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Policy rationale for Innovation Support

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Executive Summary

Innovation is one of the drivers of productivity growth. Innovating firms are assumed to be at the heart of these productivity improvements. But just as any other market, also the market for innovations can fail due to the existence of market and system failures resulting in fewer innovations. This mini-study on the policy rationale for innovation support will provide answers to the following questions: 1) What are the major market failures that need to be addressed to fully exploit the innovation potential in Europe; 2) Which persisting barriers hamper enterprises to innovate; and 3) What does economic theory suggest, and which needs for innovation support are supported by empirical evidence?

Hampering factors

An empirical analysis of Community Innovation Survey (CIS-4) data has shown that cost factors are perceived by innovating firms as the most important factor hampering their innovation activities. Market factors are the second most important category of hampering factors, followed by knowledge factors. These hampering factors grow in importance with declining firm size. The empirical analysis has also shown strong sectoral differences in the relative importance of the different types of hampering factors.

Market and system failures

In a perfect world, markets clear as supply meets demand without any interruption: social welfare and private welfare coincide and are both maximised. But our world is not perfect. Both market failures and system failures are arguments used to justify policy intervention. Market failures can occur due to the existence of externalities and spillovers, imperfect and asymmetric information, network failures and market power. System failures are linked to structural, institutional and regulatory deficiencies, which affect innovation activities.

Market failure causes firms to underinvest in innovation activity (e.g. R&D), as they are not able to appropriate the full benefits of these investments. Market failures resulting from externalities and spillovers are most likely to occur in innovation resulting from R&D investments. Government intervention is also liable to failures as a result of crowding-out effects, inelastic supply of R&D workers and a lack of information on the size of private innovation’s social returns. Market failures resulting from imperfect and asymmetric information are most likely to occur in the financial market and the education market. The financial market to some extent counteracts these failures through the introduction of banks which act as a screening and monitoring facility. Market failures resulting from market power are most likely to occur in product markets. More competition drives innovation up to a certain point, after which more competition will lower innovation. But there are significant differences between industries, and governments might not be able to identify the inflexion point.

Importance of public support

An empirical analysis of Innobarometer 2007 data has shown that for most firms receiving public support for innovation, this support was not crucial for their innovation activities. Even without this public support these firms would have completed their innovation activities.

Policy conclusions

Policy-makers need to better understand the impact of the various market failures, so that they weigh the potential benefits against the costs of implementing innovation support measures. Government will have to take several decisions based on incomplete information which could result in unnecessary government intervention. Only when the expected benefits

of government intervention are substantial and when the expected costs resulting from government failures are low, governments should clearly intervene. In all other cases it is unclear as costs might be higher than the expected revenues. Of course, there are many more gradations in the degrees of expected benefits and costs which are reflected in the above scheme, but the overall conclusion is clear. Governments will need to better explain the need for intervention, with a clear and sound message on the rationale and expected benefits of such intervention that contributes to make it plausible and logical to target the public opinion. The risk is that due to incomplete information, governments may not be able to make such evaluations; in particular as it will be very difficult to understand what the potential impact and thus expected benefit is of a market failure on different types of firms all operating in a private market.

1 Introduction

Innovation is one of the drivers of productivity growth in western economies. Innovating firms are assumed to be at the heart of productivity improvements. But just as any other market, so too can the market for innovations fail due to the existence of market and system failures resulting in fewer innovations. This mini study on the policy rationale for innovation support will provide answers to the following questions:

- What are the major market failures that need to be addressed to fully exploit the innovation potential in Europe?
- Which persisting barriers hamper enterprises to innovate?
- What does economic theory suggest, and which needs for innovation support are supported by empirical evidence?

The remainder of this report is structured as follows. In section 2 we will present empirical evidence from the 4th Community Innovation Survey (CIS-4) on the relative importance of different factors hampering innovation. Section 3 will discuss different market failures and their likely occurrence in five markets: the technology market, product market, financial market, labour market and education market and will include, where available, empirical evidence from CIS-4 or the Innobarometer 2007 (Gallup, 2007). Section 4 will discuss government and system failures. Section 5 concludes.

2 Barriers hampering enterprises to innovate

> *'Innovation activity may be hampered by a number of factors. There may be reasons for not starting innovation activities at all or factors that slow innovation activity or have a negative effect on expected results. These include economic factors, such as high costs or lack of demand, enterprise factors, such as a lack of skilled personnel or knowledge, and legal factors, such as regulations or tax rules' (OECD, Oslo Manual).*

The Community Innovation Survey (CIS) provides some empirical evidence on the relative importance of different barriers hampering innovation. The CIS is a survey on innovation activity in enterprises covering EU Member States, candidate countries, Iceland and Norway. Both innovating and non-innovating firms are asked to indicate the relative degree of importance of these hampering factors ranging from high, to medium to low or no importance. The factors are classified into four groups:

- <u>Cost factors</u>, which include Lack of own funds within the enterprise or the enterprise group; Lack of external finance from sources outside the enterprise; and to high innovation costs. The latter is strictly speaking not a cost factor as it does not specify the nature of these high costs.
- <u>Knowledge factors</u>, which include 'lack of qualified personnel', 'lack of information on technology or technological opportunities'; 'lack of information on markets'; and 'difficulty in finding cooperation partners for innovation'.
- <u>Market factors</u>: which include 'market domination by established enterprises'; and 'uncertain demand for innovative goods or services'.
- <u>Reasons not to innovate</u>, which include 'no need to innovate due to prior innovations'; and 'no need to innovate because of no demand for innovations'.

