



Neglected innovators: How do innovative firms that do not perform R&D innovate?

Results of an analysis of the Innobarometer 2007 survey No. 215

INNO-Metrics Thematic Paper

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Executive Summary

R&D is not the only method of innovating. Other methods include technology adoption, incremental changes, imitation, and combining existing knowledge in new ways. With the possible exception of technology adoption, all of these methods require creative effort on the part of the firm's employees and consequently will develop the firm's in-house innovative capabilities. These capabilities are likely to lead to productivity improvements, improved competitiveness, and to new or improved products and processes that could be adopted by other firms. For these reasons, the activities of firms that innovate without performing R&D are of interest to policy.

This report uses a new data set to explore innovation activities that are not based on R&D. These activities can be used by both innovative firms that perform R&D and by innovative firms that do not perform R&D. The data are from the Innobarometer (IB) 2007 survey, which was partly designed to delve further into innovative activities that are not based on R&D – to look more closely at how 'neglected innovators' innovate.

The IB survey is based on a quota survey for all 27 EU member states. Results are available for 4,395 innovative firms, covering innovative activities over 2005 and 2006. Of these, 52.5% innovate without performing R&D (non-R&D innovators), 40.0% perform R&D in-house, and 7.5% contract out R&D to other firms or organizations. The share of non-R&D innovators is similar to the 50% share observed for the third European Community Innovation Survey (CIS) for the three year period of 1998 to 2000.

Compared to firms that perform R&D in-house, a higher percentage of non-R&D innovators have less than 50 employees, are active in low technology service sectors, and are located in European countries with trailing or lagging average innovative capabilities. However, non-R&D innovators are found in all size categories, countries, and sectors. For example, 10% of non-R&D innovators have over 250 employees and one-third are located in the leading innovative countries of Germany and Scandinavia.

Non-R&D innovators, compared to R&D performers, are more likely to focus on process innovation and to source ideas from within the firm from production engineers and design staff. The higher prevalence of process innovation among non-R&D performers suggests that there are more options for developing process innovations without performing R&D. Non-R&D innovators spend less on innovation than R&D performers. This holds after controlling for the effect of firm size.

For product and process innovations, there is no statistically significant difference between non-R&D innovators and in-house R&D performers in the percentage of firms that report technology adoption (selling on or acquisition with little or no modification in-house) or who report modifying products or process obtained from external sources. In all cases, approximately one-third of non-R&D innovators and firms that perform R&D use these two methods.

The main difference is in the percentage of innovative firms that develop products, processes, or organizational methods in-house or in collaboration with other external sources. Twice as many firms that perform R&D in-house collaborate on product or process innovations compared to non-R&D innovators (44% versus 22% for product innovations). However, non-R&D innovators are relatively more dependent than R&D performing firms on the diffusion of knowledge from other firms, particularly through knowledge embodied in acquired products and processes.

An important method of innovating without performing R&D (used equally by non-R&D and R&D performing innovative firms) is to customize or modify products and processes obtained from other firms. The information sources used by both groups for this type of innovative activity are similar, except that a higher percentage of R&D performers draw on the use of external experts such as consultants or universities. The lower use of external experts by non-R&D innovators could be due to the higher costs of using this source or because of a qualitative difference in the degree of modification, with external experts brought in for more extensive modifications.

In general, non-R&D innovators have lower innovative capabilities than R&D performing firms, with fewer non-R&D innovators capable of developing innovations in-house and a smaller percent reporting training or skill upgrading linked to innovation. However, a striking result is that these differences are minor: 71% of non-R&D innovators report developing either product or process innovations in-house (compared to 91% of R&D performers), 54% of staff time on innovation is for developing product and process innovations in-house (compared to 63% for R&D performers) and 70% report training or skills upgrading for innovation (compared to 79% of R&D performers).

The results show that a majority of non-R&D innovators invest in creative innovative activities. Many of these firms should therefore be able to benefit from policy support for their innovative activities. However, policy appears to fail this group of 'neglected' innovators. Only 33% of non-R&D innovators report using at least one of six types of innovation support programmes, *that do not require R&D* compared to 47% of R&D performers. These differences hold after controlling for the innovative capabilities of non-R&D and R&D innovators. In particular, firms that innovate primarily through customizing or modifying products or processes are significantly less likely than firms that develop innovations in-house to apply for or use innovation support programmes.

There is no difference in the change in annual revenues between 2004 and 2006 between non-R&D innovators and firms that perform R&D. This suggests that there is no detectable penalty, in terms of revenues, for firms to innovate without investing in R&D. It also suggests that the apparent bias in policy support towards R&D performing companies is not justified in terms of the growth potential of the companies.

1. Introduction

It has long been acknowledged that R&D is not the only method of innovating. Kline and Rosenberg (1986) emphasized the importance of non-R&D inputs to innovation and argued that innovation does not depend on invention processes involving formal R&D. Evangelista et al. (1998) used the results of the first European Community Innovation Survey (CIS) to show that innovation related capital expenditures, rather than R&D, are the largest single component of innovation expenditures across all manufacturing sectors. However, due to plentiful, detailed and harmonised data, R&D expenditures are frequently used as a proxy for innovation inputs. This leads to an implicit assumption that R&D is the primary source for productivity growth (Smith, 2005) and is the only type of creative activity that can produce innovative products and processes.

An alternative view pictures firms as rather conservative in terms of new R&D spending, even with fundamental product and process innovation. For example, Kline and Rosenberg (1986) argue that when firms are faced with having to innovate they first look into their existing stock of knowledge, and if the answer cannot be found there, they then consider whether it makes sense to spend on R&D or not (or whether it is perhaps even better to discard the project in question). This is more than the ‘make’ or ‘buy’ decision examined by Cassiman and Veugeleers (1999), as the ‘make’ decision subdivides into ‘make through R&D’ and make through other means.

Sterlacchini (1999) notes that the innovation literature has emphasized the need to look beyond R&D for decades. Interest in other types of innovation was a major factor behind the design of the Community Innovation Survey (CIS). Nevertheless, most innovation research has focused on R&D performing firms. Only about 5% of research papers based on the CIS, for example, have specifically evaluated innovation by firms that do not perform R&D (Arundel et al, 2007).

Innovative firms that do not perform R&D have largely been neglected by policy and by academics, partly because of a lack of information on them. The CIS collects data on non-R&D innovators and this information has been used, for example, to characterize firms by how they innovate, or their ‘mode’ of innovation (Tether, 2001; Arundel and Hollanders, 2005). However, the CIS collects only a limited amount of information on precisely how non-R&D innovators innovate.

This report uses a new data set to explore innovation activities that are not based on R&D. These activities can be used by both innovative firms that perform R&D and by innovate firms that do not perform R&D. The data are from the Innobarometer (IB) 2007 survey, which was partly designed to delve further into innovative activities that are not based on R&D – to look more closely at how the ‘neglected innovators’ innovate. The survey also focuses on the knowledge sources that firms use to modify innovations obtained from sources outside the firm.

2. Theory of Innovation and R&D

There is frequent confusion over both the definition of an innovation and the definition of R&D. The third Oslo Manual (OECD, 2005) defines innovation as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations. (page 46)” Of note, an innovation does not need to be a world first or even to have been developed by the firm. The Oslo Manual (page 46) states that:

“The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be *new (or significantly improved) to the firm*. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organisations.”

R&D is a more complex concept that is defined by the OECD’s Frascati Manual (OECD, 2002) as follows:

“...creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (page 30)”

‘Systematic’ refers to the requirement for effort, rather than accidental discovery, whereas the reference to culture and society includes research in social sciences. The Frascati Manual divides R&D into basic research or “work to acquire new knowledge without any particular application or use in view”, applied research, which is similar to basic research but has a ‘practical aim or objective’, and experimental development, defined as:

“... systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.”

The definitions of basic and applied research create few problems, since their performance requires efforts to obtain new knowledge. Conversely, the definition of experimental development creates substantial problems, with many activities based on the use of existing knowledge, such as engineering and design, sometimes included as R&D and sometimes excluded. The Frascati Manual provides a basic criterion for identifying R&D, which is an ‘appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned’ (page 34). This suggests that many innovative activities based on new uses of existing knowledge are not R&D.

R&D is popularly viewed as a ‘good’ characteristic, which could encourage respondents to report their firm’s innovative activities as R&D. As an example, research by Statistics

Canada shows that more firms report R&D activities on the Canadian innovation survey than claim an R&D tax credit (where evidence of R&D is required¹).

Conversely, many SMEs could fail to report R&D because of the 'lack of clarity in how R&D is defined' (Smith 2005; Wyatt 2001). The definitions given above, particularly for experimental development, leave substantial room for interpretation. Problems in determining what is and what is not R&D could be common among managers in firms that do not have a formal R&D department (Dotter et al, 1990) and among firms in the services sector where many R&D activities could have a social science base (Rosa 2004; Djellal et al 2003). Roper (1999) shows that only 20% of UK manufacturing firms with 20 to 49 employees have a formal R&D department versus 66% of German firms that report an R&D department. This suggests that many UK firms might not be aware that some of their innovative activities are R&D.

