic conditions; (b) the acquisition of equipment, machinery, and software has been the form most used for acquiring knowledge; (c) in times of economic crisis, the non-R&D strategy is strengthened by a high commitment to acquiring ready-to-use knowledge, rather than relying on uncertain R&D activities; that is, in times of crisis, non-R&D innovators invest more intensively in non-R&D activities than do R&D innovators. Non-R&D innovation represents 50 % of innovation in Europe. At times of economic crisis, it is a more suitable, innovation strategy.

17.1 Introduction

R&D indicators and, by extension, R&D innovators, are the topics most intensively researched in the innovation management literature, to the extent that the mainstream literature has generally equated innovation with in-house R&D. Nevertheless, when it comes to identifying and explaining firms' innovation strategies, there is a burgeoning body of evidence indicating a need to go beyond considerations of R&D alone. In fact, according to the European Commission (2008), referring to CIS data, almost a half of innovators in Europe do not perform R&D activities. Patterns of innovation-oriented

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behaviour observed for non-R&D performers include: the acquisition of advanced machinery and equipment, patents, licenses, or know-how; and the carrying out of training or marketing activities for the purposes of implementing new, or significantly improved, products and processes (European Commission 2008). Also, the OECD (OECD 2010) points out: "…firms may introduce new products on the market without engaging in R&D. New indicators reveal that in Australia and Norway the propensity to introduce a new-to-market product innovation is similar whether or not the firm performs R&D." Cited as an example is the fact that in Luxemburg 52 % of non-R&D performers introduced new-to-market innovations, which compares to 63 % found for in-house R&D performers (p. 23).

Thus, it is clear that the body of research focused solely on R&D activities does not cover all innovation phenomena. Indeed, in our view, evidence based on R&D activities constitutes a key repository of knowledge but underestimates the influence of other innovation efforts and expenditures. Moreover, an important segment of innovative firms can be missed when research samples are limited (see Cuervo-Cazurra and Annique Un 2010) to those firms that report R&D expenditures (e.g. Mañez-Castillejo et al. 2013). So, what do we know about non-R&D performers and their innovation strategies? Do their innovation strategies differ in times of crisis? In this chapter, we offer evidence on these matters.

The motivation for this chapter is to see how the behaviour of non-R&D innovators compares to that of R&D innovators during times of crisis. Can innovation without R&D be a suitable strategy for sustaining innovation performance in times of crisis, given that it does not involve the same levels of commitment of resources and uncertainty associated with R&D activities, and given that when the environment is really uncertain firms do not want to take many risks? This chapter offers insights based on a sample of 5,640 firms drawn from CIS data for Spain in 2011, including 2,067 non-R&D innovators and 3,576 firms innovating using in-house R&D. After this introduction, Sect. 17.2 reviews those empirical studies of innovation that go beyond R&D activities. Then, in Sect. 17.3, an empirical exercise is conducted, using CIS data for Spain. A discussion and conclusion of this study's findings are presented in Sect. 17.4.

17.2 Literature Review: What Do We Know About Non-R&D Activities and Innovation?

The fact that not all firms formally invest in R&D is at the centre of an old debate in the economics of innovation literature. Smith (2005) pointed out that some activities are crucial to innovation but are not included in R&D efforts: education and training, the acquisition of products and licenses, product design, trial production runs, training, tooling up, and the acquisition of equipment or machinery related to innovation. Cohen et al. (1987) showed that 24 % of large firms in the USA did not invest in formal R&D, and Bound et al. (1984) found that 40 % of US firms did not report positive R&D expenditures. In fact, many scholars have argued that

innovation is not limited to R&D alone (Hirsch-Kreinsen 2008; Kline and Rosenberg 1986; Nelson and Rosenberg 1993; Nelson 2000).

Taken as a whole, the literature about non-R&D innovators (Arundel et al. 2008; Bougrain and Haudeville 2002; Freel 2003, 2007; Muscio 2007) has highlighted the following: (a) non-R&D activities matter when innovating (Arundel et al. 2008; Barge-Gil et al. 2011; European Commission 2008; Hervas-Oliver et al. 2011; Huang et al. 2010; OECD 2005); (b) engineering departments carry out activities that substitute for R&D functions (Pavitt 1982); (c) relationships with specialised suppliers and equipment suppliers enhance a firm's innovation processes (Pavitt 1982); (d) process innovation occurs more often than that for products (Heidenreich 2009; Hervas-Oliver et al. 2011; Huang et al. 2010); (e) there are activities other than R&D which contribute to innovation, such as training, prototyping, or design, among others (e.g. Asheim and Isaksen 1997; Freel 2005; Santamaría et al. 2009); (f) SMEs, and low and medium technology intensive industries, are the most prominent users of non-R&D activities and in adopting non-R&D strategies (e.g. Griliches 1990; Heidenreich 2009; Hervas-Oliver et al. 2011; Kleinknecht and Reijnen 1991; Santarelli and Sterlacchini 1990); (g) the utilisation of advanced machinery for innovation is extensive (e.g. Barge-Gil et al. 2011; Heidenreich 2009; Hervas-Oliver et al. 2011).