For all industries cost factors seem the most important factors hampering innovation (Table 2.1). Innovation costs are too high for 24% of EU innovators, from as high as 40% in Spain to as low as 9% in Portugal. Lack of own funds is an important hampering factor for 21% of EU innovators, from as high as 32% in Greece to as low as 8% in Romania. Lack of external finance is an important hampering factor for 15% of EU innovators, from as high as 32% for Greece to as low as 5% for Luxembourg.

Market factors are the second most important category of hampering factors. For 13% of EU innovators dominance of established firms hampers their innovation activities, from as high as 26% in Slovenia to as low as 5% in the Netherlands. About 12% of EU innovators face difficulties due to uncertain demand for their innovative products, from as high as 24% in Greece to as low as 5% in Germany. Market factors should also include 'No need to innovate because of no demand for innovations' which limits innovation activities for 6% of EU innovators, from as high as 43% in Latvia to as low as 1% in Ireland and Norway.

Knowledge factors are the third most important category of hampering factors. Finding sufficiently skilled personnel is a problem for 11% of EU innovators, in particular in Portugal (25%), whereas skilled personnel in Germany are relatively abundant (5%). About 8% of EU innovators have problems finding cooperation partners, from as low as 2% in the UK to as high as 29% in Latvia. Lack of information on markets hampers innovation activities for 6% of EU innovators, in particular in Latvia (35%) and Portugal (31%), whereas for Romanian firms this hardly is a problem. Finding a sufficient amount of information on new or existing technologies is hampering innovation activities for 5% of EU innovators, in particular in Latvia (40%) and Portugal (33%).

Table 2.1: Factors hampering innovation activities (innovators, all size classes)

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		REASONS NOT TO INNOVATE	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
European Union	21	15	24	11	5	6	8	13	12	5	6
Belgium	19	11	19	14	3	6	6	15	10	2	3
Bulgaria	24	21	26	9	6	6	11	15	15	4	5
Czech Republic	22	12	18	10	2	4	3	19	12	3	3
Denmark	21	9	12	7	3	3	3	9	12	4	5
Germany	12	11	19	5	1	3	3	7	5	7	7
Estonia	28	19	21	23	4	3	6	16	11	5	6
Ireland	24	13	19	18	5	13	4	12	13	2	1
Greece	32	32	39	23	18	18	24	22	24	5	6
Spain	29	27	40	16	11	9	12	20	21	6	11
France	30	10	28	15	4	6	10	15	16	3	5
Italy	19	19	26	11	5	4	10	13	13	5	3
Cyprus	27	24	31	15	5	3	9	11	9	3	2
Latvia	16	19	17	22	40	35	29	20	23	37	43
Lithuania	25	19	22	14	7	8	8	19	11	5	2
Luxembourg	12	5	10	12	1	3	5	15	12	3	5
Hungary	27	20	26	7	2	3	5	15	15	2	3
Malta	15	10	18	9	3	8	6	15	17	4	3
Netherlands	17	9	12	7	4	4	3	5	8	2	2
Austria	19	15	19	11	4	4	8	12	9	3	4
Poland	31	26	32	7	5	5	--	--	17	--	--
Portugal	14	15	9	25	33	31	21	21	19	27	25
Romania	8	30	30	14	7	0	16	21	16	5	4
Slovenia	31	24	24	20	5	9	11	26	9	1	5
Slovakia	24	16	21	8	2	4	7	14	12	--	--
Finland	14	10	11	9	4	5	7	8	9	5	4
Sweden	21	13	15	9	3	4	5	19	12	2	3
United Kingdom	--	--	22	10	3	5	--	13	13	--	--
Iceland	21	16	19	13	--	5	10	16	12	5	6
Norway	14	12	17	6	3	3	2	6	8	1	1

Percentages show shares of innovating firms acknowledging the respective factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

The European countries can be classified into four distinct groups based on their average scores on the different types of hampering factors:

- Greece, Poland and Spain, with above average scores on three types of hampering factors. Innovation activities are severely hampered as perceived by innovating firms in these countries.
- Latvia and Portugal, both with extremely high scores on knowledge and market factors hampering innovation and below average scores for cost factors.
- Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Ireland, Luxembourg, Malta, Netherlands and Norway, with below average scores on all types of hampering factors.
- Bulgaria, Cyprus, Estonia, France, Hungary, Iceland, Italy, Lithuania, Romania, Slovakia, Slovenia and UK, with above average scores on all three types of hampering factors.

For small firms with 10 to 49 employees and medium-sized firms with 50 to 249 employees, cost factors are also the most important hampering factors for innovation, but the percentages differ where hampering factors become less important with growing firm size (Annex II). For large firms with more than 250 employees, the three most important hampering factors are innovation costs that are too high, lack of own funds within the enterprise and uncertain demand for innovative goods or services (Annex II). This is also confirmed in Table 2.2, where the differences in importance for these cost factors are shown separately for manufacturing and services.