How do firms that do not perform R&D innovate? The innovation literature points to four main methods:

Technology adoption: Firms can acquire innovative products and processes from sources external to the firm, with little or no further work required. For example, a computer assembler can purchase faster hard drives or wireless cards, purchased from specialist firms, to include in a notebook computer, or a food processing firm can purchase improved packaging equipment. CIS data used by Evangelista and Mastrostefano (2006) show that the acquisition of new machinery and equipment is one of the most common innovation activities across firms. Similarly, firms could acquire the ideas for organisational innovations from other firms.

Minor modifications or incremental changes to products and processes, including the use of engineering knowledge (Kline and Rosenberg, 1986). Modifications can be made to both purchased products and processes or to technologies developed by the firm itself in a previous time period. These innovation activities are particularly common for process innovation (Evangelista et al 2002; Nascia and Perani 2002). Lhuillery and Bogers (2006) estimate that 15% of overall cost reductions are from incremental innovations made by employees to production processes. Incremental change can depend on learning by doing, as a firm gets better at what it already does (Cohen and Levinthal, 1989).

Imitation including reverse engineering: Many activities to replicate products or processes that are already available, including some solutions to circumvent a patent (Kim and Nelson, 2000), do not require R&D. This method of innovating could be especially common in less developed countries or for innovations that are not patentable.

¹ Frances Anderson, personal communication, March 2008. An alternative explanation is that the cost of the effort required to get the tax credit is worth less than the tax credit itself for minor R&D projects, so that these firms do not bother to apply for the credit.

Combining existing knowledge in new ways: This can include some types of industrial design and engineering projects (Grimpe and Sofka, 2007; Huston and Sakkab, 2006). The Italian ‘informal learning systems’, characterized by SMEs in traditional industries and mechanical and electrical/electronics sectors, use these methods to create new products (Evangelista et al. 2002). These systems build on tacit knowledge, engineering skills and cumulative learning processes, where the necessary knowledge is located in the system, rather than in a specific firm (Gottardi, 1996). Informal contacts and mobility of highly-skilled personnel move tacit knowledge from firm to firm.

It can also include situations where a firm adopts solutions developed by users (with users possibly doing some unreported R&D work). Von Hippel (2005) argues that user innovation is much more widespread than earlier thought. User innovation thrives when there are methods for sharing information and breaking down a problem into components (e.g. innovation toolkits). These enable users to innovate without new R&D and improve the ability of users to combine and coordinate their efforts (e.g. over the internet).² User innovation can also serve as an important source of solutions for firms.³ Von Hippel calls the ability of users to develop what they need instead of buying what is available the “democratisation of innovation”.

All firms, including large firms with major R&D projects, can use each of the above methods to innovate. The main difference between firms and between sectors is the prevalence of specific methods of innovating. Innovation processes in low and medium technology (LMT) industries are often less formal and more related to modification and incremental change, design and process optimization, rather than identifiable R&D (Hansen and Serin, 1997). The innovative activities of small firms can stress the practical application of tacit knowledge. Service sector firms innovate in a continuous, incremental way, with many people from different divisions involved. This manner of innovating makes it difficult to identify specific non-technological innovations (Tether, 2004; Gellatly and Peters, 1999).

Firms can undertake technology adoption with very little creative activity or learning, but each of the three other types of non-R&D based innovation will require some creative effort on the part of the firm’s employees and consequently develop the firm’s in-house innovative capabilities. These capabilities are likely to lead to productivity improvements, improved competitiveness, and to new or improved products and processes that could be adopted by other firms. For these reasons, the activities of firms that innovate without performing R&D should be of interest to policy.

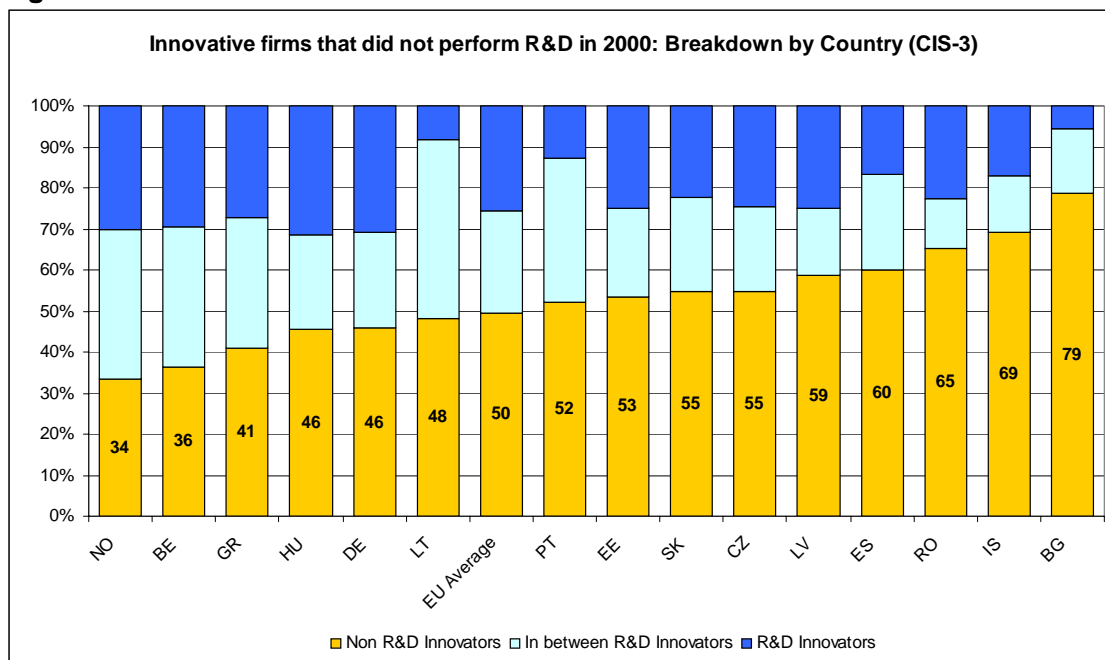
² This is obviously a link between user innovation and open innovation. Von Hippel (2002) also uses the term horizontal user innovation networks to describe groups of user innovators each freely revealing their innovations.

³ However, von Hippel (2005) argues that currently manufacturers do not spot user innovations very often, and when they do, it is normally by accident. Manufacturers could benefit much more from user innovations by seeking them more actively.

2.1 CIS results

The CIS-3 data for 2000 for 15 European countries show that half of firms that introduced an innovative product or process innovate without performing R&D or acquiring R&D services from external sources (see Figure 1). Figure 1 also shows large variations by country, with the percentage of non-R&D innovators much higher in several of the new member states such as Bulgaria, Romania and Estonia than in the more developed economies of Norway, Belgium and Germany. The percentage of innovative firms that do not perform R&D also varies by firm size: 55% of small innovative firms (10 to 49 employees), 45% of medium innovative firms (50 to 249 employees) and 25% of large innovative firms (250 or more employees) do not perform R&D. As suggested by the literature, there are also notable differences by sector. The share of non-R&D innovators is 46% in manufacturing and 53% in services. The lowest rate in manufacturing is for high-technology sectors, at 22%, compared to a high of 60% of firms active in low-technology manufacturing sectors.

Figure 1



Source: Authors' own calculation.

Non R&D Innovators are firms with a product or process innovation, but which do not perform intramural R&D. R&D Innovators are product or process innovators that perform intramural R&D. "In between Innovative firms" are firms that perform R&D on an occasional basis or innovative firms that acquire R&D (extramural R&D), either from their parent firm or from other firms or organisations.

NO, BE, GR, HU, DE, LT, PT, EE, SK, CZ, LV, ES, RO, IS and BG represent Norway, Belgium, Greece, Hungary, Germany, Lithuania, Portugal, Estonia, Slovakia, Czech Republic, Latvia, Spain, Romania, Iceland and Bulgaria, respectively.

3. Methodology

The IB survey draws a random sample from Dunn and Bradstreet data for each EU country. The survey uses a quota sample of a specified number of responses for each country. The smaller countries and new member states are over sampled in comparison to their economic weight within the EU. To counteract this, all statistical results below are reweighted to balance the sample to the actual number of firms in each country. Count results, such as for the number of respondent firms, are unweighted. All results are limited to a maximum of 4,395 self-reported innovative firms⁴. Firms that did not innovate are excluded.

Based on the CIS-3 results, respondent firms are assigned to specific groups based on their sector, size using the number of employees, and the country in which they are located. This facilitates the presentation of results, given the small number of respondents from each country.

Sector: The firm's sector of activity is based on the NACE classification available from Dunn and Bradstreet for each firm⁵. These were reassigned to five sector groups, as shown in Table 3.1.

