



The Impact of the Economic Crisis on Innovation

Analysis based on the Innobarometer 2009 survey

This report was prepared by

Minna Kanerva – MERIT¹

Hugo Hollanders – MERIT¹

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¹ MERIT, Maastricht Economic and social Research and training centre on Innovation and Technology, Maastricht University, PO Box 616, 6200 MD Maastricht, the Netherlands (<http://www.merit.unu.edu>).
Contact: Tel +31 43 3884412; Fax +31 43 3884495; Email: h.hollanders@maastrichtuniversity.nl

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Executive summary

The financial crisis which started in 2007 has triggered a global economic downturn. This has resulted in at first falling economic growth rates followed by a real economic decline in many countries. Indicators of innovation performance, including those used in European Innovation Scoreboard, have a time lag of one or more years and therefore do not yet reveal the full impact of the crisis that reached its height in the second half of 2008.

This Thematic Paper is based on an analysis of the Innobarometer 2009 survey (EC, 2009b) of innovating firms in the EU27 which was conducted in April 2009. The survey data indicates that 23% of innovative firms had decreased their innovation expenditures as a direct result of the economic downturn, and that 29% of firms expected their 2009 innovation expenditures to be lower than in 2008. This showed a marked transition from the period 2006-08 where only 9% of firms had decreased innovation expenditures. The analysis in this paper uses micro-data from the survey to analyse which factors appear to have influenced firms decisions to reduce innovation expenditure and to consider what the longer term impacts of this could be. The main findings are as follows.

Firms that are more innovative are less likely to cut back on innovation expenditures. This finding goes against the initial hypothesis that firms with higher levels of innovation expenditure would be more likely to cut back. It is a positive finding and suggests that the EU's most innovative firms may be relatively less affected by the economic crisis. Moreover, the analysis shows:

- Firms where innovative products and services account for a larger share of sales are less likely to reduce innovation expenditures.
- Firms that perform R&D as part of their innovation activities are less likely to reduce overall innovation expenditures.
- At the firm level, there is no significant difference between those with high overall innovation expenditures and others in the likelihood to have reduced innovative expenditures. However, at the sectoral level, firms in the medium to high innovation intensive sectors are more likely to expect to cut their innovation expenditures.
- Firms that view cost cutting as the main source of future competitive advantage are more likely to reduce innovation expenditures.

Firms pursuing broader innovation strategies are in some cases less likely to have reduced their innovation expenditure. This finding tends to support the hypothesis that broader strategies (i.e. that include user innovation, open innovation etc.) make firms more resilient to economic downturns. This is consistent with the EIS thematic paper on user innovation, which shows that "user innovator" firms tend to be more successful innovators. However the findings are inconclusive in that:

- Firms with innovation strategies that involve users and those that use knowledge management systems, are less likely to expect to reduce their innovation expenditures.
- However firms with strategies to integrate different activities in support of innovation (such as staff rotations, but also knowledge management systems) are more likely to have reduced their innovation expenditures in the recent past.

The economic crisis may lead to a reversal of the convergence between EU countries in innovation performance. The 2008 European Innovation Scoreboard showed a clear process of convergence between EU Member States. In the 2009 Scoreboard, this process is less clear but this still does not capture the full impacts of the crisis as most data come from 2007 and 2008. The findings in this report suggest that the rapid advances in innovation performance made in many lower performing countries may not be maintained, at least in the short term, due to the severity of the economic crisis. More specifically, the analysis shows that:

- Firms in countries which have been experiencing the fastest rates of improvement in their innovation performance have been affected most by the economic crisis.
- Firms in countries with the largest economic downturns are more likely to reduce their innovation expenditures.

Public support appears to have helped firms maintain innovation expenditures. The analysis of other factors with a significant effect on which firms decreased innovation expenditure shows that firms that have experienced a positive effect of improved financial public support are less likely to cut their innovation expenditures and more likely to have increased their expenditures. This suggests the increased importance of public support focusing on innovative firms at times of economic crisis.

Firms serving international markets and public procurement markets are more likely to reduce innovation expenditures. More specifically:

- Firms whose lead market is their own country are less likely to reduce their innovation expenditures. Similarly, firms operating on international markets are slightly more likely to decrease their innovation expenditures. This may reflect a retrenchment of firms' activities in their home markets, and points to the need to reopen export markets for innovations as part of the economic recovery.
- Firms that show interest in public procurement are slightly more likely to have decreased their innovation expenses. This is an unexpected finding as many economic stimulus packages have increased public procurements. It may however reflect that many such procurements do little to stimulate innovation and points to the broader problem of public sector purchasing decisions which favour non-innovative solutions.

Firm size does not appear to be a relevant factor. The analysis, somewhat surprisingly, finds no difference between small and large firms in their likelihood to have reduced innovation expenditures, although medium-sized firms (50-249 employees) appear less likely to further reduce their innovation expenditures.

1. Introduction

The financial crisis which started in 2007 has triggered a global economic downturn. This has resulted in at first falling economic growth rates followed by a real economic decline in many countries. The financial and economic crisis is expected to have an impact on the innovation expenditures of firms by both limiting the availability of capital and by reducing demand for innovative products.² This report explores the impact of the crisis on the innovation activities of firms by analysing the firm level data from the Innobarometer 2009 survey (EC, 2009b). This report will focus on both the direct effect on the crisis on firms' innovation activities and on the expected effect on these activities.

In terms of prior research, Kitching et al. (2009)³ provide a thorough review of literature on harsh economic conditions, including recessions, and their effects on firms and firm behaviour in the past 30 or 40 years. Their conclusion on the literature itself is that since studies focussing on recessions alone are sparse, a wider literature discussing a range of difficult economic conditions has to be considered. However, the relevance of the existing literature on the current economic crisis is in doubt for two reasons: firstly, not all harsh economic conditions are similar enough to a recession, and secondly, the current crisis may be quite dissimilar to previous crises, most importantly, as the degree of globalisation is now greater than it has been in previous recessions. Globalisation processes increasingly affect both the threats firms face and the opportunities available to them.⁴ Furthermore, according to Kitching et al. (2009), there are several actual deficiencies in the existing literature. Firstly, the literature rarely focuses on *why* firms react the way they do, in other words, are the actions part of a distinct strategy, or just operational change taking place within firms? Secondly, data on the *consequences* of actions to longer term firm performance are lacking. Thirdly, *global* influences on responses from firms are rarely taken into account.

Regarding the possible impacts on and responses by firms, the literature review by Kitching et al. (2009) notes three main business strategy related responses. Firstly, most commonly firms react in the short-term with retrenchment strategies, i.e. by cutting costs, such as innovation expenditures. Secondly, firms may react with investment strategies, by increasing their innovation expenditures or market diversification. Despite the fact that many big firms (e.g. General Electric, Hershey, Kelloggs, Microsoft, and Apple) have made their businesses successful during hard economic times, there is, however, thin evidence on how common this strategy is. Thirdly, and perhaps most importantly, firms react with a combined strategy of retrenchment and investment. Much of current relevant literature (and the think-tank of leading academics consulted for Kitching et al.,

2 The 2009 EU Industrial R&D Investment Scoreboard (EC, 2009c) shows that growth in R&D spending for the top 1000 EU companies has slowed down from 8.6% in 2007 to 7.8% in 2008. But despite the decline in growth performance in 2008, the full effects of the crisis on R&D spending are only expected to show up in 2009 due to a delayed effect of the crisis on R&D (and innovation). The Scoreboard data cover companies' R&D spending in the fiscal year 2008 and "[i]n the last part of this reporting period, the world economy entered into a strong financial and economic crisis ... Some of the effects of the crisis are already reflected in these company results, namely on indicators such as sales, operating profits and market capitalisation. However, the full effects of the crisis, especially on R&D, tend to lag and are not yet captured in this Scoreboard" (EC, 2009c).

3 This report has been produced for the Department of Business, Innovation and Skills of the UK Government.

4 Kitching et al. (2009) conclude that it is difficult to "predict trends or prescribe courses of action with a high degree of confidence in their likely success" (page i).

2009) considers such an 'ambidextrous' strategy to be the most common medium- to longer-term response from firms.⁵

The main conclusions from the broad review in Kitching et al. (2009) are that there is no single 'recession effect' on firms, nor any one 'best way' to adopt to recessions, and firm characteristics (such as size or sector) or past performance are not adequate predictors of future performance. Ambidextrous strategies, which combine cost efficiency with innovation activity may be the most appropriate responses to recessions, although perhaps also most challenging, as firms must choose wisely the appropriate costs to be cut, and the right investments to be made.