Table 2.2: Cost factors: differences between manufacturing and services

	Lack of funds within your enterprise or enterprise group		Lack of finance from sources outside your enterprise		Innovation costs too high	
	Manufacturing	Services	Manufacturing	Services	Manufacturing	Services
INNOVATORS - all firms	23	17	18	13	26	21
Small firms	26	18	20	15	29	22
Medium-sized firms	18	13	15	9	22	18
Large firms	15	14	13	7	21	18
NON-INNOVATORS - all firms	25	15	18	11	29	19
Small firms	27	16	18	11	30	20
Medium-sized firms	20	12	17	10	24	15
Large firms	17	9	15	8	21	11

Percentages show shares of innovating firms acknowledging the respective factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

Table 2.3: Hampering factors: significant differences between industries

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate because no demand for innovations
inn_tot: All NACE - Core NACE (NACE sections C, D, E, I and J and NACE divisions 51, 72, 74.2 and 74.3)	20	16	24	11	5	6	8	13	12	6
c_d_e: Total industry (excluding construction)	23	18	26	12	6	6	9	14	13	6
d: Manufacturing	23	18	27	12	6	6	9	14	13	6
da15: Food products and beverages	23	18	29	13	7	8	8	18	17	7
db17: Textiles	19	17	27	10	8	10	11	12	16	5
dd20: Wood and products of wood and cork	22	16	29	12	6	7	8	11	9	5
de21: Pulp, paper and paper products	22	17	27	9	6	5	6	17	13	5
de22: Publishing, printing, reproduction of recorded media	25	20	27	11	6	5	9	10	10	5
dg24: Chemicals and chemical products	22	18	26	8	4	8	9	22	13	4
dh25: Rubber and plastic products	23	18	26	11	6	9	11	16	13	5
di26: Other non-metallic mineral products	18	16	26	12	8	8	9	10	13	6
dj27: Basic metals	22	16	26	11	7	6	7	10	10	4
dj28: Fabricated metal products	23	17	26	13	6	6	8	12	12	6
dk29: Machinery and equipment n.e.c.	21	18	22	13	4	4	8	14	13	4
dl31: Electrical machinery and apparatus n.e.c.	22	19	28	10	3	4	7	16	15	7
dl32: Radio, television and communication equipment	28	22	31	12	5	6	11	20	18	5
dl33: Medical, precision and optical instruments, watches	24	20	27	7	2	6	7	13	12	3
dm34: Motor vehicles, trailers and semi-trailers	30	23	29	9	5	5	11	16	15	4
dn36: Furniture; manufacturing n.e.c.	23	19	28	14	6	6	9	14	15	6
inn_g_to_k: Core G_to_K Services	17	13	21	9	5	5	7	12	10	6
g51: Wholesale trade and commission trade	16	12	20	10	6	5	8	13	10	7
i: Transport, storage and communication	18	14	24	9	5	5	7	12	9	8
j: Financial intermediation	6	4	11	8	2	2	3	7	5	4
inn_k: K: Core coverage (NACE 72, 74.2 and 74.3)	22	17	23	9	3	6	6	11	13	6

Percentages show shares of innovating firms acknowledging the respective factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

There are also sectoral differences in the relative importance of the different types of hampering factors as shown in Table 2.3. The different cost factors are seen as a relatively more important factor hampering innovation in Radio, TV and communications equipment (NACE 32) and Automotive (NACE 34) but as a less important factor in the services sectors and in particular in Financial intermediation (NACE J). Knowledge factors are more important for manufacturing sectors, in particular lack of qualified personnel in Furniture (NACE 36), lack of information on technology in Textiles (NACE 17) and Other non-metallic mineral products (NACE 26), lack of information on market in Textiles (NACE 17) and Rubber and plastic products (NACE 25) and difficulty in finding cooperation partners in Textiles (NACE 17), Rubber and plastic products (NACE 25), Radio, TV and communication equipment (NACE 32) and Automotive (NACE 34). Of the different market factors markets dominated by established enterprises are more important in Chemicals and chemical products (NACE 24) and Radio, TV and communications equipment (NACE 32) and uncertain demand for innovative products in Food products and beverages (NACE 15) and Radio, TV and communications equipment (NACE 32).

3 Market, government and system failures

In a perfect world markets clear as supply meets demand without any interruption: social welfare and private welfare coincide and are both maximised. But our world is not perfect. Markets do not always function properly due to market failures and system failures. There is not one market for innovation. One can distinguish between R&D and non-R&D innovation, where the first relies on technological knowledge. One can also distinguish between the creation of knowledge and the use of knowledge.

The market failure approach focuses on resources allocation to knowledge production and other innovative activities. Failure is associated with risk and uncertainties. The system failure approach focuses on units' interactions in knowledge exploration and exploitation. It recognises that actors have different motivations when engaged in knowledge creation and diffusion. This approach is broader in nature. However, the relationships between the two are not always clear and not always mutually exclusive. In some ways they may overlap. The main goal of both approaches is to facilitate innovation activity by creating incentives to those actors that are considered to be constrained.

Market failure causes firms to underinvest in innovation activity (e.g. R&D), as they are not able to appropriate the full benefits of these investments. We distinguish between the following market failures:

i) Externalities and spillovers
ii) Imperfect and asymmetric information
iii) Network failures
iv) Market power

These market failures will be discussed in detail below in relation to five different markets of relevance for innovation: the technology market, product market, financial market, labour market and education market (the discussion in sections 3.1 to 3.5 follows the argumentation in chapters 2 to 6 in Jacobs and Theeuwes, 2004).