Table 3.1 Distribution of innovative firms by sector (unweighted count data)

Sector Group	Number of Firms	Percent	NACE classes
Low tech manufacturing & resources	1,150	26.2%	Agriculture, fishing, oil extraction, mining, food, textiles, wearing apparel, leather, wood products, pulp and paper, printing, petroleum products, non metallic mineral products, basic metals, fabricated metal products, furniture.
Medium & high tech manufacturing	673	15.3%	Chemicals, rubber and plastics, machinery, office machinery, electrical machinery, telecom equipment, instruments, automobiles, other transport equipment.
Utilities & construction	453	10.3%	Utilities, water, construction, sewage
Low tech services	1,183	26.9%	Wholesale, retail, hotels and restaurants, land, sea and air transport, rentals, personal services.
Knowledge services	935	21.3%	Telecommunications, finance, insurance, real estate, computer and software, R&D, other business activities, education, health, recreation and entertainment.
<i>Total</i>	<i>4,395</i>	<i>100%</i>	

⁴ This excludes 5 respondent firms active in public administration.

⁵ The survey contains several variables for the firm's sector. One variable identifies firms active in several sectors of policy interest, including software, biotechnologies, pharmaceuticals and medical devices. Unfortunately, the results are not accurate and consequently these results are not used. As an example, approximately one-third of Portuguese firms are accordingly active in biotechnology, which is not credible.

Notes: After weighting: 24.6% of firms are in low tech manufacturing and resources, 13.5% in medium and high tech manufacturing, 12.4% in utilities and construction, 30.1% in low tech services, and 19.3% in knowledge services.

Firm size: Firms were allocated to one of three size classes (20 to 49 employees, 50 to 249 employees, and 250 plus employees), using pre-survey data from Dunn and Bradstreet. The number of respondent firms in each size class is given in Table 3.2.

Table 3.2 Distribution of innovative firms by size (unweighted data)

Employees	Number of respondent firms	Percent
20 to 49	1,716	39.1%
50 to 249	1,536	34.9%
250+	1,143	26.0%
<i>Total</i>	<i>4,395</i>	<i>100%</i>

Notes: After weighting: 58.1% of firms have 20 to 49 employees, 30.0% have 50 to 249 employees, and 11.6% have 250 or more employees.

Country classification: The country of location for each firm is classified into one of four 'innovative classes' based on the overall innovative capability of the country, as measured by the 2007 European Innovation Scoreboard⁶. The four groups and number of respondent firms in each class are given in Table 3.3.

Table 3.3 Distribution of innovative firms by country group (unweighted data)

Innovative country class	Number of respondent firms	Percent	Countries
Leaders	1,022	23.3%	Sweden, Switzerland, Finland, Denmark, Germany, UK, Luxembourg
Followers	821	18.7%	Ireland, Austria, Netherlands, France, Belgium
Trailing	1,183	26.9%	Estonia, Norway, Czech Republic, Slovenia, Italy, Cyprus, Spain, Malta, Lithuania
Lagging	1,369	31.1%	Hungary, Greece, Slovakia, Poland, Portugal, Bulgaria, Latvia, Romania
<i>Total</i>	<i>4,395</i>	<i>100%</i>	

Notes: After weighting: 32.9% of respondent firms are in leader countries, 19.6% in follower countries, 22.0% in trailing countries, and 25.5% in lagging countries.

⁶ See European Innovation Scoreboard 2007, Inno Metrics, DG Enterprise, February 2008. This labels the corresponding country groupings as: "innovation leaders", "innovation followers", "moderate innovators" and "catching-up countries".

3.1 Comparison with the CIS





The 2007 IB survey includes 6 questions of relevance to non-R&D innovators that are not included in any of the five versions of the CIS:

1. Question 4 asks the respondent if the firm developed any product, process, or organizational innovations without using R&D (either in-house or contracted out R&D). The question is asked of both R&D performing firms and innovative firms that did not perform R&D.
2. Question 5 asks the respondent to estimate if the firm focused on product innovation, process innovation, or both equally.
3. Question 7 asks about the major sources of ideas for innovation from within the firm: production engineers, marketing, design staff, management, and the research department.
4. Questions 8, 10 and 13 ask, respectively, how firms innovate for product, process and organizational innovations. The question is similar to the CIS question on ‘who developed the innovation’, as shown in Table 2 for process innovation. However, the 2007 IB questionnaire subdivides the ‘mainly others’ question into two questions. One asks about ‘acquiring processes developed by other companies’, while the other asks about ‘customizing or modifying processes originally developed by other companies’.
5. Questions 9 and 11 ask, respectively, about the information sources used by the firm to modify products and processes obtained from other companies. Very little is known about knowledge sourcing for follow-on innovations. The CIS, for example, only asks about collaboration partners. In many cases the process at work for customization or modification will be similar to the process described by von Hippel for ‘user driven’ innovation, where commercial firms pick up and further develop innovations developed by users.
6. Questions 14 and 15 ask about the use of ten different types of publicly funded schemes to support innovation. Two of the schemes provide support for R&D while the other eight do not require R&D.

In respect to question 4 on ‘who developed’ the innovations, response categories B, C and D (see column 2 of Table 3.4) represent conditions in which the innovation is, in part, dependent on the diffusion of knowledge from sources external to the firm. For example, option B where the innovation is developed through collaboration requires the diffusion of knowledge, whereas both options C and D require the diffusion of embodied knowledge in the process acquired by the firm⁷.

⁷ For a copy of the IB survey questionnaire and for more methodological details on the IB survey, see Gallup, 2007.

Table 3.4 Comparison of the ‘who developed’ question for process innovations in the CIS and in the 2007 IB questionnaires

CIS	2007 IB version	
Who developed these process innovations [introduced over the previous three years]: Select only one option that best describes your firm.	In the last two years, has your firm introduced new or significantly improved processes using each of the following methods? Select all that apply:	
1. Mainly your enterprise or enterprise group	 A. Developing entirely new processes or significantly improving existing ones in-house	<i>If customized/modified, did your company obtain information, advice or support to help customize or modify these processes from:</i> The original developer or supplier Other companies that use similar processes Your customers for these processes Experts such as consultants, universities, etc.
2. Mainly your enterprise together with other enterprises or institutions	 B. Developing entirely new processes or significantly improving existing ones in collaboration with other companies, consultants, universities etc.	
3. Mainly other enterprises or institutions	 C. Customizing or modifying processes originally developed by other companies, organizations or individuals	
	 D. Acquiring processes developed by other companies, organizations or individuals, with little or no modification by your company	

3.2 R&D status

The focus of this report is on innovation that does not involve R&D. The sample of 4,395 innovative firms⁸ is divided into three groups based on their R&D status:

1. ***In-house R&D performers***: Firms that innovate and perform R&D in-house.
2. ***Contract R&D performers***: Firms that innovate and do not perform R&D in-house, but report contracting out R&D to other companies, consultants, universities, or research institutes.
3. ***Non-R&D innovators***: Firms that innovate but do not perform R&D in-house or report contracting out R&D.

⁸ An innovative firm reported having applied for a patent or introducing a new or significantly improved good, service, manufacturing process, logistics process, support process, or organizational method in the two years preceding the survey.

This report evaluates four aspects on non R&D based innovation: 1) firm characteristics that are correlated with whether or not an innovative firm performs R&D, 2) *how* non-R&D innovators innovate, including the information sources that they use, 3) the use of innovation support policies by non R&D innovators, and 4) the effect of R&D status on performance, measured by a change in turnover between 2004 and 2006. Although results are provided for contract R&D performers, most of the analyses compare the characteristics and activities of non-R&D innovators with those of in-house R&D performers.

4. Firm Characteristics and R&D Status

Of the 4,395 innovative firms, 52.5% (after weighting) are non-R&D innovators, 40.0% are in-house R&D performers, and 7.5% are contract R&D performers. The share of non-R&D innovators is similar to the 50% share observed for the CIS-3.

As shown in Table 4.1, several firm characteristics are correlated with R&D status. Compared to in-house R&D performers, a higher percentage of non-R&D innovators have less than 50 employees (62.9% versus 50.7%), are active in low technology service sectors (34.5% versus 21.4%), and are located in countries with trailing or lagging average innovative capabilities (54.8% versus 36.6%). In addition, a higher percentage of non-R&D innovators only sell to final consumers (26.1% versus 16.7% of in-house R&D performers). Contract R&D performers have similar markets as in-house R&D performers, but differ in terms of size, sector, and country from both in-house R&D performers and non-R&D innovators.

There is no statistically significant difference for the age of the firm, with 13.8% of non-R&D innovators established after January 1st 2000 versus 14.6% of in-house R&D performers.

Of note, non-R&D innovators are found in all size categories, countries, and sector classes. For example, 9.8% of non-R&D innovators have over 250 employees. Approximately one-third (31.3%) of non-R&D innovators are located in the leading innovative countries versus 38.4% of in-house R&D performers, while there is only a small difference in the percentage of non-R&D innovators and in-house R&D performers active in knowledge service sectors: 17.7% versus 21.7%.