Non-R&D innovation is mostly based on incremental problem solving and experimentation on the shop floor (Romijn and Albaladejo 2000: 4–5). These problem-solving activities, following Arundel et al. (2008), involve minor changes of engineering knowledge (e.g. Kline and Rosenberg 1986), reverse engineering (Kim and Nelson 2000) or adaption (Von Hippel 2005), and the recombination of existing knowledges (e.g. Evangelista et al. 2002) in new design forms or prototypes (Asheim and Isaksen 1997).

17.3 An Empirical Exercise

17.3.1 Sample and Data

Our data was sourced from the Spanish Innovation Survey (the "Technology Innovation Survey" is the official name), administered by the Spanish National Statistics Institute (INE), and conducted in 2011. This survey was based on core elements of the Eurostat Community of Innovation Surveys (CIS). The methodology and questions used in CIS are described by the Organisation for Economic Co-operation and Development (OECD 2010). Our final sample covers 2,067 non-R&D innovators and 3,576 R&D innovators in 2011. We focus on technological innovators (both those engaged in R&D and those not engaged) due to the fact that technological non-active firms (firms which did not innovate) did not answer many questions in the survey. The sample covers NACE-92 2-digit industries from 14 to 74, including therefore manufacturing and service industries. The period covered was from 2009 to 2011 (3 years).

17.3.2 Description of Non-R&D Innovators in Comparison with R&D Innovators

The variables analysed are presented in Table 17.1.

Table 17.2 shows the differences between non-R&D and R&D innovators concerning their adoption of technological innovations. The table shows that non-R&D innovators prefer adopting technological process innovations to product innovations and that also R&D innovators are more ready to undertake both (product and process) innovations at the same time. Around half (49 %) of non-R&D innovators carry out solely technological process innovations, without developing product innovations; whereas process innovations alone are only carried out by 16 % of R&D innovators, these firms being more oriented to product innovation. This means that there is a tendency for non-R&D performers to mainly focus on introducing only process innovations; introducing a new, or significantly improved, method for the manufacture, or production, of goods or services; introducing a new, or significantly improved, logistics system, or delivery or distribution method, for its supplies, goods, or services; or introducing support activities for its processes, such as new or significantly improved maintenance systems or IT operations, or purchasing procedures, or accounting practices. In contrast, R&D innovators are more oriented to introducing product and process innovations simultaneously (58 %, compared with 30 % in the case of the non-R&D innovators).

According to Table 17.3, non-R&D innovators carry out higher investments in many non-R&D activities. Despite the fact that R&D innovators spend more money on innovation activities per volume of sales (when including also R&D expenditures: 15.39 compared with 1.25), the results indicate that in times of crisis the non-R&D innovators spend much more on some non-R&D activities: acquiring machinery and equipment (exp_maq variable); buying knowledge such as patents (exp_buy_R&D variable); and spending on innovation support activities such as tooling up (exp_preparation_support). All these activities are performed more intensively (in terms of expenditures) by non-R&D innovators than by R&D innovators. The results indicate that at times of crisis, for purposes of innovation the acquisition by non-R&D innovators of external knowledge in its different forms is more attractive than developing in-house R&D activities. Investing in R&D is risky and returns are not immediately appropriated, whereas the acquisition of external knowledge (such as patents, machinery, and even extramural R&D) is less risky as long as the knowledge is ready for application and can be inserted in the production process quickly and safely.

Following this comparison, it can be stated that: (a) the innovation process is persistent across different time periods and that firms innovate whatever the economic conditions; (b) in times of economic crisis, the non-R&D strategy is strengthened by a high commitment to acquiring ready-to-use knowledge, rather than relying on uncertain R&D activities.

Table 17.1 Table of variables in the analysis

Variable	Meaning	Codification
Exp_ext_R&D	*Extramural R&D expenditures per sales*: comprising the acquisition of R&D services; total expenditures divided into the sales	Continuous
Exp_buy_R&D	*Buying R&D expenditures per sales*: comprising the acquisition of external knowledge, i.e. "the purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations"; total expenditures divided into the sales	Continuous
Exp_maq	*Embodied technology expenditures per sales*: comprising expenditure on the acquisition of machinery and equipment offering improved technological performance, including major software; total expenditures divided into the sales	Continuous
Exp_Training_support	*Training activities expenditures per sales*: comprising expenses on internal or external training for personnel specifically involved with the development and/or introduction of innovations; total expenditures divided into the sales	Continuous
Exp_Marketing_ support	*Marketing activities expenditures per sales*: comprising expenses on activities for accessing the market, and the introduction of new or significantly improved goods and services, including market research and launch advertising; total expenditures divided into the sales	Continuous
Exp_Preparation_ support	*Preparation activities expenditures per sales*: comprising expenses on design and tooling up of design functions for the development or implementation of new or improved goods, service processes, and the improvement of production; total expenditures divided into the sales	Continuous
Total_non_R&D_ inno_expen	*Total expenditures on non-R&D innovation activities per sales*: represent the sum of: Exp_ext_R&D, Exp_buy_R&D, Exp_maq, Exp_Training_support, Exp_Marketing_support, and Exp_Preparation_ support; total expenditures divided into the sales	Continuous
Inno_product	*Product innovation*: indicating whether the firm has carried out product innovations (goods and/or services) during the research period (2009–2011)	0–1
Inno_process	*Process innovation*: indicating if the enterprise has introduced at least one of the following during the research period (2009–2011): – *New or significantly improved methods for the manufacture or production of goods or services* – *New or significantly improved logistics systems or delivery or distribution methods for supplies, goods, or services* – *Support activities for processes, such as maintenance systems or IT operations, or purchasing procedures, or accounting, being new or significantly improved*	0–1