3.1 Failures in the technology market

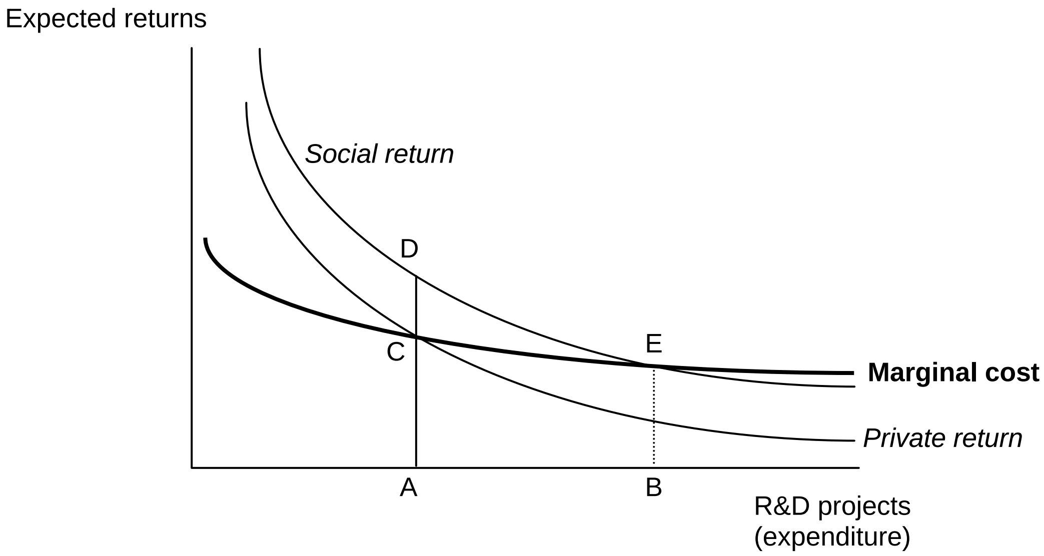
Knowledge can be both technological and non-technological. Advances in technological knowledge follow from investments in R&D and market failures can have different effects on R&D investments.

The dominant view in economic theory is that technology markets fail and that market failures lead to underinvestment in R&D. According to this theory, R&D results in technological knowledge with public good characteristics: technology or R&D is non-rivalrous and non-excludable. Market failures lead to underinvestment in knowledge production for the following reasons:

- Other firms will benefit from the R&D efforts at no cost by incorporating new ideas in their own products and processes. This is the consequence of *knowledge spillovers*.
- End-users (e.g. consumers) pay less for the innovative product than they would be willing to pay if the innovating firm could use different prices for different consumers so that every consumer would exactly pay what the innovation is worth to this consumer. This leads to *rent spillovers* as firms cannot appropriate the whole increase in surplus that results from the innovation.

  The effects of spillovers can be demonstrated in the simplified graph shown in Figure 3.1. Firms will invest up until point A where their private return matches the marginal cost of an additional R&D project. But due to knowledge or rent spillovers social return will be above private return, and from a social point of view the optimal level of investment is B. The welfare loss for society is equal to the area CDE. If government could persuade firms to invest more in R&D, this welfare loss can be minimised and might even disappear if firms invest up to B.

Figure 3.1: The effect of spillovers on the optimal size of R&D investments



- Differences in knowledge about the innovative product (i.e. the product or process innovation to be developed) between the firm and the supplier of finance, i.e. *asymmetric information*, will result in some R&D projects not being funded (see section 3.3).
- Problems of *moral hazard and risk averseness* (see section 3.3).

But there are also theoretical arguments for overinvestment. According to the *business-stealing-effect,* new R&D replaces old R&D thereby reducing the returns for those firms who already invested in R&D. The expectation of this effect will lower expected returns and thus current investment in R&D. Firms can also *duplicate* R&D investment when they are involved in an R&D-race leading to the inefficient use of scarce resources. And there can be *negative external effects*, e.g. because the new innovation harms the environment, lowering social return below private return: there is thus too much investment in R&D.

Another strand of theory claims that <u>markets have built-in incentives to prevent market failures</u>. R&D collaboration and R&D networks internalise knowledge spillovers (Kamien & Zang, 2000) and firm size prevents failures due to asymmetric information, moral hazard and risk averseness (by an increased use of internal funding, cf. section 3.3).

Coordination or network failures affecting collaborative R&D projects are more likely to occur 1) the larger the need for firms to interrelate for the project to succeed, 2) the greater the sunk costs arising from the project, and 3) the riskier the project and the more difficult for investors to price such risk (Oxera, 2005).

Some even claim that knowledge is a rivalrous good, that although an idea as such is non-rivalrous, the diffusion of the knowledge resulting from the idea is rivalrous (Boldrin & Levine, 2004). If knowledge is indeed a rivalrous good then the market for R&D cannot be failing due to market failures resulting from the non-rivalrous nature of innovations.

Empirical evidence in economic literature seems to confirm that social returns exceed private returns (Jones and Williams, 1998) but there is a whole range of measurement and specification errors (Mohnen, 1996) of which the most important one is the fact that these studies cannot distinguish between intentional and unintentional spillovers, therefore overestimating the effect of knowledge spillovers as only unintentional spillovers reflect market failures.

Technological or knowledge spillovers are more likely to occur 1) the more general the knowledge created by the innovative activity, 2) the more unlikely it is that the inventor can appropriate all of its effects, and 3) the easier it is to transfer knowledge between agents. Appropriating the results of an innovation is more difficult 1) the more difficult it is to codify the knowledge, and 2) the easier it is to transfer such knowledge (Oxera, 2005).

Effective government policies and government failures

The effectiveness of government policy can be evaluated using the following two concepts: additionality and composition[1]. Additionality refers to how much extra private R&D will be performed resulting from government policy:

- Subsidies and tax credits will not only generate new R&D products but will also replace private funding for existing projects. Public funding will thus crowd out private R&D funding.
- Publicly funded R&D projects can also replace private R&D projects as firms might no longer be willing to invest in an R&D project for which it will be more difficult to appropriate revenues in case of success of the publicly funded R&D project since results are expected to become available to others for free.
- Subsidies and tax credits might simply lead to researchers' wage increases when the supply of researchers is inelastic. The size of this 'wage effect' was estimated to be as high as 66% for the US (Goolsbee, 1998) and between 10% (Lokshin and Mohnen, 2008) and 20% (Marey and Borghans, 2000) for the Netherlands (cf. section 3.5).
- Firms will be tempted to rename activities as R&D projects to claim government support. One of the few empirical studies by Mansfield (1986) estimates this effect to be as high as 10% of extra R&D investments.