Table 4.1 Characteristics of innovative firms by R&D status

Characteristic	R&D status			All innovative firms
	No R&D	in-house R&D	Contract R&D	
<i>Number of employees</i>				
20-49	62.9%	50.7%	64.1%	58.1%
49-249	27.2%	35.1%	22.3%	30.0%
250+	9.8%	14.2%	13.6%	11.8%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>
<i>Sector</i>				
Low tech manufacturing	21.2%	30.8%	15.5%	24.6%
Medium & high tech manuf	10.0%	19.1%	8.7%	13.5%
Industrial	16.6%	7.0%	11.5%	12.4%
Low tech services	34.5%	21.4%	46.0%	30.1%
Knowledge services	17.7%	21.7%	18.3%	19.3%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>
<i>Country class</i>				
Leader	31.3%	38.4%	14.9%	32.9%
Follower	13.9%	25.1%	31.0%	19.6%
Trailing	22.0%	21.5%	25.1%	22.0%
Lagging	32.8%	15.1%	29.1%	25.5%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>
<i>Firm's market</i>				
Other divisions of firm only	0.6%	1.6%	0.7%	1.0%
Other firms only	40.1%	50.1%	53.2%	45.0%
Consumers only	26.1%	16.7%	15.6%	21.6%
Other firms & consumers	33.2%	31.6%	30.5%	32.4%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>10.0%</i>	<i>100.0%</i>

1: Excludes 192 (4.4%) of innovative firms that could not reply to the questions on their market.

4.1 Logistic model: factors influencing non-R&D performance

Table 4.3 gives regression results for the factors that influence whether or not an innovative firm performs R&D. The purpose of the regression is to determine if the differences between non-R&D innovators and R&D performers hold after controlling for potential confounding. For example, the relationship between firm size and R&D status could be confounded if a high percentage of smaller firms are located in sectors where R&D is rarely necessary for innovation.

Table 4.2 includes both variables for firm characteristics (size, sector, country of location, age, and market), variables for how firms innovate (skills, a focus on product or process innovation, the source of ideas, from within the firm, for innovation; total innovation expenditures, and the change in the firm's turnover). Of note, the reduced regression is limited to firm characteristics. The complete regression is limited to firms that are both product and process innovators.

A negative coefficient indicates a lower probability that the firm performs R&D. For example, the coefficient for firms with 20-49 employees is negative 0.41 and highly statistically significant. This shows that compared to firms with over 250 employees (the reference category), small firms are much less likely to perform R&D.

The results for the reduced regression support the simple correlations in Table 4.1. Smaller innovative firms are less likely to perform R&D, there are large differences by sector (medium and high tech manufacturing firms are more likely to perform R&D than the reference category of high tech services), firms that only sell to individual consumers are less likely to perform R&D, and firms located in the Leader and Follower countries are more likely to perform R&D. The age of the firm has no effect on R&D status.

The variables for how firms innovate are evaluated in greater depth in Section 5 below. Of interest, firms that focus on processes are less likely to perform R&D, possibly because many process innovations can be developed through production engineering. This is also supported by the results for the sources of ideas. Firms that report production engineers/technicians or design staff as a major source of ideas are less likely to perform R&D.

Table 4.2 Probability of performing R&D (in-house or through contracts)

Variables	Reduced regression	Complete regression
Constant	-0.35*	2.66***
<i>Size</i>		
20-49 employees	-0.41***	0.05
50-249 employees	-0.14	0.11
<i>Sector</i>		
Low tech manufacturing	0.18*	0.13
Med & High tech manufacturing	0.44***	0.09
Industrial	-0.87***	-1.14***
Low tech services	-0.37***	-0.16
<i>Age</i> (established after 01/01/2000)	-0.06	-0.12
<i>Market</i>		
Other divisions of same firm only	0.56	0.08
Other firms only	0.16*	0.17
Consumers only	-0.49***	-0.56***
<i>Innovative capability of country of location</i>		
Leader	0.84***	0.58***
Following	1.19***	1.07***
Trailing	0.69***	0.78***
<i>Change in turnover (2004 to 2006)</i>		
Declined by > 25%		-0.28
Declined by 5%-25%		-0.45
Little change		-0.29
Increased by 10% to 50%		-0.09
<i>Skills for innovation</i>		
Focus prod/proc (More effort on products)		0.22**
Focus prod/proc (More effort on processes)		0.32*
		-0.47***
<i>Total Innovation expenditures in last year</i>		
< 100,000 Euros		-2.19***
100,000 to 499,000 Euros		-1.52*
500,000 to 1m Euros		-1.05
1 m to 5m Euros		-0.87
<i>Source of ideas for innovation from within the firm</i>		
Production Engineers & technicians		-0.66***
Marketing department		-0.03
Design staff		-0.85***
Management		0.09
Number of cases	4197	2757
% correctly predicted	66%	70.0%
Model with only intercept	53%	54%

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

Note: Results are weighted. The weights have been re-scaled to the size of the sample.

Reference categories: Dependent variable: Firm innovates without performing R&D. **Independent variables:** size: 250+ employees; sector: knowledge services; market: both other firms and consumers; country: lagging; change in turnover: over 50% increase; skills: no training for innovation; focus on product or process innovation: both equally; total innovation expenditures: over 5 million Euros

5. How non-R&D Innovators Innovate

This section first evaluates the relationship between R&D status and the types of innovations introduced by firms, the internal sources of ideas for innovation, and total innovation expenditures. Second, we look in greater detail at how firms develop innovations, with a specific focus on the types of knowledge that firms use to customize or modify products and processes. This is followed by an evaluation of the in-house creative capabilities of firms by R&D status.

5.1 Types of innovations

All firms are asked if they introduced a product, process, or organizational innovation “without using R&D (either in-house or contracted out R&D)”. Table 5.1 gives the percentage of firms by R&D status that introduced each of these three types of innovations without performing R&D. By definition, non-R&D innovators only innovate without performing R&D. A higher percentage of these firms introduce process innovations (82.2%) than product innovations (68.4%). Significantly fewer in-house and contract R&D firms introduce each type of innovation without performing R&D. This is particularly noticeable for process innovations.

Table 5.1 Percent of firms that introduced an innovation without performing R&D
(weighted results)

	No R&D	In-house R&D ¹	Contract R&D ¹
<i>N (unweighted)</i>	1996	2093	306
Product innovations	68.4	42.9	32.3
Process innovations	82.2	38.4	34.6
Organisational innovations	49.1	34.2	25.3
Any of the above	99.5 ²	63.0	55.8

1: Includes all R&D performing firms. 37% of in-house R&D firms and 44.2% of contract R&D firms did not report introducing any type of innovation without performing R&D.

2: The total does not add up to 100% because a small percentage of non R&D innovators only applied for one or more patents.

Firms were asked if they focused on product or process innovations, or on both equally. The first half of Table 5.2 shows that almost 52% of non R&D innovators focus on process innovation, whereas a higher percentage of in-house R&D performers focus on product innovation (42.4% versus 31.3% of non-R&D innovators). The second half of Table 5.2 is limited to firms that introduced both a product and a process innovation. Again, non-R&D innovators focus relatively more on process innovation while R&D performers focus on product innovation ($p < .000$). The higher prevalence of process innovation among non-R&D performers suggests that there are more options for developing process innovations without performing R&D. One possibility is the use of production engineering for process innovation.

Table 5.2 R&D status by a focus on product or process innovation¹

Expenditures (million Euros)	R&D status			Total
	No R&D	In-house R&D	Contract R&D	
<i>All firms that introduced a product or process innovation¹</i>				
More effort on products	29.2%	42.4%	37.0%	34.9%
More effort on processes	51.7%	31.3%	39.9%	42.9%
Both equally	19.1%	26.3%	23.1%	22.2%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>
<i>Firms that introduced <u>both</u> a product and process innovation²</i>				
More effort on products	25.8%	39.6%	29.9%	32.6%
More effort on processes	40.1%	26.5%	36.4%	33.5%
Both equally	34.1%	33.9%	33.7%	34.0%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>

1: Excludes 339 firms that did not introduce either a product or process innovation. Firms that only introduced a product innovation are assigned to 'more effort on products' while firms that only introduced a process innovation are assigned to 'more effort on processes'.

2: Excludes 99 firms (3.4%) out of 2,891 that had introduced both a product and process innovation that could not answer the question. The difference in the distribution between non-R&D innovators and in-house R&D performers is statistically significant with $p < 0.000$.

Table 5.3 shows the source of ideas for innovation by R&D status. Non-R&D innovators are less likely than firms that perform R&D to report each of the types of internal staff or departments as a 'major source of ideas for innovative activities'. This is partly because non R&D performing firms are smaller and fewer of them have marketing or design staff. There is little difference in the percent that source ideas from management, reported by 74.8% of non-R&D firms versus 79.1% of firms that perform R&D in-house. The most frequently cited source for non-R&D performers, after management, is marketing, production engineers and design staff. For in-house R&D performers, the most frequently cited sources are production engineers, marketing, and design staff.