Table 17.2 Product and process innovations carried out by non-R&D and R&D innovators

	Non-R&D innovators		R&D innovators	
	N	%	*N*	%
Only process innovations	1,003	49	588	16
Only product innovations	454	22	913	26
Process and product innovations simultaneously	610	30	2,057	58

Table 17.3 Innovation activity expenditures by non-R&D and R&D innovators: a nonparametric test

	Non-R&D innovators (*N*=2,067)		R&D innovators (*N*=3,576)	
	Mean	SD	Mean	SD
exp_ext_R&D	0.385	4.458	1.418	6.409
exp_maq	0.712	3.863	0.544	3.877
exp_buy_R&D	0.033	0.556	0.020	0.243
exp_preparation_support	0.109	1.315	0.099	0.946
exp_training_support	0.004	0.028	0.039	0.197
exp_marketing_support	0.004	0.039	0.066	0.0305
Total_non_R&D_inno_expen	1.250	6.087	2.185	8.220

Mean comparison tests are consistent and statistically significant at $p<0.01$, using nonparametric Mann–Whitney *U* test

17.4 Conclusion

The goal of this chapter has been to understand and compare innovation patterns of non-R&D and R&D innovators, as they have occurred in a context of economic crisis. This work has contributed to the literature on innovation by shedding light on a frequently omitted innovator segment which accounts for roughly 50 % of the firms innovating in Europe: namely, non-R&D innovators.

This chapter makes a contribution by going beyond the use of traditional R&D indicators (Arundel et al. 2008; Bougrain and Haudeville 2002; Freel 2003, 2007; Muscio 2007) and confirms the generally accepted view that non-R&D activities also matter for innovation (Arundel et al. 2008; Barge-Gil et al. 2011; European Commission 2008; Hervas-Oliver et al. 2011; Huang et al. 2010; OECD 2005), especially during times of economic crisis. That is to say, the non-R&D innovation strategy is persistent also in time periods characterised by crisis. In fact, the strategy grows stronger at times of uncertainty and crisis, when R&D activities are believed riskier because of difficulties in being transformed into appropriable returns. In contrast, non-R&D activities are perceived as less risky, because they involve the acquisition of knowledge that is ready for use in the production process and incur less problems of appropriation.

Overall, the study has shown that non-R&D firms exhibit a pattern of technological innovation characterised by a high dependence on external knowledge

acquisition, with the acquisition of equipment, machinery, and software being the most prevalent ways of acquiring knowledge. These results confirm those of Hervas-Oliver et al. (2011) and Huang et al. (2010), both of which also revealed a similar pattern of innovation by non-R&D performers. For them, the structure of innovation patterns is mainly formed by the carrying out of internal non-R&D initiatives, including technological support activities (such as tooling up), and by accessing external sources of knowledge (mainly through machinery acquisition). This structure confirms the validity of both the RBV and relational viewpoints (Barney 1991; Dyer and Singh 1998, respectively) and their predictions about a significant relationship between a firm's internal and external resources.

The above having been said, we do not want readers to come away with the message that non-R&D activities are an optimal choice, and better than R&D ones. Indeed, and as shown above, non-R&D innovation strategies are associated with weak internal innovation capabilities that are supported by a strong dependence on external sources of knowledge, such as the acquisition of embodied knowledge, and a notable preference for process innovation.

Non-R&D innovation strategies are carried out by around 50 % of Europe's innovators, and this should not be overlooked by managers, scholars, and policy-makers. In fact, innovation can occur without R&D, especially in SMEs and in low-medium technology contexts. The conclusions of this paper matter for scholars. In fact, they suggest how important it is to widen our lens and scope in order to include neglected innovators in our samples. Omitting those firms from our studies will not contribute to a better understanding of technical change or to the design and implementation of effective policy-making which may otherwise be constructed from incomplete samples. It seems, in fact, that most studies that measure innovation could have presented misleading results by just focusing on R&D activities, and then generalising the findings, implicitly assuming that only R&D is the way to innovate. For future studies, the role of non-R&D innovators should be analysed further, by, in particular, comparing countries of the European Union, and doing so specifically in times of crisis.

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