Composition refers to which R&D projects are stimulated: policy should aim at those projects with highest social returns:

- Governments face a similar (or worse) lack of information on returns as private firms. As governments do not know which projects have highest social returns, government intervention may lead to the selection of projects with low social returns.
- Lobbying groups will influence policy makers for directing public funding to their own projects. These projects will not necessarily have highest social returns, lobbying is also biased in favour of large firms.

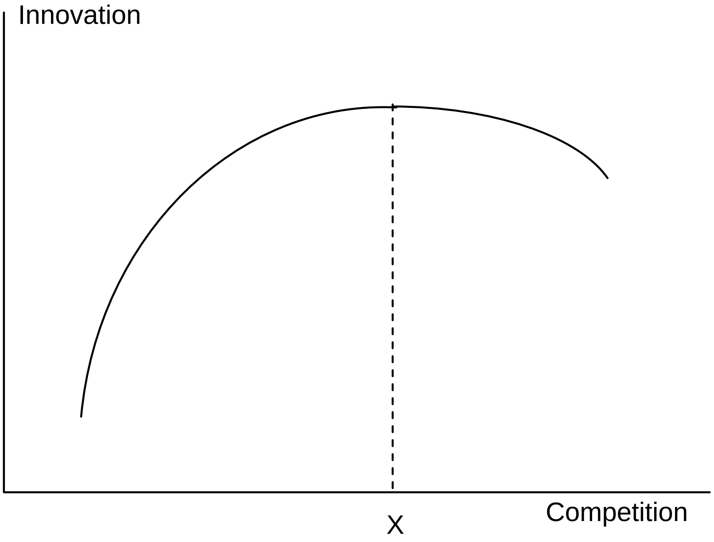
Most effective policy instruments would result in many extra R&D projects (high additionality) with high social returns (high composition). But given the factors influencing additionality and composition it is unlikely that most policy instruments will not fall short of at least one of these factors. There are thus clear government failures and choosing the right instrument is of utmost importance. Available policy instruments include the use of patents (which offer a temporary protection to the innovating firm prohibiting others from freely using that innovation but patents at the same time hinder the diffusion of knowledge), prizes for inventions, subsidies and tax credits, and stimulating public-private (research) collaboration.

[1] In his inaugural lecture 26 May 2008 B. Jacobs (2008) claims that government intervention is not efficient and that for every euro reallocated by the government cost for society is as high as 50 cents.

3.2 Failures in the product market

Competition has a positive effect on productivity as it fosters the efficient use of resources. However, competition is even more important for innovative activities as it is an incentive for firms to seek individuality from competitors and thereby establish their own market niches by developing new technologies or exploring new markets. Recent advances in economic theory suggest that the relationship between competition and innovation activities follows an inverted U shaped relationship (Aghion et al., 2002). This means that competition has a positive effect on innovation up to a certain point, after which more competition will lower the level of innovative activity (Figure 3.2).

Figure 3.2: The relation between competition and innovation



Policy makers face two difficulties. First, for each industry the nature of the relationship between competition and innovation has to be determined. For most industries this will be an inverted U shape, but for other sectors this share might be different. The Sectoral Innovation Watch project finds differences at the sector level for the existence of this inverted U shaped relationship. An inverted U shaped curve is found for the Food sector, Chemicals, Machinery and equipment and the Automotive sector. But for the Energy sector a concave pattern is found and for Aerospace and the ICT sector a linear pattern is observed. For Textiles the observed pattern is even a regular U shaped curve where innovation at first declines with increasing levels of competition and then starts to rise when competition intensifies even more (cf. Reinstaller and Unterlass, 2008)[2]. But even when the observed relationship is an inverted U shape as shown in Figure 3.2, policy makers will have to determine whether the industry is performing at the below optimal competition level ('X') or above that level. In that case further liberalisation of that industry will increase competition and thus innovation. There is an inherent risk for the creation of a government failure if industries are classified wrongly as to their position on this inverted U shaped curve or if their position on or the curve itself changes over time without governments being aware of this change.

3.3 Failures in the financial market

Firms need access to internal or external funds to finance their innovation activities and new firms or start-ups rely even more on accessing external funding: well functioning financial markets promote innovation and new start-ups. But access to finance is perceived as one of the major factors hampering innovation in SMEs, and could result from market failures in this market (cf. the discussion of CIS-4 hampering factors in section 2).

Financial markets are not without frictions resulting in higher costs of finance or even in firms not having access to finance. The latter case is a clear example of a possible market failure. Market failures are caused by problems of asymmetric information resulting in problems of 'adverse selection' or limited verifiability resulting in 'moral hazard' problems.

[2] The Sectoral Innovation Watch project studied 11 sectors for which for 8 sectors data availability allowed the calculation of the relationship between competition and innovation (cf. for more details Crespi and Patel, 2008).

Adverse selection is the result of information differences about the quality and future returns from innovation projects between the firm and its financiers. Financiers not only cannot value the true expected returns from the innovation project but also know that the innovating firm has more information about the innovation project. Financiers will value the firm's innovation project at an average expected return with accompanying less beneficial financing conditions. Firms with an innovation project with above average expected return but which are confronted with average financing conditions will either look for other funding possibilities or might not invest at all and, similarly, firms with an innovation project with below average expected return will accept these, for them, beneficial financing conditions. Theoretically this market failure could result in equilibrium where 'bad' innovation projects replace 'good' innovation projects.