The results in Table 5.3 do not distinguish between the effects of different idea sources on the probability that the firm performs R&D. As shown in the logistic model in Table 4.3, firms that assign a major importance to design staff and production engineers as a source of ideas for innovation, after controlling for all other factors, are *less* likely to perform R&D.

Table 5.3 R&D status by the source of ideas for innovation within the firm

Internal source of ideas	R&D status			Total
	No R&D	In-house R&D	Contract R&D	
Production engineers or technicians	27.7%	56.6%	35.1%	39.8%
Marketing department	34.5%	46.3%	35.7%	39.3%
Design staff	15.6%	41.2%	28.0%	26.7%
Management	74.8%	79.1%	70.0%	76.1%
<i>Any of the above</i>	84.9%	92.9%	81.1%	87.8%
R&D staff	-	49.5%	28.9%	24.6%

Notes: All differences between non-R&D innovators and in-house R&D performers are statistically significant with $p < 0.002$,

In-house R&D performers have higher total innovation expenditures than non-R&D innovators, while contract R&D firms lie in the middle. As shown in Table 5.4, 1.8% of non-R&D innovators had innovation expenditures over 1 million Euros, versus 2.8% of contract R&D firms and 8.2% of in-house R&D performers. Over half (58.7%) of non-R&D innovators spent less than 0.1 million Euros on innovation, versus 38.9% of in-house R&D performers. As shown in the logistic model in Table 4.3, firms that spend less than 0.5 million Euros on innovation are significantly less likely to perform R&D, but there is no difference for firms that spend over 0.5 million Euros on innovation.

Table 5.4 R&D status by innovation expenditures

Expenditures (million Euros)	R&D status			Total
	No R&D	In-house R&D	Contract R&D	
< 0.1	58.7%	38.9%	46.3%	49.8%
0.1 – 0.5	13.0%	23.4%	20.8%	17.7%
0.5 – 1.0	2.7%	7.7%	2.2%	4.6%
1.0 – 5.0	1.6%	6.5%	2.2%	3.6%
> 5.0	0.2%	1.7%	0.6%	0.8%
DK/NA	23.9%	21.7%	28.0%	23.3%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>

Notes: The difference in the distribution of innovation expenditures between non-R&D innovators and in-house R&D performers is statistically significant with $p < 0.000$.

5.2 How firms innovate

Table 5.5 gives the percentage of non-R&D innovators and in-house R&D performers that used each of four possible methods to introduce a product, process, or organizational innovation⁹. Respondents could check all four methods or only one method. For product and process innovations, there is no statistically significant difference between non-R&D innovators and in-house R&D performers in the percentage of firms that report technology adoption (selling on or acquisition with little or no modification in-house) or who report modifying products or process obtained from external sources. In all cases, approximately one-third of non-R&D innovators and in-house R&D use these two methods. For organizational innovations, significantly fewer non-R&D innovators report these two methods. For example 28.4% of non-R&D innovators report modifying organizational methods, versus 35.7% of in-house R&D performers.

The main difference is in the percentage that develop products, processes, or organizational methods in-house or in collaboration with other external sources. Approximately twice as many firms that perform R&D in-house collaborate on product or process innovations compared to non-R&D innovators (44.3% versus 21.8% for product innovations). In contrast, the difference is not as large for organizational innovations, where 29.9% of non-R&D innovators collaborate versus 40.1% of R&D performers, and 69.9% of non-R&D innovators develop organizational innovations in-house, versus 80.3% of in-house R&D performers.

The first three methods in Table 5.5 depend on the diffusion of knowledge in either embodied or disembodied form. At least one of these methods is reported by a higher percentage of in-house R&D performers than non-R&D performers. However, a higher percentage of non-R&D performers are dependent on methods based on the diffusion of knowledge than R&D performers. For example, over half (54.1%) of non-R&D innovators develop entirely new or significantly improved products in-house, but slightly more, 56.5%, use one of the three methods based on the diffusion of technology or knowledge. An even higher percentage of in-house R&D firms (66.2%) use diffusion based methods for product innovations, but even more (80.2%) develop product innovations in-house. The implication is that non-R&D innovators are relatively more dependent on the diffusion of knowledge than firms that perform R&D.

⁹ Full results, including for contract R&D performers, are given in Annex tables A1, A2 and A3.

Table 5.5 How non R&D innovators and in-house R&D performers developed innovations in the previous two years (percent of all firms by R&D status reporting each method)

Method	Product innovations		Process innovations		Organisational innovations	
	No R&D	In-house R&D	No R&D	In-house R&D	No R&D	In-house R&D
Selling on products or acquiring processes or organizational methods from external sources with little or no modification in-house	32.9%	32.7%	32.8%	30.1%	24.9%	32.3%
Customizing or modifying products, processes or organizational methods obtained from external sources	32.7%	33.8%	30.0%	35.3%	28.4%	35.7%
Developing entirely new or significantly improved products, processes or organizational methods in collaboration with other firms, consultants, universities, etc.	21.8%	44.3%	19.4%	38.9%	29.2%	40.1%
<i>Any diffusion based method</i>	<i>56.5%</i>	<i>66.2%</i>	<i>47.6%</i>	<i>56.0%</i>	<i>55.0%</i>	<i>60.9%</i>
Developing entirely new or significantly improved products, processes, or organizational methods in-house	54.1%	80.2%	47.8%	72.2%	69.9%	80.3%

Notes: Results limited to firms that introduced a product, process, or organizational innovation respectively.

Statistical significance of difference between non-R&D innovators and in-house R&D performers: Products: statistically significant for collaboration, in-house, and any diffusion method ($p < 0.001$). Process innovations: statistically significant for customizing, collaboration and in-house ($p < 0.001$). Organizational innovations: all differences statistically significant ($p < 0.002$).

5.2.1 Source of information for modification or customisation

Table 5.6 looks at the sources of information, advice or support that are used to customize or modify products and processes obtained from other external sources (the question was not included for organizational innovation)¹⁰. As noted above in section 3.1, very little is known about this form of ‘follow on’ innovation, where firms build upon or modify technologies or organizational methods obtained from other firms.

Table 5.6 Information sources used to help customize or modify products and processes obtained from external sources: percent of firms by R&D status reporting each source

Method	Product innovations		Process innovations	
	No R&D	In-house R&D	No R&D	In-house R&D
Original developer or supplier	56.0%	59.0%	64.2%	58.0%
Other companies that use similar products	34.1%	34.0%	34.0%	39.0%
Your customer for these products	52.6%	57.0%	35.6%	39.0%
Experts (consultants, universities, etc)	23.0%	45.1%	32.1%	53.3%

Statistical significance of differences between non-R&D innovators and in-house R&D performers: For both product and process innovations, only significant for experts ($p < 0.000$).

There is no statistically significant difference in the percentage of non-R&D innovators and in-house R&D performers that report using the assistance of the other companies, customers, or the original developer to modify or customize product or process innovations. The largest and only significant difference for both product and process innovations is for the use of external experts, which are used by a much higher percentage of in-house R&D firms (53.3% versus 32.1% for process innovations).

For both types of firms, the most frequently reported source is the original developer or supplier, followed by customers. The exception is for process innovations, where the second most frequently cited source is external experts for in-house R&D performers. Of interest is the fact that approximately one-third of both types of firms report obtaining information from other companies that use similar products, many of which could be competitors. The lower use of external experts by non-R&D innovators could be due to the higher costs of using this source or because of a qualitative difference in the degree of modification, with external experts brought in for more extensive modifications.

5.3 Innovative capabilities

The innovative capabilities of firms roughly fall along four levels of capabilities ranging from firms that innovate only by obtaining products, processes and organizational

¹⁰ Full results are given in Annex Tables A4 and A5.

innovations developed by other firms (adoption), to firms with intensive in-house projects to develop innovations. Table 5.7 gives results by R&D status for where the respondent firms fall along this categorisation for product and process innovations combined and for organizational innovations.

Activities to customize or modify products, processes or organizational methods obtained from external sources are likely to require greater in-house capabilities than adoption, while collaborative efforts will require even more skills. Even firms that only collaborate through contracting out activities must have some in-house innovative capabilities to formulate and describe the problem to contractors. The most advanced innovative capabilities probably occur among firms that can develop innovations largely in-house. It is possible that many collaborative innovations could require more skills than those used on in-house projects, but as shown in Table 5.7 collaboration by itself is infrequent.