According to Kitching et al. (2009), the literature suggests that the role of governments be mainly in encouraging innovation and providing various forms of support, such as "promoting cross-sector and cross-specialism linkages and dialogues with organisations" (see also Box 1). Further, "propping up outmoded business models or industries in structural decline" may not be appropriate governmental support in recessions (Kitching et al., 2009: p. v-vi).

Box 1: Kitching et al. (2009) discuss the following possible roles for public policy to counter the negative effect of the current crisis:

- Legitimise change and innovation within organisations. Governments could, for example, promote examples of firms that have grown fast in previous economic downturns and could build stories or narratives of these successful companies and their way of doing business, in order to promote an environment in which people will be more confident about innovation.
- Stimulate experimental approaches to supporting innovation. Kitching et al. use the term 'innovation at the edge' both for business models and product and process innovation. Policies should aim e.g. at furthering new business models, new networks of private firms and public research organisations.
- Promote the provision of finance. In particular SMEs and fast-growing high-tech firms are in need of finance. Governments could use their support for bailing out banks from the financial crisis to persuade these banks to provide more finance to the before-mentioned firms.
- Pay attention to business closures, in particular to the cost of closing a business. High costs of bankruptcy may encourage entrepreneurs to shut down their companies instead of running the risk of going bankrupt.
- Pay attention to small firms and new firms initiatives. Governments could help firm creation by facilitating and promoting local networks in which small and new firms have better access to investors, technology and information.
- Redefine sectors and cross-sector initiatives, as many policies are rooted in traditionally defined sectors, whereas the blurring of e.g. the manufacturing and services activities may call for a redefinition of the current industrial NACE classification system.
- Promote policy messages for recovery by repeating the lessons from previous economic downturns, so as to avoid high rates of business failures from repeating the same mistakes.
- Harness creativity and sources of national excellence. Governments should foster creative talent and areas of technological strength. New policies focusing on current societal challenges – climate change, ageing population – could encourage new innovative business opportunities.

⁵ Apart from considering firms as active strategic players, Kitching et al. (2009) consider two other views of general effects of recessions on firms being relevant: recessions as periods of 'creative destruction', where some firms or industries fail, while others emerge; and recessions as either causing organisational inertia which prevents firms from appropriately adopting, or conversely, causing firms to innovate more because of opportunity cost related factors.

This paper will explore the impact of the crisis on firms' innovation performance by analyzing the following hypotheses:

1. Firms with higher innovation expenditures are more likely to have reduced their expenditures. This hypothesis is based on the assumption that larger budgets are likely to be more exposed to cost reductions.
2. Firms in countries where the overall economic downturn has been largest (i.e. countries with the greatest GDP declines) are more likely to have reduced their innovation expenditures. The assumption is that the overall economic environment is a key factor.
3. Firms with broader innovation strategies (e.g. open innovation, soft skills, etc.) are less likely to have reduced their expenditures. This hypothesis is based on the assumption that these strategies make innovation activities more resilient.

Furthermore, the following broader research questions will be also be addressed:

- I. What (other) factors seem to influence whether firms reduce their innovation expenditures or not?
- II. What are the implications for longer term patterns of convergence or divergence in innovation performance across EU countries?

The structure of the report is as follows. Section 2 discusses the methodology used in this report. Section 3 briefly discusses differences between EU Member States and Section 4 discusses in detail differences between firms. Section 5 concludes.

2. Methodology and data

This report uses the firm-level data for the EU27 Member States from the Innobarometer 2009 survey. The Innobarometer survey (EC, 2009b) included firms employing 20 or more persons in all 27 EU Member States. The list of firms has been developed by Dun and Bradstreet and the sample is stratified according to size (4 categories: 20-49 (40%), 50-249 (30%), 250-499 (20%), 500 or more employees (10%)) and sectors.⁶ The survey was done by telephone interviews among top-level executives responsible for strategic decision making (typically General Managers, Financial Directors or significant owners). The number of main interviews was between 200 and 204 in each country surveyed, except Malta, Cyprus and Luxembourg, where the number of interviews was between 70 and 72. Interviews are weighted to correct for the disproportional selection of the number of firms in countries and industries.⁷

For measuring the effect of the crisis we focus on replies from firms to two questions. The first question (question Q4 in the survey) measures the direct effect of the economic crisis; the second question (question Q5 in the survey) measures the expected effect on the economic crisis:

Q4. In the last six months has your company taken one of the following actions as a direct result of the economic downturn? (one answer only)

- Increased total amount of innovation expenditures
- Decreased total amount of innovation expenditures
- Maintained total amount of innovation expenditures at the same level
- [Not applicable/No innovation]
- [Do not know/No answer]

Q5. Compared to 2008, do you expect your company to increase, decrease or maintain the total amount of its innovation expenditures in 2009? (one answer only)

- Increase
- Decrease
- Maintain
- [Not applicable/No innovation]
- [Do not know/No answer]

Innovation expenditures are measured as the aggregate of expenditures on any of the following activities:

- Research & development performed within the company;
- Research & development performed for the company by other enterprises or by research organisations;

6 The target activities were: Information technology, Medical devices, Production technology, Communications equipment, Biopharmaceuticals, Automotive, Analytical industry, Construction equipment, Metal manufacturing, Lighting and electrical equipment, Aerospace vehicles, Defence, Plastics, Construction materials, Entertainment, Transportation and logistics, Furniture, Processed food, Business services, Aerospace engines, Chemical products, Heavy machinery, Power generation and transmission, Building fixtures, Equipment, Services, Hospitality and tourism, Publishing and printing, Textiles, Financial services, Oil and gas products and services, Apparel, Distribution services, Fishing and fishing products, Heavy construction services, Footwear, Jewellery and precious metals, Sporting and children's goods, Leather.

7 See EC (2009b) for more detailed information about this disproportional weighting.

- Acquisition of new or significantly improved machinery, equipment and software;
- Purchase or licensing of patents, inventions, know-how, and other types of knowledge;
- Training to support innovative activities;
- Design (graphic, packaging, process, product, service or industrial design);
- Application for a patent or registration of a design.

The results shown for five different groups of sectors in Sections 3 and 4 are based on the classification by Peneder (2007) using CIS-3 firm-level data (Table 1).⁸ The country classification into four groups of innovative countries is taken from the European Innovation Scoreboard 2008 (EC, 2009a) (Table 2).

Table 1: The sector classification based on innovation intensity (based on Peneder, 2007)

| Sector group | NACE sector (Rev. 1.1) |
|----------------------------------|---|
| High innovation intensive | 29: Manufacture of machinery and equipment n.e.c. 30: Manufacture of office machinery and computers 31: Manufacture of electrical machinery and apparatus n.e.c. 32: Manufacture of radio, television and communication equipment and apparatus 33: Manufacture of medical, precision and optical instruments, watches and clocks 72: Computer and related activities 73: Research and development |
| Medium-high innovation intensive | 17: Manufacture of textiles 23: Manufacture of coke, refined petroleum products and nuclear fuel 24: Manufacture of chemicals and chemical products 25: Manufacture of rubber and plastic products 26: Manufacture of other non-metallic mineral products 27: Manufacture of basic metals 34: Manufacture of motor vehicles, trailers and semi-trailers 35: Manufacture of other transport equipment 64: Post and telecommunications |
| Medium innovation intensive | 20: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials 21: Manufacture of pulp, paper and paper products 28: Manufacture of fabricated metal products, except machinery and equipment 36: Manufacture of furniture; manufacturing n.e.c. 62: Air transport 65: Financial intermediation, except insurance and pension funding 70* Real estate activities 71* Renting of machinery and equipment without operator and of personal and household goods 74: Other business activities |
| Medium-low innovation intensive | 10: Mining of coal and lignite; extraction of peat 11: Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying 15: Manufacture of food products and beverages 16: Manufacture of tobacco products 22: Publishing, printing and reproduction of recorded media 40: Electricity, gas, steam and hot water supply 41: Collection, purification and distribution of water 45* Construction 66: Insurance and pension funding, except compulsory social security |

⁸ The following NACE sectors which are covered in the IB2009 survey (EC, 2009b) could not be classified and are thus not used in the analyses in section 4: 1 Agriculture, hunting and related service activities; 13 Mining of metal ores; 75 Public administration and defence; compulsory social security; 80 Education; 85 Health and social work; 90 Sewage and refuse disposal, sanitation and similar activities; 91 Activities of membership organizations n.e.c.; 92 Recreational, cultural and sporting activities; and 93 Other service activities.

| Sector group | NACE sector (Rev. 1.1) |
|--------------------------|---|
| Low innovation intensive | 14: Mining: other 18: Manufacture of wearing apparel; dressing and dyeing of fur 19: Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear 37: Recycling 50* Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel 51: Wholesale trade and commission trade, except of motor vehicles and motorcycles 52* Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods 55* Hotels and restaurants 60: Land transport; transport via pipelines 61: Water transport 63: Supporting and auxiliary transport activities; activities of travel agencies 67: Activities auxiliary to financial intermediation |

* NACE sectors 45, 50, 52, 55, 70 and 71 were not included in Peneder's classification and have been assigned by the authors of this report.