Moral hazard problems will occur as a result of verifiability problems after the innovation project has been funded. Firms could, having secured their funding, adjust their innovation project increasing its risk and lowering its expected future return[3]. Financiers will, next time they have to decide whether or not to provide funds for an innovation project, expect this kind of behaviour and will adjust their financing conditions upward leading to less investment in innovation.

Adverse selection is more common among start-ups and fast growing firms who depend relatively more on immaterial assets, in particular firms heavily involved in R&D projects. Adverse selection is also more common among small firms because for these firms solving information differences is relatively more costly than for large firms, but also medium-sized firms will be less open towards financiers compared to large firms. Small and medium-sized firms have more restricted access to external funding with good financing conditions than large firms and will have to rely more on internal funding or by relying on banks for their external funding[4].

Banks, by screening firms' (innovation) behaviour and performance, act as the financial market's solution to market failures caused by asymmetric information. Other financiers will positively react to a bank's decision to provide a loan to a firm for financing its innovation activities by also providing finance to this firm. A well-established banking system can remedy most of the negative effects of market failures. However, a possible drawback is the so-called hold-up problem where firms become dependent on the bank's monopoly on information offering these firms less favourable financing conditions knowing that the firm cannot easily find other financiers (e.g. Sharpe, 1990). More competition within the banking sector could overcome this hold-up problem.

For SMEs it seems that banks can act as external financiers to overcome market failures due to asymmetric information. For large firms access to external funding is more easily accessible and large firms can also more easily use profits as internal funding for risky innovation projects.

Financial market failures are more likely to occur 1) the riskier the project is from an economic and technical perspective, 2) the greater the information asymmetries, 3) the more complex the project is, 4) the higher the due-diligence costs[5], 5) the lower the collateral of the firm, 6) the less likely it is that the firm undertaking the innovation has a track record, and

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[3] Management could e.g. shift from a more long-term perspective in favour of the innovation project to a more short-term perspective in favour of its shareholders.

[4] Block (2002) has defined two types of financial systems and evaluated their effect on innovation. He uses four financial structure variables (bank concentration, a financial structure index, accounting standards and ownership concentration) to develop an insider/outsider indicator. Relative to insider or bank-based systems, outsider or market-based systems are characterized by lower bank and ownership concentration, better accounting standards, and greater stock market concentration. Block's analysis suggests that outsider systems promote higher growth rates in product-oriented and science-based sectors, whereas export-competitiveness in process-oriented sectors is positively correlated with insider systems.

[5] Due diligence is used to investigate and evaluate a business opportunity. The term due diligence describes a general duty to exercise care in any transaction. As such, it spans investigation into all relevant aspects of the past, present, and predictable future of the business of a target company.

7) the lower the access of the firm to retained earnings to finance the innovation (Oxera, 2005).

3.4 Failures in the labour market

A more flexible labour market will spur innovation by firms as highly skilled workers can be reallocated to those innovation projects which are expected to yield highest returns. Successful innovation will also change the existing production process within firms demanding workers to flexibly adjust to new working conditions. Innovation will also render inefficient firms obsolete releasing their employees to the labour market. Flexible workers and a flexible labour market create necessary framework conditions for firms and industries to innovate successfully. Continuous investments in human capital are needed and here market failures could have a negative effect on innovation by deterring an adequate supply of highly skilled workers.

Formal education (cf. section 3.5) and training on the job result in investments in human capital. Production processes have become more complex over time requiring a continuous renewal of skills. Workers need to continuously upgrade themselves; the concept of life long learning becomes crucial for an innovative society. Here we need to distinguish between general and more specific skills (or human capital). General skills can be used in a broad setting and workers will invest themselves in acquiring these general skills as they can easily transfer them from one job to another without losing the return on this investment. Specific skills benefit not only the worker but also his employer as it will increase that worker's productivity. Firms thus have an incentive to also invest in increasing the specific skills of their employees, but when doing so, face the risk that these employees will switch jobs to another firm thereby making the firm's investment in these specific skills obsolete. Market failures in the labour market result from asymmetric information when employers and employees have different perceptions of the value of employees' skills. Employees investing in upgrading their human capital will receive a wage increase which is below their productivity increase and workers will thus underinvest in upgrading their skills.

Market failures can result from both poaching externalities and hold-up problems. Poaching externalities result from the risk that employees will leave a firm once their specific training has been completed as other firms will offer them a better reward. Firms will thus invest less in training their own employees. Hold-up problems result from incomplete contracts. Complete contracts would specify all potential future events, but as the future cannot always be foreseen, many contracts between firms and their employees do not fully describe the allocation of the returns from the investments in employees' specific skills. Firms, once the training is finished, find themselves in a strong bargaining position as employees might not be able to cash in on their improved skills by switching to another firm. As the employees will not be paid up to their productivity improvement, they are tempted to invest less in their own training. Empirical evidence however has shown that these effects are relatively small (Leuven and Oosterbeek, 2002). There is thus only weak evidence for the existence of market failures resulting from poaching externalities and hold-up problems in the labour market.

However, government interventions in the labour market can cause government failures. Government policies aiming at improving income equality can create hold-up problems as policies implementing minimum wages lower the potential gain for employers resulting from productivity increases by training low skilled workers. A similar argument can be made for social security systems which create a lock-in situation for unemployed workers.