Table 5.7 Method of innovation (from least to most advanced in-house capabilities) for product or process innovation and for organisational innovation

Method	Product/process		Organisational	
	No R&D	In-house R&D	No R&D	In-house R&D
<i>N (unweighted)</i>	1,529	1,861	813	1,151
Selling on products, acquiring processes, adopting organizational methods developed by others	11.2%	2.3%	2.2%	0.8%
Customizing or modifying products/processes or organizational methods obtained from external sources	12.7%	3.3%	8.4%	5.5%
Developing entirely new or significantly improving products/processes or organizational methods in collaboration	5.3%	3.8%	5.5%	4.8%
Developing entirely new or significantly improving products/processes or organizational methods in-house	70.9%	90.5%	83.9%	88.9%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>

Note: 12.3% (unweighted) of firms that introduced either a product or process innovation and 16.3% of organizational innovators were unable to answer this question.

Statistical significance of the difference in the distribution of capabilities between non-R&D innovators and in-house R&D performers: Product/process $p < 0.000$, Organisational innovation $p = 0.004$.

The results in Table 5.7 show that, as expected, a significantly higher percentage of non-R&D firms have less advanced capabilities, i.e. they report that they only sell on products or acquire processes from other sources, (11.2%) than firms that perform R&D in-house (2.3%). A similar difference also applies to firms that have only customized or modified products obtained from other sources (these firms could have also sold on products or

acquired processes)¹¹. Of interest, 70.9% of non-R&D innovators and 90.5% of in-house R&D performers develop technical innovations in-house. This is a substantial share of non-R&D innovators, showing that these firms, even if they do not perform R&D, are likely to have significant innovative capabilities in-house.

The difference in the distribution of innovative capabilities for organizational innovation between non-R&D innovators and in-house R&D performers, although statistically significant, are very minor. A slightly larger share of non-R&D innovators go no further than modifying organizational innovations, while a slightly larger share of in-house R&D performers can develop organizational innovations in-house.

Table 5.8 gives the average percent of time spent by staff using each method of developing technical innovations. No time is allotted to technology acquisition, as this is expected to require very little in-house effort¹².

Table 5.8 Average percent of staff's time to develop product and process innovations spent on each of three innovation methods.

Method	R&D status			Total
	No R&D	in-house R&D	Contract R&D	
<i>N (unweighted)</i>	1,248	1,422	185	2,855
Customizing or modifying products or processes obtained from external sources	25.9%	18.9%	24.2%	22.9%
Developing entirely new or significantly improving products or processes in collaboration with other firms, consultants, universities, etc.	19.7%	18.2%	22.4%	19.2%
Developing entirely new or significantly improving products or processes in-house	54.4%	62.9%	53.5%	57.9%
<i>Total</i>	100.0%	100.0%	100.0%	100.0%

Note: 31.3% of eligible respondents were unable to answer this question, with the rate higher among non-R&D firms than among in-house R&D firms (34.5% for non-R&D firms, 27.9% for in-house R&D firms, and 33.2% for contract R&D firms).

Statistical significance of difference between non-R&D innovators and in-house R&D performers: $p < 0.000$ for share of time spent on modification and in-house activities, but no difference for time spent on collaboration ($p = 0.153$) based on ANOVA.

¹¹ The percentage of innovative firms that only innovate by technology adoption or through modification is lower than in the CIS-3 survey. The difference is due to the design of the relevant questions. The CIS question on 'who' developed the innovations asks respondents to select one option only that is most characteristic of their method of innovating. As an example, firms that mostly innovate through technology adoption, even though they occasionally modify technologies or innovate in-house, are consequently self-defined as technology adopters.

¹² As with contracting out, this will require some skills for evaluating new technologies on the market in order to make a purchase decision.

As expected, non-R&D innovators have the highest average percentage of time spent on technology modification (25.9% versus 18.9% for in-house R&D firms), but there is a larger difference between non-R&D innovators and in-house R&D performers in the average share of time expended on in-house innovation: 54.4% versus 62.9% of all time spent on innovative activities. The questionnaire does not ask for the total amount of time spent on innovation, but it is highly probable that non-R&D firms spend less time in total. This is supported by the results on innovation expenditures, where non-R&D firms spend less on innovation than in-house R&D firms.

Another measure of innovative capabilities is investment in skills or training for innovative activities. Table 5.9 shows that a higher percentage of in-house R&D performers compared to non-R&D innovators provide training or skills upgrading for their innovations (79.0% versus 69.5%). However, a large majority of non-R&D innovators still invest in upgrading skills as part of their innovative activities.

Table 5.9 Percent of firms providing training or skill upgrading for product, process, or organizational innovation¹

Skills	R&D status			Total
	No R&D	in-house R&D	Contract R&D	
No training or skills for innovations	30.5%	21.0%	25.3%	26.4%
Training or skills provided	69.5%	79.0%	74.7%	73.6%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>

1: Excludes 140 innovative firms that did not introduce a product, process, or organizational innovation. Statistical significance of difference between non-R&D innovators and in-house R&D performers: $p < 0.000$.

6. Use of Policies to Support Innovation

Section 5 above shows that the majority of non R&D innovators invest in creative innovative activities. Many of these firms should therefore be able to benefit from policy support for their innovative activities.

Table 6.1 summarizes the percentage of each type of firm that report applying for or receiving support from 10 different types of innovation support policies. The ten programmes are divided into three types: programmes that specifically support R&D (non-R&D innovators can report applying for these programmes), programmes that do not require R&D, and networking support programmes that do not specifically require R&D, but which in the European context are frequently linked to R&D. A lower percentage of non R&D innovators report using each programme, even when the programme does not require R&D, as in subsidies for acquiring machinery, equipment or software. Overall, only 35.3% of non-R&D innovators report using at least one innovation support programme, compared to 55.3% of R&D performers.

Table 6.1 Policy use by R&D status (percent of firms by R&D status that have applied for or received support from each publicly funded scheme)

Policy	R&D status			
	No R&D	In-house R&D	Contract R&D	Total
<i>N (unweighted)</i>	1,996	2,093	306	4,395
<i>Programmes that require R&D</i>				
Direct support to finance R&D based innovation projects	2.7%	20.1%	12.1%	10.3%
Tax reductions for R&D expenditures	2.1%	14.7%	5.9%	7.4%
<i>Any R&D based programme</i>	4.3%	27.2%	15.8%	14.3%
<i>Programmes that do not require R&D</i>				
Direct support to finance innovation projects with no R&D	5.6%	7.9%	8.0%	6.7%
Subsidies for buildings/infrastructure for innovation activities	7.4%	8.6%	9.0%	8.0%
Subsidies for acquiring machinery, equipment, software	10.4%	17.3%	21.7%	14.0%
Tax reductions for innovation expenditures other than R&D	3.2%	7.2%	7.8%	5.1%
Attending/participating in trade fairs or trade missions	15.0%	28.4%	36.3%	22.0%
Information on market needs, conditions, new regulations etc	13.8%	27.1%	25.5%	21.0%
<i>Any non-R&D based programme</i>	32.6%	47.2%	60.7%	40.5%
<i>Programmes that are often linked to R&D</i>				
Networking with universities or research institutes	5.0%	15.9%	19.8%	10.5%
Networking with companies	12.8%	22.0%	28.8%	17.7%
<i>Any of the above ten programmes</i>	35.3%	55.3%	63.4%	45.4%

Note: Question refers to last two years before the interview.

Statistical significance of difference between non-R&D innovators and in-house R&D performers: For all ten support programmes, $p < 0.000$.

A separate question asked respondents who reported the use of one or more innovation support programmes if 'the support... was crucial to any of your company's innovation projects, such that the innovation would not have been developed or introduced without the support'. There is almost no difference in the percentage of in-house R&D performers and contract R&D performers who answered yes (26.3% versus 25.5%), but a significantly lower percentage of non-R&D innovators than in-house R&D performers replied yes (20.3%, $p = 0.005$).

6.1 Regression analyses

In order to control for possible confounding, for example by the country of location of the firm, separate logistic regressions were run for firms that apply for or receive support for innovation activities that do not require R&D. Table 6.2 gives results for any of six programmes that do not require R&D.

Table 6.2 Use of or application for any of six innovation support policies that do not require R&D

	Reduced regression	Full regression ¹
<i>Size</i>		
20-49 employees	-0.40***	-0.25*
50-249 employees	-0.10	-0.11
<i>Sector</i>		
Low tech manufacturing	1.93*	0.12
Medium/high tech manuf	0.03	-0.03
Industrial	0.08	-0.14
Low tech services	0.08	0.28**
<i>Innovative capability of country of location</i>		
Leader	-0.90***	-0.94***
Follower	0.45***	0.71***
Trailing	-0.19**	-0.39***
Age (estab. After 01/01/2000)	-0.14	-0.34**
Non R&D innovator	-0.67***	-0.39***
<i>Total innovation expenditures</i>		
< 100,000 Euros		-0.51
100,000 to 499,000 Euros		-0.56
500,000 to 1m Euros		-0.08
1 m to 5m Euros		-0.60
Skill training for innovation		0.36***
<i>Innovative capabilities</i>		
Adopter		-0.28*
Customise/modify		-0.52**
Collaboration		-0.26
Constant	0.38**	0.62
Number of cases	4,389	2,761
% correctly predicted	64.8%	64.9%
Model only with intercept	59.5%	56.2%
Model Chi-square	383.4***	307.2***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

1: Limited to innovative firms that had introduced a product or process innovation (excludes 113 firms that only introduced an organizational innovation).