Table 2: Country classification from the 2008 European Innovation Scoreboard (EC, 2009a)

| | |
|-----------------------|---|
| Innovation leaders | Denmark, Finland, Germany, Sweden, Switzerland, UK |
| Innovation followers | Austria, Belgium, France, Ireland, Luxembourg, Netherlands |
| Moderate innovators | Cyprus, Czech Republic, Estonia, Greece, Italy, Norway, Portugal, Slovenia, Spain |
| Catching-up countries | Bulgaria, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia |

The analyses in this report focus on 4195 innovative firms. An innovative firm is defined as a firm which has answered 'yes' to at least one of the innovation activities as defined in Question 6 of the IB2009 survey (EC, 2009b):

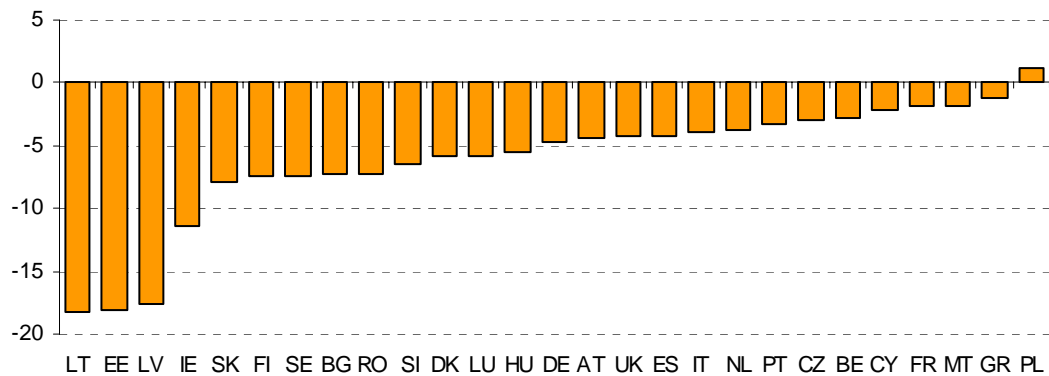
Q6. Has your company introduced any of the following innovations since 2006?

- a) New or significantly improved products
- b) New or significantly improved services
- c) New or significantly improved processes (e.g. production processes, distribution methods, support activities)
- d) New or significantly improved marketing strategies
- e) New or significantly improved organisational structures (e.g. knowledge management, workplace organisation or external relations)

In the analysis in Section 4, we control for differences in the overall impact of the crisis on countries' economic performance by including an indicator capturing the decline in economic performance. The indicator is defined as the difference between the value of GDP in the 2nd quarter of 2009 (which reflects the survey period of the IB2009 survey (EC, 2009b)) and the highest value of GDP in any quarter between the 3rd quarter of 2007 and the 2nd quarter of 2009) (Figure 1).⁹ All countries, except Poland, have experienced a decline in the level of GDP. The sharpest decline (15% change or more) is observed for Lithuania, Estonia and Latvia.

⁹ All quarterly data are expressed as index values relative to GDP in the 1st quarter of 2008 (which takes the value of 100). For Bulgaria and Sweden quarterly GDP data were not available from Eurostat. For Bulgaria we have assumed that the rate of change is equal to that of Romania, for Sweden we have assumed that the rate of change is equal to that of Finland.

Figure 1: GDP change between peak performance (3rd quarter 2007 onwards) and 2nd quarter 2009



Peak performance in GDP for Estonia and Ireland in 4th quarter for 2007, for Germany, Luxembourg and Slovenia in 1st quarter of 2008, for Finland, Hungary, Italy, Latvia, Portugal, Spain and UK in 2nd quarter of 2008, for Austria, Belgium, Cyprus, Denmark, France, Lithuania, Netherlands and Slovakia in 3rd quarter of 2008, and for Czech Republic, Greece, Malta and Romania in 4th quarter of 2008. For Poland peak performance in GDP was in the 2nd quarter of 2009 and the GDP change is between the 1st and 2nd quarter of 2009.

Section 4 initially analyses bilateral relations between the dependent and independent variables using cross tabulations. These results provide a first insight into the possible relation between firms' responses to the crisis and firm characteristics. However, these results do not take into account the effect of other variables. Therefore, in Section 4 we also use logistic regressions in order to capture the influence of several variables simultaneously.¹⁰ As the dependent variable is nominal (either 0 – no decrease in innovation expenditures, or 1 – a decrease in innovation expenditures), a logistic regression model is called for to analyse the Innobarometer 2009 data. Two logistic regressions have been performed, one for whether cuts have been made in the prior six months before the survey was done (in the last quarter of 2008 and the first quarter of 2009), and another for whether cuts would be expected in the rest of 2009. All independent variables are the same for the two regressions, with one exception: for the past decrease it was investigated whether cuts even further back (between 2006 and 2008) would be relevant, and for the future decrease, it was investigated whether cuts in the previous six months would be influential.

Additionally, two other logistic regressions have been performed with *increases* in innovation expenditures as the dependent variable. Although these models do not show good fits overall, a couple of interesting results will be discussed in Section 4.

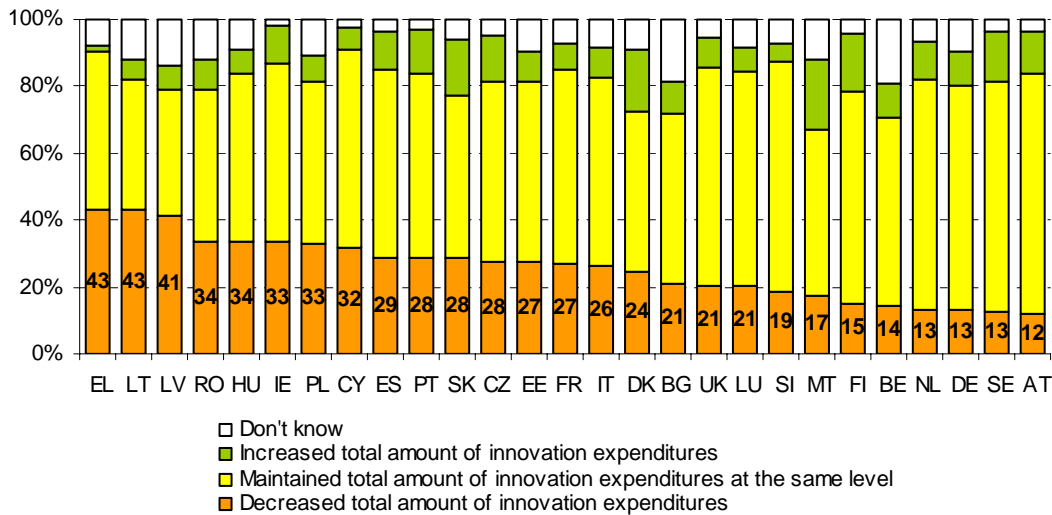
In conclusion, mostly the results between the cross tabulations and the logistic regressions support each other, but in some cases the regression results offer more insights.

¹⁰ For example, it could be that the cross tabulations show a link between decreasing innovation expenditures and firm size, or between decreasing innovation expenditures and sectors. At the same time, it is known that size distributions differ between sectors, but the results from the cross tabulations do not take this into account. Regressions do, so these results are more reliable.

3. Effects of the crisis on innovation activities at country level

In this section, we focus on a brief descriptive analysis of the IB2009 results for differences between countries.¹¹ The IB2009 data show that, as a direct effect of the crisis between late 2008 and early 2009, 23% of EU27 innovators decreased their innovation expenditures. These percentages were lowest (15% or less) in Austria, Sweden, Germany, Netherlands, Belgium and Finland, all classified as either innovation leaders or innovation followers in the EIS. The highest percentages (40% or more) of firms with decreasing innovation expenditures are for Greece, Lithuania and Latvia (Figure 2).

Figure 2: In the last six months has your company taken one of the following actions as a direct result of the economic downturn?