3.5 Failures in the education market

Formal education by increasing the average level of human capital is expected to have a positive effect on productivity. Higher education in particular is expected to provide an adequate supply of highly skilled knowledge workers. Higher education is expected to yield positive externalities as more and better skilled workers will benefit firms seeking highly skilled workers for their innovation activities such as investments in R&D. The existence of such externalities would reflect a market failure as the education market, by not incorporating these externalities, would train an insufficient amount of people as social returns exceed private returns. But empirical evidence for the existence of such externalities is weak as is the existence of market failures in the education market. There is ample empirical evidence for the existence of positive spillovers from R&D investments (cf. section 3.1), but there is no empirical evidence that R&D and human capital are complementary (Nonneman and Vanhoudt, 1996; Klenow, 1998), which could possibly be explained by the fact that only a small share of highly educated workers – R&D personnel – will be employed in innovation activities and in particular in R&D activities.

The effectiveness of R&D policies depends on the elasticity of both the demand for R&D and the supply of R&D, in particular the supply of R&D personnel. With an inelastic supply of R&D personnel, R&D subsidies and tax credits, policies will not result in more investments in R&D but only in higher wages. Empirical evidence shows that supply of R&D is fairly elastic as wage increases only make up between 10% and 20% of increases in R&D investments of (cf. section 3.1 for some empirical evidence). With an increasing international mobility of R&D workers it is expected that the supply of these workers on markets with labour shortages will increase thereby increasing supply elasticities. The evidence for market failures in the education market is weak and the supply of highly skilled workers and in particular R&D workers is fairly elastic.

3.6 System failures[6]

Both market failures and system failures are arguments used to justify policy intervention. Market failures can occur due to the existence of externalities and spillovers, imperfect and asymmetric information, network failures and market power. System failures are linked to structural, institutional and regulatory deficiencies, which effect innovation activities. The system failures argument justifies interventions that address structural and institutional deficiencies. Although they can be seen as complementary, economists differentiate between market failures and system failures, depending on the theory that they embrace. While market failures are grounded in neoclassical theory, system failures are rooted in evolutionary and systemic approaches. Considering that innovation policy has a wide range of objectives, both economic (economic and productivity growth, employment and competitiveness) and non-economic ones (cultural, social, environmental and military), government intervenes in factors that influence the innovation process to assure these objectives will be achieved (Chaminade and Edquist, 2008).

The assumptions of neo-classical theory contrast with those of the evolutionary approach in several aspects, and these differences create the basis for different ways of public intervention. One basic assumption of the neoclassical approach has been that of perfect information by all economic agents. Knowledge is information which is generic and accessible to all. According to Lipsey and Carlaw (1998), knowledge has the following properties: *uncertainty*, as one can never completely know research outcomes and risks involved; *inappropriability*, as firms cannot fully appropriate the benefits from innovation; and *indivisibility*, reflecting a minimum level of investment in knowledge prior to new knowledge creation. The last two properties lead to underinvestment in R&D by firms, justifying governmental intervention in research activities. Governments thus intervene because there are 'market failures'. The main goal of policy intervention is to reach equilibrium and this is only achieved when there is perfect information, perfect competition and profit maximization. Government intervention takes place to correct for negative externalities, asymmetric

[6] Parts of this section reflect the discussion on system failures for services innovation as discussed in van Cruysen and Hollanders (2008).

information, inefficiency and the elimination of barriers of entry (Chaminade and Edquist, 2008). The neo-classical theory does not emphasize the economic structure and the institutional framework in which innovation takes place (Lipsey and Carlaw, 1998).

The evolutionary or systemic approach, on the other hand, is less focused on the individual level (firms and consumers) and more geared towards the collective level. It looks into the system and all its actors that contribute to the creation and dissemination of knowledge. Under this approach, asymmetric information is not a market failure, but essential to create novelty and variety (Chaminade and Edquist, 2008). Moreover, competition is seen as the engine of innovation, together with diversity. The approach emphasises the interactions among all organisations in the system, with the understanding that firms do not innovate alone. The evolutionary theory or the systemic approach looks into the system and the interactions among players (organisations) and rules (institutions). Within-systems interactions can be sub-optimal. Freeman (1988) cited these sub-optimalities as 'unsatisfactory innovation'. Policy intervention is justifiable in areas where the system is not functioning well. Intervention is required when uncertainly and risks are high and private actors do not have the incentives to invest. This is particularly true for new activities: the system is not able to break free from an established framework and fails to take up new and more productive arrangements. This argument has been named 'lock-in' or 'path-dependence failure' (Smith, 1997). Typically, systems evolve from more lose arrangements to more tightly coupled stages (Forrester, 1961). Although individual actors may be performing efficiently, the system as such may be performing sub-optimally, in particular during phases of important (or more radical) technological changes. The system’s underperformance can be the result of poor internal interactions, an inability or unwillingness to take action, thus calling for government interaction in order to adapt the system to changes taking place in a larger environment. These interventions are mostly aimed to enhance interaction, trust and coordination (Carlsson and Jacobsson, 1994; Lundvall, 1988). Moreover, policy intervention is selective and focused on specific products, activities or technologies. There must thus be a 'systemic problem' which cannot be solved by either the actors or the market forces. As a result, policy intervention is additional to the actions of private firms and market forces. The idea is not to reach an optimum level as in the neo-classical theory, as there is no notion of optimality.