Note: Results are weighted. The weights have been re-scaled to the size of the sample.

Reference categories: **Dependent variable:** reports no use of any of the six programmes to support non-R&D based innovation. **Independent variables:** Size - 250+ employees; Sector- knowledge services; Country- lagging; Innovation expenditures – over 5 million Euros; Non R&D innovator – firms that perform R&D in-house or on a contract basis; Skills – no training for innovation provided; Innovative capabilities – in-house development of product or process innovations.

The reduced regression results in Table 6.2 control for the effect of confounding by size, sector, country of location and age. Innovative firms that do not perform R&D are significantly more likely *not* to apply for or benefit from any of these programmes that do not require R&D (coefficient of -0.67)¹³. In addition, smaller firms are less likely to benefit from innovation support policies and firms in low technology manufacturing sectors, compared to the reference category of knowledge intensive services.

The full regression in Table 6.2 includes the confounder variables plus variables for the innovative capabilities of the firm. This is because one possible explanation for the fact that non-R&D innovators are less likely to apply for or benefit from innovation support policies is that they lack in-house innovative capabilities. Three variables are included to capture innovative capabilities: total innovation expenditures, skills (if the firm provided training or skill upgrading for product, process, or organizational innovations), and the highest level of in-house innovative capability for product or process innovation.

After controlling for innovative capabilities, non-R&D innovators are still significantly less likely to apply for or use innovation support policies (coefficient of -0.39), although the effect is not as large as in the reduced regression. Of note, the variable for the firm's total innovation expenditures has no effect. Firms that innovate primarily through customizing or modifying products or processes are significantly less likely than firms that develop innovations in-house to apply for or use innovation support programmes¹⁴.

7. R&D Status and Performance

There is little difference in the distribution of a change in annual revenues between 2004 and 2006 by R&D status (see Table 7.1). The difference is not statistically significant between non-R&D innovators and in-house R&D performers ($p = 0.84$). This shows that the R&D status of innovative firms has little effect on revenue growth. Of note, data are not available for profitability.

The performance variable is measured on an ordinal level which is suitable for an ordered logit regression. However, an ordered logit model gives poor results. Consequently we use a logistic model which compares firms with positive revenue growth against firms with no change in revenue combined with firms with a decline in revenues. The regression includes the same variables as in Table 6.2 with one exception: it includes a variable 'Policy' that equals 1 when the firm reports that public support for innovation was 'crucial to any of the company's innovation projects' and 0 otherwise.

¹³ The results (not shown) for any of the ten programmes are similar. The only difference is that the effect for the age of the firm is statistically significant, with young firms less likely than older firms to use or apply for any innovation support policy.

¹⁴ The results (not shown) for any of the ten programmes are similar. The only difference is that low tech manufacturing firms are significantly less likely to apply for or benefit from one or more programme and the coefficient for adopter firms is no longer significant.

Table 7.1 R&D status by change in turnover between 2004 and 2006¹

Change in income	R&D status			Total
	No R&D	R&D in-house	Contract R&D only	
Decreased > 25%	1.7%	1.7%	0.4%	1.6%
Decreased 5% - 25%	7.8%	7.8%	8.3%	7.8%
Little change	54.6%	52.9%	63.9%	54.6%
Increased 10% to 50%	32.7%	34.6%	24.9%	32.9%
Increased > 50%	3.2%	3.0%	2.5%	3.1%
<i>Total</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>	<i>100.0%</i>

1: Excludes 553 (12.6%) innovative firms that could not reply to the question series.

The regression results are given in Table 7.2. Neither the reduced or full regression models give good results, with low model chi-squares and little or no improvement in the ability of the model to correctly predict the dependent variable. However, in both models there is no difference in the likelihood or reporting an increase in revenues for non-R&D innovators and for firms that perform R&D¹⁵. This suggests that there is no detectable penalty, in terms of revenues, for firms that innovate without performing R&D. The largest effect on revenue performance is for firms active in industrial sectors (possibly due to an increase in mineral and energy prices over this time period) and for firms located in the reference group 'lagging' countries, most of which are new member states, where structural changes are possibly producing rapid revenue growth. As expected, young firms are more likely to report revenue growth than older firms.

Of the variables for innovative capabilities, total innovation expenditures and skill training have no effect on revenue growth. Firms that only customize or modify products or processes have a significantly lower probability of revenue growth than the reference category of firms that can develop innovations in-house. Finally, 'crucial' policy support had no effect on the probability of reporting revenue growth.

¹⁵ There is no difference when the reference category for R&D status excludes contract R&D performers.

Table 7.1 Logistic regression for an increase in revenues between 2004 and 2006

	Reduced regression	Full regression ¹
<i>Size</i>		
20-49 employees	-0.16	-0.13
50-249 employees	-0.03	0.07
<i>Sector</i>		
Low tech manufacturing	0.03	-0.10
Medium/high tech manuf	0.22*	0.04
Industrial	0.40**	0.61***
Low tech services	0.06	-0.04
<i>Innovative capability of country of location</i>		
Leader	-0.52***	-0.57***
Follower	-0.37***	-0.29*
Trailing	-0.42***	-0.42**
Age (estab. After 01/01/2000)	0.21**	0.39**
Non R&D innovator	-0.08	-0.05
<i>Total innovation expenditures</i>		
< 100,000 Euros		-0.37
100,000 to 499,000 Euros		-0.00
500,000 to 1m Euros		0.20
1 m to 5m Euros		0.16
Skill training for innovation		0.03
<i>Innovative capabilities</i>		
Adopter		-0.13
Customise/modify		-0.44**
Collaboration		-0.12
Policy support crucial		-0.20
Constant		0.24
Number of cases	3,839	2,609
% correctly predicted	63.8%	64.4%
Model only with intercept	64.0%	61.7%
Model Chi-square	57.9***	93.4***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

1: Limited to innovative firms that had introduced a product or process innovation (excludes 113 firms that only introduced an organizational innovation).

Note: Results are weighted. The weights have been re-scaled to the size of the sample.

Reference categories: Dependent variable: decline or no change in revenue growth. **Independent variables:** Size - 250+ employees; Sector- knowledge services; Country- lagging; Innovation expenditures – over 5 million Euros; Non R&D innovator – firms that perform R&D in-house or on a contract basis; Skills – no training for innovation provided; Innovative capabilities – in-house development of product or process innovations. Policy- policy support crucial for one or more of the firm's innovations.

8. Conclusions

Innovative firms that do not perform R&D have been recognized in innovation theory, but largely neglected by both academic research and by the policy community. This is partly due to the belief that non-R&D innovators are either infrequent or have little to offer, with most productivity improvements and performance outcomes due to more advanced innovative activities based on R&D. The results of this study show that many of these assumptions are not justified. To start, slightly over half of all innovative firms do not perform R&D and there is no difference in performance, measured by a change in revenues, between innovative firms that do and do not perform R&D. A major question then is: how do these firms innovate?

Compared to firms that perform R&D in-house, innovative firms that do not perform R&D spend less on innovation and have lower innovative capabilities than firms that perform R&D. In addition, a much higher percentage of non-R&D innovators, 11% versus 2% of R&D performing firms, only introduced a product or process innovation through technology adoption in the two years preceding the survey. This is not surprising. However, a striking result of this study is that many of the differences are minor: 71% of non-R&D innovators report developing either product or process innovations in-house (compared to 91% of in-house R&D performers), 54% of staff time on innovation is for developing product and process innovations in-house (compared to 63% for in-house R&D performers) and 70% report training or skills upgrading for innovation (compared to 79% of in-house R&D performers).

An important method (not identified in the CIS surveys) that is used by both non-R&D innovators and R&D performing firms to innovate is to customize or modify products, processes, or organizational methods developed by other firms or organisations. This is reported by approximately one-third of both types of firms. The largest difference in how non-R&D and R&D performers innovate is in the use of collaboration, which is reported by twice as many in-house R&D performers: 44% versus 22% of non-R&D innovators. Another difference is that non-R&D innovators focus more on process innovation and are less likely to draw on the expertise of production engineers and design staff. However, without an R&D department, design and engineering staff could be relatively more important to non-R&D innovators than to R&D performing firms (see Table 4.2).

These results suggest that simply providing subsidies for R&D with the expectation that the fruits will trickle to other firms through simple technology diffusion is not enough. Most innovative firms need to conduct creative innovative activities in-house. These activities, which involve are a lot more than R&D, need to be supported. The goal for policy should be to provide support for innovative firms to develop their innovative capabilities: to move from simple technology adoption, to the ability to modify technology in-house, to developing products and processes entirely in-house.