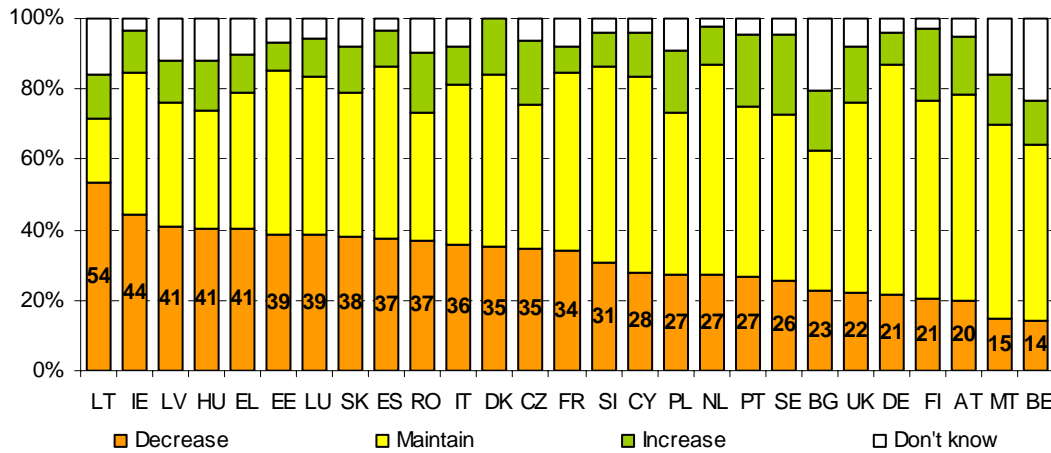


Source: Innobarometer 2009, own calculations. Interviews were done between April 1 and 9, so the last six months refer to the period October 2008 to March 2009.

Even more EU27 innovators (29%) expect that their innovation expenditures will decrease in 2009 as compared to 2008. The results for the individual countries are similar to those for the direct effect of the crisis. The percentages were lowest in Belgium, Malta, Austria, Finland, Germany, UK and Bulgaria. The highest percentages (40% or more) of firms expecting decreasing innovation expenditures are for Lithuania, Ireland, Latvia, Hungary and Greece (Figure 3).

¹¹ Filippetti and Archibugi (2009) provide a more detailed analysis at the country level using the same IB 2009 data.

Figure 3: Compared to 2008, do you expect your company to increase, decrease or maintain the total amount of its innovation expenditures in 2009?



Source: Innobarometer 2009, own calculations.

4. Effects of the crisis on innovation activities at firm level

In this section, we discuss the research questions and hypotheses as defined in the introductory Section 1. The discussion will use both descriptive statistics based on simple cross tabulations and logistic regressions (see Tables 3 to 5 at the end of the Section).

Table 3 summarizes the results based on cross tabulations for the characteristics of the firms in relation to their real and expected actions on innovation expenses. On average, 23% of innovative firms in the survey sample have decreased their innovation expenses in the six months prior to the survey, and 29% expect to decrease them in the year following the survey (until the end of 2009).

Table 4 shows the regression results for the direct effect of the crisis on innovation expenditure in the six months prior to the survey. There seems to be a modest improvement in the ability of this model to predict the dependent variable (past decrease in innovation expenditure), with the percentage of correctly predicted values rising from 75.4% to 77.0%. But the likelihood ratio chi-square of 478.861 with a p-value of 0.000 tells us that our model as a whole fits significantly better than the model which only includes an intercept as explanatory variable.

Table 5 shows the regression results for expected decreases in innovation expenditures in the near future, i.e. the remainder of 2009 from the time of the survey in April 2009. There is an improvement in the ability of the model to predict the dependent variable - future decrease in innovation expenditures - with the percentage of correctly predicted values rising from 69.1% (model with intercept only) to 76.5% (predictor variables included). This is confirmed by the likelihood ratio chi-square of 863.919 with a p-value of 0.000 which tells us that our model as a whole fits significantly better than the model which only includes an intercept as explanatory variable.

The effect of different firm characteristics will now be discussed in more detail.

Effect of size of firms

In terms of size, Table 3 indicates that there are only very small differences between shares of firms in terms of actual decreases of innovation expenditures as a result of the economic downturn. Marginally larger shares of medium-sized firms and large firms (both 24%) have decreased their innovation expenditures as compared to small firms (23%). In terms of expectations for 2009, 32% of small firms expect to decrease their innovation expenditures in the near future, with large and medium-sized firms being less likely to do so (29% and 25%, respectively).

According to Table 4, there is no direct size effect for the overall population of firms. However, as Figure 2 showed, there is a lot of variation at the country level, and a recent study for German firms (Association of German Chambers of Industry and Commerce, 2009) indicates that the current economic crisis is not so harmful for small German firms: 30% of them have increased their innovation activities while only 5% have reduced them. On the other hand, 18% of all firms (small and large) in Germany have had to postpone their innovation projects, and only 17% have increased their innovation activities, showing that large firms are more adversely effected by the crisis.^{12,13}

According to Table 5, a size effect is observable for the expected effect of the economic downturn. Compared to small firms (20-49 employees), it is less likely that medium-sized firms (50-249 employees) will decrease their innovation expenditures. For large firms (250+ employees) the results are not significantly different from those for small firms.

In short, the cross tabulations and logistic regression results show that there is only a minor effect of firm size on how firms respond to the economic crisis. Compared to small and large firms, medium-sized firms appear to be affected the least by the crisis.

Effect of innovativeness of sector

Within sectors, the cross tabulations in Table 3 show that the medium-high innovation intensive sectors are more likely than other sectors to have decreased their innovation expenditures, and they are also clearly more likely (at 40%) to expect to decrease them in the near future. In terms of actual decreases, the high innovation intensive sectors are least likely to have made recent cuts (at 20%).

Table 4 does show a direct sector effect, with medium-high innovation intensive sectors being more likely than low innovation intensive sectors to have decreased their innovation expenses, indicating that the direct effect of the crisis on these

12 Interestingly, Geroski and Gregg (1997) argue – in a study on the effects of recessions in the 1980's and 1990's on UK firms - that large firms may react more strongly to downturns than small firms, even though they are not necessarily more affected.

13 It should also be noted that the German survey was carried out in July-August 2009 whereas the Innobarometer was carried out in the 1st week of April 2009. Differences in survey periods can explain differences in survey results, as the impact of the crisis, or the perception of the impact, is likely to have changed in three or four months.

firms may have been more significant. The results for the other sector classes are not significant as compared to the low innovation intensive sectors. For the expected effect of the crisis, the results in Table 5 show that the sector effect is similar to that for the actual decrease in innovation expenditures.

Therefore, firms in the medium-high innovation intensive sectors are more likely to expect to cut their innovation expenditures as compared to firms in the low innovation intensive sectors. For the medium-low innovation intensive sectors, it is slightly less likely that firms in these sectors will decrease their innovation expenditures, as compared to firms in the low innovation intensive sectors.

Effect of innovation capability of countries

At the country level, Table 3 shows a clear order in terms of decreases in innovation expenditures in the recent past, with firms in catching-up countries being most likely (33%) and firms in leader countries being least likely (16%) to have made cuts. In the near future, firms in leader countries are also most likely (23%) not to expect decreases, with firms in moderate innovator countries expecting to make cuts more frequently than others (36%).

Table 4 also indicates that, compared to firms in catching-up countries, firms in all other country groups are less likely to have made direct cuts in their innovation expenses as a result of the crisis. Firms in leader countries are least likely to have reduced their innovation expenses. These results suggest that those countries which have been experiencing the fastest rates of improvement in their innovation performance have been affected most by the economic crisis. In response to the second research question formulated in Section 1, these results could signal a slowdown and even a reversal of the observed convergence process in innovation performance in the 2008 EIS report (EC, 2009a). In their country analysis using the Innobarometer 2009 data, Filippetti and Archibugi (2009) confirm these findings showing that the crisis is in particular harming the New Member States, undermining their growth potential and jeopardizing their catching-up process.

According to Table 5, it is somewhat more likely that firms in follower countries and moderate innovating countries expect to decrease their innovation expenditures in the near future, as compared to firms in catching-up countries.¹⁴ For the leader countries, the results are not significant. When compared to the results in Table 4, it seems that firms in innovation follower and moderately innovating countries may be experiencing the effect of the recession slightly later than firms in catching up countries.

Effect of previous trends in innovation expenditures

As could be expected, there seems to be a link between more distant and more recent past cuts as well as future cuts in expenses. Table 3 indicates that most firms (56%) that had decreased their innovation expenditures between 2006 and 2008 also decreased them in the six months prior to the survey. Conversely, only 17% of those who had increased their innovation expenses between 2006 and 2008 had decreased them in the six months prior to the survey. Further, two

¹⁴ These results are slightly different from the simple cross tabulations in Table 3.

thirds (64%) of firms that have decreased their innovation expenditures in the previous 6 months, expect to continue to do so in the near future.

Similarly, Table 4 indicates that, for those firms that have increased their innovation expenditures from 2006 to 2008, it is much less likely that they would have made more recent cuts as a direct consequence of the economic crisis, as compared to firms that have decreased their expenditure in the period 2006-2008. Firms where innovation expenditures have been stable are also less likely to have decreased them because of the crisis than firms with decreasing expenditures between 2006 and 2008.¹⁵

These results are confirmed in the results for the expected effect of the crisis on innovation expenditures, as shown in Table 5. Firms with already decreasing innovation expenditures in the past six months (late 2008 and early 2009) are much more likely to further reduce their innovation expenditures between 2008 and 2009 than firms which have not reduced their expenditure in the recent past as a direct result of the economic downturn.

Effect of type of innovator

Table 3 suggests that there is almost no difference between the shares of product and process innovators and marketing and organisational innovators¹⁶ in terms of their likelihood to recently have made or expect to make cuts in their innovation expenditures.

However, once we control for the effect of other firm characteristics, the type of innovator a firm is does seem to matter for how the crisis has directly affected firms' innovation expenditures, a result which is not visible in the simple cross tabulations in Table 3. Those firms that are product or process innovators are less likely to have made recent reductions than those firms that are not product or process innovators. In contrast, those firms that are marketing or organisational innovators are more likely to have made cuts than firms that are not marketing or organisational innovators.¹⁷

For the expected effect, the results in Table 5, however, are not significant for the type of innovator. Statistically there is no difference in the likelihood that product or process innovators will decrease their innovation expenditures in 2009 as compared to 2008. For marketing or organisational innovators we find the same result.

15 These results can be seen as reflecting what Wu et al. (2007) found when looking at the global economic downturn of 2001-2002, namely that a persistent strategy before and during a crisis helps firms endure the crisis.

16 These categories are partly overlapping, with most firms being both product-process and marketing-organisational innovators. Only 22% of the firms are product-process innovators only and 10% marketing-organisational innovators only. This may explain the results to a large extent.

17 This is, however, against some earlier empirical evidence. For example, results in Nickell et al. (2001) indicate that during recessions, firms introduce more organisational innovation. Further, Pearce and Michael (2007) and Srinivasan et al. (2005) offer evidence on the importance of marketing innovation for firm survival during recessions.

Effect of innovating by performing R&D

According to Table 3, a third (32%) of firms who do not have R&D expenditures (i.e. non-R&D innovators) expect to decrease their (non-R&D) innovation expenditures in the near future, slightly more than firms on average. Whether the firm invests in R&D or not shows no significant results for the model reflected in Table 4. However, it is slightly more likely that non-R&D innovators will cut their innovation expenditures compared to R&D innovators, according to Table 5.

These results provide some, although weak, evidence that innovation resulting from R&D activities is affected less by the economic crisis than innovation resulting from non-R&D activities.

Effect of firms' innovation intensity

Table 3 indicates that the innovation intensity of firms has some effect on their likelihood to decrease their innovation expenditures, with high innovation intensive firms (firms which spend at least 25% of their turnover on innovation) clearly more likely to both have made recent cuts (34%) and expect to make cuts in the near future (38%). For the other firms, the differences are smaller, although more medium-sized firms expect to decrease their innovation expenditures in 2009 than small firms.

Table 4 shows the innovation intensity of the firm having a clear effect on direct cuts in innovation expenditures, so that firms with high innovation intensities are much more likely to have made cuts in the recent past, as compared to firms with low innovation intensities. It seems that for firms with higher innovation intensities, it may be more difficult to maintain their higher innovation expenditures during a crisis.

Compared to low innovation intensive firms, firms with medium innovation intensities are more likely to expect to decrease their innovation expenditures in the near future, according to Table 5. The results are not significant for firms with high innovation intensities.

The above cross tabulation and regression results for the effect on expected decreases in innovation expenditures do not seem to support each other. Although the cross tabulation results in Table 3 show a much larger share of high innovation intensive firms (38%) expecting to decrease their innovation expenditures as compared to 33% for medium innovation intensive and 28% for low innovation intensive firms, once we take into account other firm characteristics, the logistic regression results show that differences between high and low innovation intensive firms disappear and that both groups of firms are less likely to reduce their innovation expenditures than medium innovation intensive firms. The hypothesis that firms with higher innovation expenditures are more likely to reduce their expenditures (the first hypothesis in Section 1) is thus not confirmed.

Effect of importance of innovative sales

In terms of how important innovative products and services are to firm sales, Table 3 shows some differences regarding changes in innovation expenditure.

Most markedly, the more important innovative products are to firms, the smaller the share of firms (21%) expecting to decrease their innovation expenditures in the near future. For past cuts, there is no such trend, with firms for whom innovative products and services are not very important are more likely to have decreased their innovation expenditures in the recent past.

The regression results in Table 4 for the direct effect of the crisis show that those firms where innovative and non-innovative products and services account for about an equal share each are less likely to have decreased their innovation expenditures than those firms for which innovative products and services are not a major part of their sales.

For the expected effect of the crisis, the results in Table 5 show that firms where innovative products and services account for a significant share of sales are less likely to decrease their innovation expenditures in the near future, as compared to firms where non-innovative products and services account for most sales.

In conclusion, firms where innovative products and services account for a larger share of sales are thus affected less than firm firms where innovative products and services account for a small share of sales. For the latter type of firms innovation is not a key part of their sales and most likely these firms invest a relatively small share of their sales in innovation activities which can be easily reduced without compromising their competitive position. Firms for which innovative sales dominate total sales have no choice but to maintain their investments in innovation activities as new innovative products and processes drive their competitive performance.

Effect of integration of company activities in support of innovation

According to Table 3, the integration of various activities within firms in support of innovation seems to make a small difference to how likely firms are to decrease their innovation expenses. Firms that use knowledge management systems are slightly less likely to expect to make cuts than the average firm (27% vs. 29%). Those firms that use staff rotations between different functions are slightly more likely to have decreased their innovation expenditures in the recent past than firms on average (27% vs. 23%).

These results are partly confirmed by the logistic regressions. Firms that use staff rotations between different functions seem to be more likely to have cut their innovation expenditures than firms that do not use staff rotations (Table 4). A possible explanation for this observation could be that firms using staff rotations are relatively more involved in organisational innovations, and as discussed earlier, the data indicate that organisational innovators have cut back more than other firms. Firms which have further integrated their knowledge management systems in support of innovation are also slightly more likely to have cut their innovation expenses in the recent past, but at the same time, they are less likely to reduce their innovation expenditures in the near future (Table 5). The latter result is in line with Kwon and Watts (2006), whose results indicate that knowledge management IT systems improve firm performance in hostile environments, such as recessions.

Effect of broader innovation strategies

Involving potential and current users of products and services in the innovation activities of firms does not seem to make firms significantly less or more likely to decrease their innovation activities, according to Table 3. On the other hand, targeting creativity in training and recruitment activities to support innovation seems to make firms slightly less likely both to have made recent cuts (22%) and to expect to make cuts in the near future (28%).

Once accounting for other firm characteristics, involving potential or current users in innovation activities does not lead to significant differences for the likelihood that firms have decreased their innovation expenditures as a direct effect of the crisis (Table 4). Similarly, targeting creativity in training or recruitment activities to support innovation is not significant in Table 4.

However, involving current or potential users in innovation activities does seem to make firms slightly less likely to reduce their innovation expenditures in the future, as indicated by Table 5. Moreover, when the additional logistic regression was run with future *increases* as the dependent variable, user demand for innovation showed further and slightly stronger evidence in the same direction.¹⁸ Firms who involved users were more likely to increase their future innovation expenses.

These results provide some evidence in support of the third hypothesis in Section 1 that firms with broader innovation strategies are less likely to reduce their expenditures, in particular regarding involving users in the innovation process.

Effect of strategies for increasing competitive advantage

Table 3 indicates that the importance given to the development of new products, services or processes, on the one hand, and to achieving reduced costs, on the other hand, seem to have opposite impacts on the likelihood of making cuts in innovation expenditure.¹⁹ Considering the former as the main competitive advantage makes firms slightly less likely to have decreased their expenditures (22%) and significantly less likely to expect to decrease them in the near future (23%). On the contrary, considering reducing costs as the main competitive advantage seems to make firms much more likely to both have decreased their innovation expenditures in the recent past (32%), and to expect to continue reducing them in the future (42%). Assuming that both the ability to make new products and the ability to reduce costs are likely to include some innovation, with the latter being mostly in terms of process and perhaps organisational innovation, this is a somewhat unexpected result.

For the direct effect of the crisis, the regression results in Table 4 show that the results for the development of new products, services or processes are not significant. However, firms which see reduced costs as their main competitive advantage in the near future are more likely to have cut their innovation expenditures than firms that do not consider reduced costs as a main priority. Linked to this, Dostie and Jayaraman (2009) have empirical results from Canada

¹⁸ Value for the coefficient (B) was 0.431, with $p < 0.01$.