Unfortunately, non-R&D innovators are considerably less likely to apply for or use innovation support programmes. Only 33% of non-R&D innovators report using at least one of six types of innovation support programmes, *that do not require R&D* compared to 47% of R&D performers. These differences hold after controlling for the innovative

capabilities of non-R&D and R&D innovators. This suggests that there is a general policy failure to support non-R&D innovators in upgrading their innovative capabilities.

References

- Arundel, A. and H. Hollanders, 2005. *EXIS: An exploratory approach to innovation scoreboards*. European Trend Chart on Innovation. Brussels: European Commission.
- Arundel, A, Bordoy C, Mohnen P, and Smith, K. Innovation Surveys and Policy: Lessons from the CIS, In Nauwelaers, C. and R. Wintjes (ed.), *Innovation Policy in Europe*, Edward Elgar, Cheltenham, 2007.
- Cassiman B, Veugelers R. Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms, *Research Policy*, 1999, 28, p.63-80.
- Cohen, W.M. and D.A. Levinthal, 1989. Innovation and learning: The two faces of R&D. *The Economic Journal*, 99, pp. 569-596.
- Djellal, F., Francoz., D., Gallouj, C., Gallouj, F. and Y. Jacquin (2003). Revising the definition of research and development in the light of the specificities of services. *Science and Public Policy*, 30(6), pp. 415-429.
- Dotter, H.J., de Groot, A.G.A. and J.A.H. Snijders, 1990. *The Financing of Product Innovations* (in Dutch). Report to the Rabobank. EIM, Zoetermeer.
- Evangelista, R., Sandven, T., Sirrilli, G. and K. Smith, 1998. Measuring innovation in European industry. *International Journal of Economics and Business*, 3(5), pp. 311-333.
- Evangelista, R., Iammarino, S., Mastrostefano, V. and A. Silvani, 2002. Looking for regional systems of innovation: Evidence from the Italian innovation survey. *Regional Studies*, 36(2), pp. 173-186.
- Evangelista, R. and V. Mastrostefano, 2006. Firm size, sectors and countries as sources of variety in innovation. *Economics of Innovation and New Technology*, 15(3), pp. 247-270.
- Gallup, 2007. Flash EB Series #215: Innobarometer 2007: Analytical Report. DG Enterprise, European Commission, Brussels.
- Gellatly, G. and V. Peters, 1999. Understanding the innovation process: Innovation in dynamic service industries, *Research Paper Series, No. 127*. Statistics Canada.
- Gottardi, G., 1996. Technology strategies, innovation without R&D and the creation of knowledge within industrial districts. *Journal of Industry Studies*, 3(2), pp. 119-134.
- Grimpe, C. and W. Sofka, 2007. Search patterns and absorptive capacity: A comparison of low- and high-technology firms from thirteen European countries. *ZEW Discussion Paper No. 07-062*. ZEW Centre for European Economic Research.
- Hansen, P.A. and G. Serin, 1997. Will low technology products disappear? The hidden innovation processes in low technology industries. *Technological Forecasting and Social Change*, 55, pp. 179-191.
- Hippel, E. von, 2002. Horizontal innovation networks – By and for users. *MIT Sloan School of Management Working Paper No. 4366-02*. MIT Sloan School of Management.
- Hippel, E. von, 2005. *Democratizing innovation: The evolving phenomenon of user innovation*. *State-of-the-art-article*. MIT Sloan School of Management.
- Huston, L. and N. Sakkab, 2006. Connect and develop. *Harvard Business Review*, 84(3), pp. 58-66.

- Kim, L. and R.R. Nelson, 2000. *Technology, learning and innovation: Experiences of newly industrialising economies*. Cambridge: Cambridge University Press.
- Kline, S. and N. Rosenberg, 1986. An overview of innovation, in R. Landau (ed.), *The positive sum strategy: Harnessing technology for economic growth*. Washington: National Academy Press.
- Lhuillery, S. and M. Bogers, 2006. Measuring user innovation: What can a standard innovation survey tell us? *Paper presented at the International Conference on Science, Technology and Innovation Indicators – History and New Perspectives*. Lugano, 15-17 November.
- Nascia, L. and G. Perani, 2002. Diversity of innovation in Europe. *International Review of Applied Economics*, 16(3), pp. 277-293.
- OECD, 2002. Frascati Manual, OECD, Paris.
- OECD, 2005. Oslo Manual, OECD, Paris.
- Roper, S., 1999. Under-reporting of R&D in small firms: The impact on international R&D comparisons. *Small Business Economics*, 12, pp. 131-135.
- Rosa, J.M., 2004. Importance of research and development in the business services sector, *Innovation Analysis Bulletin (Statistics Canada)*, 6(2), pp. 11-13.
- Smith, K., 2005. Measuring innovation, in Fagerberg, J., Mowery, D.C. and R.R. Nelson (eds.) *The Oxford handbook of innovation*. Oxford: Oxford University Press.
- Sterlacchini, A. (1999), “Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance”, *Research Policy*, 28 pp.819-832.
- Tether, B.S., 2001. Identifying innovation, innovators and innovative behaviours: A critical assessment of the Community Innovation Survey (CIS). *CRIC Discussion Paper No. 48*. Manchester: University of Manchester, Centre for Research on Innovation and Competition.
- Tether, B.S., 2004. Do services innovate (differently)? *CRIC Discussion Paper No. 66*. Manchester: University of Manchester, Centre for Research on Innovation and Competition.
- Wyatt, A. 2001. Accounting for intangibles: The great divide between obscurity in innovation and the balance sheet. *The Singapore Economic Review*, 46(1), pp. 83-117.

Annex A: Supplementary Tables

**Table A1 How firms developed product innovations in the previous two years
(percent of firms by R&D status reporting each method)**

Method	R&D status			Total
	No R&D	R&D in-house	Contract R&D only	
<i>N (unweighted)</i>	1428	1769	225	3422
Selling on products from external sources with little or no modification in-house	32.9%	32.7%	50.6%	34.1%
Customizing or modifying products obtained from external sources	32.7%	33.8%	37.2%	33.5%
Developing entirely new or significantly improved products in collaboration with other firms, consultants, universities, etc.	21.8%	44.3%	60.3%	34.6%
<i>Any diffusion based method</i>	56.5%	66.2%	79.5%	62.5%
Developing entirely new or significantly improved products in-house	54.1%	80.2%	45.2%	65.1%

**Table A2 How firms developed process innovations in the previous two years
(percent of firms by R&D status reporting each method)**

Method	R&D status			Total
	No R&D	R&D in-house	Contract R&D only	
<i>N (unweighted)</i>	1600	1774	250	3624
Acquiring processes developed by others, with little or no modification in-house	32.8%	30.1%	43.8%	32.4%
Customizing or modifying processes obtained from external sources	30.0%	35.3%	38.7%	32.7%
Developing entirely new or significantly improving processes in collaboration with other firms, consultants, universities, etc.	19.4%	38.9%	50.6%	29.3%
<i>Any diffusion based method</i>	47.6%	56.0%	64.4%	52.1%
Developing entirely new or significantly improving processes in-house	47.8%	72.2%	65.1%	58.8%

Table A3 How firms developed organisational innovations in the previous two years (percent of firms by R&D status reporting each method)

Method	R&D status				Total
	No R&D	R&D in-house	Contract R&D only		
<i>N (unweighted)</i>	1,030	1,316	175	2,521	
Acquiring organizational methods developed by others, with little or no modification in-house	24.9%	32.3%	34.9%	28.9%	
Customizing or modifying organizational methods originally developed by external sources	28.4%	35.7%	45.0%	32.7%	
Developing entirely new or significantly improving organizational methods in collaboration with other firms, consultants, universities, etc.	29.2%	40.1%	38.5%	34.7%	
<i>Any diffusion based method</i>	55.0%	60.9%	63.1%	58.2%	
Developing entirely new or significantly improving organizational methods in-house	69.9%	80.3%	53.7%	73.5%	

Table A4 Information sources for customizing or modifying products obtained from external sources (percent of firms by R&D status reporting each source)

Method	R&D status				Total
	No R&D	R&D in-house	Contract R&D only		
<i>N (unweighted)</i>	445	694	81	1220	
Original developer or supplier	56.0%	59.0%	74.2%	58.8%	
Other companies that use similar products	34.1%	34.0%	56.2%	35.9%	
Your customer for these products	52.6%	57.0%	52.3%	54.5%	
Experts (consultants, universities, etc)	23.0%	45.1%	52.8%	35.4%	

Table A5 Information sources for customizing or modifying processes obtained from external sources (percent of firms by R&D status reporting each source)

Method	R&D status			Total
	No R&D	R&D in-house	Contract R&D only	
<i>N (unweighted)</i>	480	759	92	1331
Original developer or supplier	64.2%	58.0%	75.0%	62.4%
Other companies that use similar products	34.0%	39.0%	60.4%	38.3%
Your customer for these products	35.6%	39.0%	63.0%	39.3%
Experts (consultants, universities, etc)	32.1%	53.3%	42.9%	42.2%