¹⁹ Combining these two – exploration and efficiency – would reflect an ambidextrous strategy, discussed in Section 1. Wu et al. (2007) offer evidence of the usefulness of such a strategy during a recession. The Innobarometer 2009 questionnaire did not, however, allow for examining this aspect.

which indicate that adversity may increase process innovation, but not so much in terms of new innovation. Instead, according to Dostie and Jayaraman, innovation diffusion between firms may increase during adversity. Looking at the results in Table 4, such diffusion might result in overall cost reductions without causing additional innovation expenses.

Similarly, Table 5 indicates that firms which see reduced costs as their main competitive advantage in the near future are more likely to expect to cut their innovation expenditures than firms that do not consider reduced costs as a main priority. With a significance level almost below the required 10% level, Table 5 also indicates that firms which see product, service or process innovation as their main competitive advantage in the near future will be slightly less likely to reduce their innovation expenses.

Effect of interest in public procurement

The interest firms show in public procurement by having won a contract, submitted a tender or investigated opportunities within public procurement makes them somewhat more likely to have decreased their innovation expenditure in the recent past as a direct consequence of the economic crisis (26%), according to Table 3.

Correspondingly, Table 4 indicates that firms that show interest in public procurement are slightly more likely to have decreased their innovation expenses in the recent past than firms who do not show interest in public procurement. These results would, therefore, indicate that the effect of the crisis might be more severe on firms showing interest in public procurement.

Table 5 does not show significant results for interest in public procurement. However, the results of the additional logistic regressions with past and future *increases* in innovation expenditures indicate that, on the one hand, firms showing interest in public procurement are less likely to have increased their innovation expenses in the recent past²⁰ than firms who are not interested, but on the other hand, firms interested in public procurement are somewhat more likely to increase their innovation expenditures in the near future.²¹ The first result is in line with Table 4.

Effect of internationalization

In terms of the international activities of firms, about a third (32%) of firms that operate on international markets expect to make cuts in their innovation expenditures in the near future, as shown in Table 3. Similarly, considering export markets as the greatest opportunity for innovation in the near future makes firms significantly more likely to both have decreased their innovation expenditures (30%) and expect to decrease them further (33%). On the other hand, firms that consider their own country to be their lead market are slightly less likely to both have decreased their innovation expenditures in the past six months and to expect to decrease them in the near future.

20 Value for the coefficient (B) was -0.698, with $p < 0.01$.

21 Value for the coefficient (B) was 0.209, with $p < 0.1$.

As for the direct effect of the crisis, the logistic regression in Table 4 shows significant results only for the importance of export markets. According to these results, firms that see new export markets as the greatest innovation opportunity in the near future are more likely to have reduced their innovation expenditure than firms that do not see export markets so important for innovation. Although export orientation would generally seem to be beneficial in crises, one would also expect that the pervasiveness of a crisis on an international scale would have an impact on this variable, so that the more pervasive and global the crisis, the less helpful export orientation is. Indeed, there is some literature indicating that export orientation would be beneficial for firm survival and recovery during and after a regional recession: Lee and Makhija (2009) study the effect of the Asian economic crisis on South Korea in the late 1990s, and Narjoko and Hill (2007) examine the effects of the same crisis on Indonesia.

The results in Table 5 for the expected effect of the crisis show significant results for all three variables related to internationalization. Firstly, for firms operating on international markets (EU or non-EU), it is slightly more likely that innovation expenditures will decrease compared to firms operating within their domestic market only. Confirming this, firms whose lead market is their own country, are less likely to reduce their innovation expenditures, as opposed to firms whose lead market is outside their own country or for whom lead markets are not relevant. A different conclusion as compared to Table 4, is reached for firms which see new export markets as their greatest opportunity for innovation in the near future, as they are less likely to expect to reduce their innovation expenditures.

Effect of issues related to environmental innovation

Two measures have also been included to see whether there are any effects visible regarding eco-innovation, either from increased demand for sustainable or energy-efficient products or services as the main innovation opportunity in the near future (eco-demand), or from new requirements from environmental regulations or standards seen as a positive influence on innovation.

Neither the cross tabulation results in Table 3 nor the logistic regression results in Table 4 for the direct effect of the crisis shows any significant differences for firms expecting either a positive effect from increased environmental regulation or increased eco-demand as compared to the average firm.

Also for the expected effect (Table 5), there are no significant results regarding the two variables linked to eco-innovation. However, the results of the additional logistic regressions with past and future *increases* in innovation expenditures indicate that firms which see increased demand for sustainable or energy-efficient products and services as their greatest opportunity for innovation (eco-demand) in the near future are less likely to have increased their innovation expenditure in the six months prior to the survey²² than firms which do not see eco-demand important to them. Based on these results, the direct effect of the economic crisis has been bigger for those firms that do see eco-innovation as important. This may reflect the perception that environmental concerns get a lower priority in difficult economic times.

22 Value for the coefficient (B) was -0.428, with $p < 0.01$.

Effects of changes in policies in support of innovation

Two possible changes in finance related policies could have an effect on firms' response to the financial crisis. The first asks firms if a significant change in the tax environment, e.g. R&D or innovation tax credit, has had a positive effect on innovation. The second asks firms if a significant change in public financial support (e.g. grants, loans or support for recruiting staff) has had a positive effect on innovation.

The cross tabulations (Table 3) and the logistic regressions (Tables 4 and 5) show that there is no difference in behaviour between innovators which have experienced a positive effect from a change in the tax environment and those that have not.

Firms who have experienced a positive effect from changes in public financial support are both clearly less likely to have made recent cuts (18%) or to expect more cuts in the near future (25%) as compared to the average innovating firm (Table 3). These results are confirmed in the logistic regression results for the direct effect of the financial crisis (Table 4) with these firms being far less likely to have reduced their innovation expenditures. For the expectations for 2009 there are no differences with the average innovation as shown in the results in Table 5. The results of the additional logistic regressions with past and future *increases* in innovation expenditures indicate that firms which have experienced a positive effect from changes in public financial support are more likely to have increased their innovation expenditure in the six months prior to the survey²³ and are also more likely to expect to increase these expenditures in the near future.²⁴

Improved public financial support therefore has had a beneficial effect on firms' direct response to the financial crisis. But for the near future a similar beneficial effect is not observed.

Effect of the overall economic downturn

The final independent variable looks at the relationship between a country-specific decline in GDP within the last two years and innovation expenditure. However, the results for the direct effect in Table 4 are not significant. For the expected effect however, Table 5 does show a significant result indicating that firms operating in countries where GDP has fallen most over the past two years are slightly more likely to reduce their innovation expenditures. This result offers support for the second hypothesis presented in Section 1.

23 Value for the coefficient (B) was -0.258, with $p < 0.1$.

24 Value for the coefficient (B) was -0.410, with $p < 0.01$.

Table 3: Responses from firms to actual and expected decreases in innovation expenditures

| | Did NOT decrease total amount of innovation expenditures in the last 6 months | Decreased total amount of innovation expenditures in the last 6 months | Total | Expected NOT to decrease near future (2009) innovation expenses | Expected to decrease near future (2009) innovation expenses | Total |
|---|---|--|---------------|---|---|---------------|
| ALL FIRMS | 76.7% | 23.3% | 100.0% | 70.6% | 29.4% | 100.0% |
| Size | | | | | | |
| 20-49 employees | 77.4% | 22.6% | 100.0% | 68.1% | 31.9% | 100.0% |
| 50-249 employees | 75.6% | 24.4% | 100.0% | 75.3% | 24.7% | 100.0% |
| 250+ employees | 76.1% | 23.9% | 100.0% | 71.2% | 28.8% | 100.0% |
| Sector group | | | | | | |
| High innovative | 80.3% | 19.7% | 100.0% | 73.0% | 27.0% | 100.0% |
| Medium-high innovative | 71.6% | 28.4% | 100.0% | 60.0% | 40.0% | 100.0% |
| Medium innovative | 76.1% | 23.9% | 100.0% | 71.6% | 28.4% | 100.0% |
| Medium-low innovative | 76.9% | 23.1% | 100.0% | 74.7% | 25.3% | 100.0% |
| Low innovative | 75.9% | 24.1% | 100.0% | 69.5% | 30.5% | 100.0% |
| Innovative capability of country (EIS country group) | | | | | | |
| Leader | 83.9% | 16.1% | 100.0% | 77.4% | 22.6% | 100.0% |
| Follower | 78.6% | 21.4% | 100.0% | 70.1% | 29.9% | 100.0% |
| Moderate innovator | 71.9% | 28.1% | 100.0% | 64.5% | 35.5% | 100.0% |
| Catching-up | 67.1% | 32.9% | 100.0% | 67.1% | 32.9% | 100.0% |
| Trend in 2006-2008 innovation expenditures | | | | | | |
| Increasing | 82.8% | 17.2% | 100.0% | | | |
| Decreasing | 44.0% | 56.0% | 100.0% | | | |
| Stable | 77.6% | 22.4% | 100.0% | | | |
| Decreased total amount of innovation expenditures in the last 6 months | | | | 35.7% | 64.3% | 100.0% |
| Type of innovator | | | | | | |
| Product and/or process innovator | 77.4% | 22.6% | 100.0% | 70.5% | 29.5% | 100.0% |
| Marketing and/or organizational innovator | 76.5% | 23.5% | 100.0% | 71.0% | 29.0% | 100.0% |
| Non R&D innovator | 76.3% | 23.7% | 100.0% | 68.0% | 32.0% | 100.0% |
| Innovation intensity of the firm | | | | | | |
| Low (<5%) | 76.9% | 23.1% | 100.0% | 72.3% | 27.7% | 100.0% |
| Medium (5% to 25%) | 77.6% | 22.4% | 100.0% | 67.1% | 32.9% | 100.0% |
| High (>25%) | 65.6% | 34.4% | 100.0% | 61.7% | 38.3% | 100.0% |
| Importance of innovative products or services for sales | | | | | | |
| Most sales came from innovative products or services | 76.0% | 24.0% | 100.0% | 78.7% | 21.3% | 100.0% |
| About equal share of innovative and non-innovative products or services | 81.1% | 18.9% | 100.0% | 72.8% | 27.2% | 100.0% |
| Most sales came from non-innovative products or services | 73.0% | 27.0% | 100.0% | 66.8% | 33.2% | 100.0% |

| | Did NOT decrease total amount of innovation expenditures in the last 6 months | Decreased total amount of innovation expenditures in the last 6 months | Total | Expected NOT to decrease near future (2009) innovation expenses | Expected to decrease near future (2009) innovation expenses | Total |
|--|---|--|---------------|---|---|---------------|
| ALL FIRMS | 76.7% | 23.3% | 100.0% | 70.6% | 29.4% | 100.0% |
| Integration of company activities in support of innovation activities | | | | | | |
| Knowledge-management systems | 76.3% | 23.7% | 100.0% | 73.0% | 27.0% | 100.0% |
| Staff rotations between different functions | 72.6% | 27.4% | 100.0% | 69.5% | 30.5% | 100.0% |
| Involving potential and current users in innovation activities | | | | | | |
| | 76.4% | 23.6% | 100.0% | 71.6% | 28.4% | 100.0% |
| Targeting creativity in training or recruitment | | | | | | |
| | 78.0% | 22.0% | 100.0% | 72.5% | 27.5% | 100.0% |
| Main competitive advantage in the near future will be | | | | | | |
| Development of new products, services or processes | 78.5% | 21.5% | 100.0% | 76.8% | 23.2% | 100.0% |
| Reduced costs | 68.2% | 31.8% | 100.0% | 58.1% | 41.9% | 100.0% |
| Interest in public procurement (won contract, submitted a tender or investigated opportunities) | | | | | | |
| | 73.7% | 26.3% | 100.0% | 70.3% | 29.7% | 100.0% |
| Firm operating on international markets | | | | | | |
| | 76.6% | 23.4% | 100.0% | 67.7% | 32.3% | 100.0% |
| Lead market is own country | | | | | | |
| | 77.6% | 22.4% | 100.0% | 72.5% | 27.5% | 100.0% |
| Greatest opportunities for innovation in the near future come from | | | | | | |
| New export markets | 69.9% | 30.1% | 100.0% | 66.6% | 33.4% | 100.0% |
| Eco-demand | 76.8% | 23.2% | 100.0% | 71.1% | 28.9% | 100.0% |
| Significant changes in policy-related areas having a positive effect on innovation | | | | | | |
| New requirements from environmental regulations/standards | 76.6% | 23.4% | 100.0% | 71.4% | 28.6% | 100.0% |
| Changes in tax environment | 76.9% | 23.1% | 100.0% | 71.5% | 28.5% | 100.0% |
| Changes in public financial support | 82.0% | 18.0% | 100.0% | 75.2% | 24.8% | 100.0% |

Table 4: Logistic regression for an actual decrease in innovation expenditures in late 2008 and early 2009, as a result of economic downturn

| | B | S.E. | Wald | Sig. | Exp(B) |
|---|-----------|-------------|-------------|-------------|---------------|
| Size | | | | | |
| 250+ employees | 0.170 | 0.159 | 1.139 | 0.286 | 1.185 |
| 50-249 employees | 0.102 | 0.094 | 1.199 | 0.274 | 1.108 |
| Sector group | | | | | |
| High innovative | -0.199 | 0.187 | 1.124 | 0.289 | 0.820 |
| Medium-high innovative | 0.369*** | 0.131 | 7.892 | 0.005 | 1.446 |
| Medium innovative | 0.037 | 0.123 | 0.091 | 0.763 | 1.038 |
| Medium-low innovative | -0.099 | 0.120 | 0.683 | 0.409 | 0.905 |
| Innovative capability of country (EIS country group) | | | | | |
| Leader | -0.716*** | 0.128 | 31.372 | 0.000 | 0.489 |
| Follower | -0.501*** | 0.139 | 13.088 | 0.000 | 0.606 |
| Moderate innovator | -0.266** | 0.123 | 4.637 | 0.031 | 0.767 |
| Trend in 2006-2008 innovation expenditures | | | | | |
| Increasing | -2.031*** | 0.147 | 190.444 | 0.000 | 0.131 |
| Same | -1.549*** | 0.136 | 129.071 | 0.000 | 0.212 |
| Type of innovator | | | | | |
| Product and/or process innovator | -0.376*** | 0.138 | 7.365 | 0.007 | 0.687 |
| Marketing and/or organizational innovator | 0.246** | 0.112 | 4.809 | 0.028 | 1.278 |
| Non R&D innovator | -0.025 | 0.093 | 0.071 | 0.790 | .976 |
| Innovation intensity of the firm | | | | | |
| High (>25%) | 0.969*** | 0.226 | 18.298 | 0.000 | 2.635 |
| Medium (5% to 25%) | 0.120 | 0.100 | 1.432 | 0.231 | 1.128 |
| Importance of innovative products or services for sales | | | | | |
| Most sales came from innovative products or services | -0.229 | 0.144 | 2.531 | 0.112 | 0.796 |
| About equal share of innovative and non-innovative products or services | -0.562*** | 0.093 | 36.113 | 0.000 | 0.570 |
| Integration of company activities in support of innovation activities | | | | | |
| Knowledge-management systems | 0.157* | 0.090 | 3.004 | 0.083 | 1.170 |
| Staff rotations between different functions | 0.511*** | 0.089 | 32.706 | 0.000 | 1.668 |
| Involving potential and current users in innovation activities | -0.097 | 0.094 | 1.068 | 0.301 | 0.908 |
| Targeting creativity in training or recruitment | -0.098 | 0.090 | 1.185 | 0.276 | 0.906 |
| Main competitive advantage in the near future will be | | | | | |
| Development of new products, services or processes | 0.112 | 0.111 | 1.024 | 0.312 | 1.119 |
| Reduced costs | 0.556*** | 0.099 | 31.843 | 0.000 | 1.744 |
| Interest in public procurement (won contract, submitted a tender or investigated opportunities) | 0.257*** | 0.089 | 8.426 | 0.004 | 1.294 |

| | B | S.E. | Wald | Sig. | Exp(B) |
|--|------------|-------------|-------------|-------------|---------------|
| Firm operating on international markets | -0.089 | 0.098 | 0.828 | 0.363 | 0.915 |
| Lead market is own country | -0.059 | 0.101 | 0.344 | 0.557 | 0.943 |
| <i>Greatest opportunities for innovation in the near future come from</i> | | | | | |
| New export markets | 0.342*** | 0.121 | 7.984 | 0.005 | 1.408 |
| Eco-demand | 0.010 | 0.096 | 0.011 | 0.916 | 1.010 |
| <i>Significant changes in policy-related areas having a positive effect on innovation</i> | | | | | |
| New requirements from environmental regulations or standards | 0.061 | 0.091 | 0.441 | 0.507 | 1.062 |
| Changes in tax environment | 0.111 | 0.112 | 0.971 | 0.325 | 1.117 |
| Changes in public financial support | -0.498*** | 0.112 | 19.874 | 0.000 | 0.608 |
| Overall economic downturn | -0.003 | 0.013 | 0.054 | 0.817 | 0.997 |
| Constant | 0.647** | 0.261 | 6.134 | 0.013 | 1.911 |
| Number of cases | 4195 | | | | |
| % correctly predicted | 77.0% | | | | |
| Model with only intercept | 75.4% | | | | |
| Model Chi-square | 478.861*** | | | 0.000 | |

* p<0.1, ** p<0.05, *** p<0.01

Reference categories: Size: 20-49 employees; Sector: low innovative; Innovative capability of country: Catching-up; Trend in 2006-2008 innovation expenditures: decreasing; Innovation intensity of the firm: low (<5%); Importance of innovative products or services for sales: most sales came from non-innovative products or services.

Table 5: Logistic regression for an expected decrease in innovation expenditures between 2008 and 2009

| | B | S.E. | Wald | Sig. | Exp(B) |
|---|-----------|-------------|-------------|-------------|---------------|
| Size | | | | | |
| 250+ employees | -0.077 | 0.159 | 0.234 | 0.628 | 0.926 |
| 50-249 employees | -0.537*** | 0.097 | 30.743 | 0.000 | 0.584 |
| Sector group | | | | | |
| High innovative | -0.136 | 0.179 | 0.576 | 0.448 | 0.873 |
| Medium-high innovative | 0.483*** | 0.130 | 13.899 | 0.000 | 1.621 |
| Medium innovative | -0.173 | 0.123 | 1.995 | 0.158 | 0.841 |
| Medium-low innovative | -0.271** | 0.121 | 4.979 | 0.026 | 0.763 |
| Innovative capability of country (EIS country group) | | | | | |
| Leader | -0.142 | 0.131 | 1.181 | 0.277 | 0.868 |
| Follower | 0.248* | 0.143 | 3.013 | 0.083 | 1.281 |
| Moderate innovator | 0.313** | 0.130 | 5.786 | 0.016 | 1.367 |
| Decreasing innovation expenditures in past six months (4 th quarter 2008 to 1 st quarter 2009) as a result of the economic downturn | 2.054*** | 0.094 | 481.410 | 0.000 | 7.799 |
| Type of innovator | | | | | |
| Product and/or process innovator | 0.146 | 0.147 | 0.990 | 0.320 | 1.157 |
| Marketing and/or organizational innovator | 0.021 | 0.105 | 0.040 | 0.842 | 1.021 |
| Non R&D innovator | 0.244*** | 0.092 | 7.049 | 0.008 | 1.276 |
| Innovation intensity of the firm | | | | | |
| High (>25%) | 0.386 | 0.247 | 2.446 | 0.118 | 1.470 |
| Medium (5% to 25%) | 0.413*** | 0.096 | 18.607 | 0.000 | 1.511 |
| Importance of innovative products or services for sales | | | | | |
| Most sales came from innovative products or services | -0.722*** | 0.157 | 21.193 | 0.000 | 0.486 |
| About equal share of innovative and non-innovative products or services | -0.165* | 0.090 | 3.395 | 0.065 | 0.848 |
| Integration of company activities in support of innovation activities | | | | | |
| Knowledge-management systems | -0.278*** | 0.091 | 9.427 | 0.002 | 0.757 |
| Staff rotations between different functions | -0.031 | 0.089 | 0.120 | 0.729 | 0.969 |
| Involving potential and current users in innovation activities | -0.189** | 0.092 | 4.247 | 0.039 | 0.827 |
| Targeting creativity in training or recruitment | -0.110 | 0.089 | 1.518 | 0.218 | 0.896 |
| Main competitive advantage in the near future will be | | | | | |
| Development of new products, services or processes | -0.180 | 0.111 | 2.635 | 0.105 | 0.835 |
| Reduced costs | 0.603*** | 0.097 | 38.624 | 0.000 | 1.828 |
| Interest in public procurement (won contract, submitted a tender or investigated opportunities) | -0.006 | 0.089 | 0.005 | 0.942 | 0.994 |

| | B | S.E. | Wald | Sig. | Exp(B) |
|--|------------|-------------|-------------|-------------|---------------|
| Firm operating on international markets | 0.273*** | 0.096 | 8.062 | 0.005 | 1.314 |
| Lead market is own country | -0.294*** | 0.098 | 8.970 | 0.003 | 0.745 |
| <i>Greatest opportunities for innovation in the near future come from</i> | | | | | |
| New export markets | -0.349*** | 0.126 | 7.681 | 0.006 | 0.705 |
| Eco-demand | -0.038 | 0.095 | 0.161 | 0.689 | 0.963 |
| <i>Significant changes in policy-related areas having a positive effect on innovation</i> | | | | | |
| New requirements from environmental regulations or standards | -0.017 | 0.090 | 0.036 | 0.850 | 0.983 |
| Changes in tax environment | 0.032 | 0.112 | 0.084 | 0.772 | 1.033 |
| Changes in public financial support | -0.133 | 0.105 | 1.594 | 0.207 | 0.875 |
| Overall economic downturn | 0.043*** | 0.014 | 9.504 | 0.002 | 1.044 |
| Constant | -1.465*** | 0.254 | 33.166 | 0.000 | 0.231 |
| Number of cases | 4195 | | | | |
| % correctly predicted | 76.5% | | | | |
| Model with only intercept | 69.1% | | | | |
| Model Chi-square | 863.919*** | | | 0.000 | |

* p<0.1, ** p<0.05, *** p<0.01

Reference categories: Size: 20-49 employees; Sector: low innovative; Innovative capability of country: Catching-up; Innovation intensity of the firm: low (<5%); Importance of innovative products or services for sales: most sales came from non-innovative products or services.

5. Summary and conclusions

The financial crisis and accompanying economic downturn are having a negative effect on firms' innovation expenditures. The Innobarometer 2009 survey data indicates that 23% of innovating firms in the EU27 had decreased their innovation expenditures between October 2008 and March 2009 as a direct result of the economic downturn. Even more innovating firms (29%) expected, when asked in April 2009, that their innovation expenditures in 2009 would be lower than those in 2008.

Our results offer support for the second hypothesis (firms in countries where the overall economic downturn has been largest are more likely to have reduced their innovation expenditures) and third hypothesis (firms with broader innovation strategies – e.g. open innovation, soft skills, etc. – are less likely to have reduced their expenditures) presented in Section 1, but not for the first hypothesis (firms with higher innovation expenditures are more likely to have reduced their expenditures). Further, our results indicate that:²⁵

- There is almost no size effect. Only medium-sized firms are less likely to reduce their innovation expenditures as compared to small and large firms, but there is no difference between the latter.
- Firms in the medium to high innovation intensive sectors are more likely to expect to cut their innovation expenditures as compared to firms in the low innovation intensive sectors.
- Firms in innovation follower and moderately innovating countries are expected to experience the effect of the recession slightly later than firms in catching up countries.
- Countries which have been experiencing the fastest rates of improvement in their innovation performance have been affected most by the economic crisis leading to a possible slowdown or even a reversal of the convergence process in innovation performance.²⁶
- Firms already experiencing a decline in their innovation expenditure before the crisis are more likely to experience a further decline resulting from the crisis.
- Firm innovating by performing R&D are affected less by the economic crisis than firms innovating by performing non-R&D activities.
- Firms with higher innovation expenditures are as likely to reduce their expenditures as firms with average or lower innovation expenditures.
- Firms where innovative products and services account for a larger share of sales are affected less than firms where innovative products and services account for a small share of sales.

25 Most of these points are in response to the first research question given in Section 1 (page 6).

26 This conclusion provides an answer to the second research question given in Section 1 (page 6).

- Firms who have integrated certain company activities in support of innovation are more likely to reduce their innovation expenditures as a direct effect of the crisis, but specifically, firms that have integrated their knowledge management systems are less likely to further cut their innovation expenditures.
- Firms with broader innovation strategies, in particular, firms involving users in the innovation process, are less likely to reduce their expenditures.
- Firms that see reduced costs as their main competitive advantage in the near future are more likely to cut their innovation expenditures.
- Firms that show interest in public procurement are slightly more likely to have decreased their innovation expenses.
- For firms operating on international markets, it is slightly more likely that their innovation expenditures will decrease.
- Firms whose lead market is their own country are less likely to reduce their innovation expenditures.
- Firms which see new export markets as their greatest opportunity for innovation in the near future are less likely to expect to reduce their innovation expenditures.
- The direct effect of the economic crisis has been more pronounced for those firms that see eco-innovation as important.
- Firms that have experienced a positive effect of improved financial public support are less likely to cut their innovation expenditures. Improved public financial support has a positive effect on firms' innovation expenditures.
- Firms operating in countries where GDP has fallen most over the past two years are slightly more likely to cut their innovation expenditures.

The Innobarometer 2009 survey did not include any questions on the relative importance or availability of different finance schemes, and the impact of these schemes on the responses of firms to the economic downturn could not be analysed in this report. Policy issues related to the availability of these finance schemes could thus not be discussed.

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