Gustafsson and Autio (2006) identify four types of system failures: sub-optimality in the adaptation of innovation structures, lack of actor interactions and functions bridging knowledge production and knowledge use, sub-optimal lock-ins by implementing actors and lack of supportive structures for innovation. The sub-optimal adaptation of innovation structures may result from firms being locked into prevailing systems. These firms find it difficult to break away from these systems and to pursue new knowledge or to establish new collaborations. The failure to be able to engage in new and better opportunities has been called 'lock-in or path-dependency failure' by Smith (1997). Factors leading to failure to evolve from present systems may relate to institutional commitments and power relations (Walker, 2000). There is a tendency to strengthen both social and technological relations over time, making it difficult to break free (Weick and Roberts, 1993). The increasing rigidity of systems is due to uncertainties and financial risks. Consequently, systems tend to enforce exploitation rather than exploration. The actors and new technologies are hampered by both lack of legitimacy (Stinchcomb, 1965) and lack of interaction within the system (Carlsson et al., 2002).

In their discussion of the system approach versus mainstream economics Hers and Nahuis (2004) conclude that 'system failures are not complementary to market and government failure'. System failures resulting from too much or too little interaction between actors will result in suboptimal learning in the innovation system and too little transfer of knowledge. However, due to government failures the optimal level of interaction is not known. Insufficient interaction between private actors is likely to be the result of imperfect information, high transaction costs and market power, in short of market failures. Insufficient interaction between public and private actors can also be explained by failures due to market power where firms have no interest in collaborating with universities and public research institutes to strengthen their applied research as competition is limited. System failures resulting from missing or inadequate institutions, e.g. insufficient supply of venture capital, inadequate resources for (high-tech) starters, insufficient demand for new innovations and the absence of specific knowledge institutions (Bemer et al., 2001) can also be traced back to underlying incentive problems which are related to market and government failures as can system failures due to path-dependency and lock-in.

The market and system failure approaches can be seen as complementary: while market failure is concerned with failure in the production of knowledge due to associated risks and uncertainties, the system failure goes one step further, re-shifting the discussion from sub-optimality at unit-level to sub-optimality in unit-level interactions in terms of knowledge exploration and exploitation. It recognises that actors have different motivations to engage in knowledge creation and diffusion.

3.7 Failures in services innovation

The discussion in sections 3.1 to 3.5 is biased towards technological or R&D innovation. But half of European innovators innovate by non-technological innovation, such as organisational or marketing innovation (Arundel et al., 2008; Huang et al.; 2008). Market failures in the technology market will not directly apply to these non-R&D innovators. Non-R&D innovation is dominant in services innovation. According to Gronroos (1990), there is a wide range of possible sources of innovation in services: not only the service concept (service as a product) innovation, but also service process innovation, service infrastructure innovation, customer process innovation, business model innovation, commercialisation innovation (sales, marketing, delivery), and hybrid innovation serving several user groups in different ways simultaneously and service productivity innovation. As a result of the different types of innovation that can take place in services, there is a lack of indicators and methodologies to measure services innovation, which make it even more difficult to determine the need for and develop appropriate policies. The existence of different market failures and system failures in eight different policy areas is discussed in van Cruysen and Hollanders (2008) (Table 3.1). Government intervention could correct these failures, but more research is needed to identify the extent and impact of these failures so that the most appropriate policies can be implemented. The authors conclude that there is a need to increase competition in services to raise innovation. Competition could be stimulated e.g. by increasing cross border tradability and by an increased use of public procurement aimed at provoking creative solutions. Within services there is a relatively higher importance of intercultural and language skills. These could be supported by more (and targeted) training and mobility programmes. Non-technological innovation is much more prevalent in services than in manufacturing. Innovation support programmes are needed which support organisational and marketing innovations similar as R&D support programmes have supported technological innovation. Services firms need to be encouraged to make more use of existing intellectual property rights. IPRs may need to take further into account the specificities of services and services innovation such as their reliance on non-technological innovation and the fact that many services are credence goods where reputation plays a determining factor for achieving market success.

Table 3.1: The occurrence of failures in services innovation

	Appropriability / Externalities	Market power	Asymmetric information	Resource mobility	System failures
Encourage use of intellectual property	√		√		√
Public procurement		√	√		√
Improve supply of qualified personnel				√	
Improve access to public finance				√	√
Support start-ups	√	√	√	√	√
Improve innovation support for services firms	√	√	√	√	√
Reduce regulatory burden	√	√	√	√	√
Improve financing	√	√	√	√	√

Source: adapted from van Cruysen and Hollanders (2008).

3.8 Government failures due to high administrative costs

Cunningham (2008) discusses the importance of administrative costs of innovation measures. 'The perception that administrative costs presented a barrier to participation in innovation support measures was supported by a substantial amount of both hard evidence (i.e. from reviews, surveys and evaluations) and anecdotal evidence from several countries. Some of the more specific issues reported concerned: the existence of policy mixes comprising large numbers of measures, sometimes with overlapping goals, which promoted confusion and a loss of clarity amongst the potential targets and applicants; poor general awareness of the opportunities for innovation support and the types of support available; the absence of a long-term government strategy and commitment to innovation support thereby creating uncertainty amongst potential applicants; unpredictability of funding of specific measures and use of 'one-off' measures; and frequent changes to administrative personnel in government support services and other losses of continuity (e.g. political change)'.

High external administrative costs can reduce the effectiveness of policy interventions aimed at reducing the effect of market (and system) failures. In particular small firms are more likely to face relatively high external administrative costs. However, high external administrative costs as such are not a market failure but a government failure (cf. the discussion in section 3.1). These costs, as other government failures, do jeopardize the efficiency of implementing innovation support measures, but can, most likely, not entirely be prevented. Governments should aim at reducing these costs, in particular for small firms, in particular as for small firms the effect of market failures are more severe than for large firms.

High internal administrative costs, e.g. by requiring a significant input of government personnel to supervise the implementation of support measures, will create high direct costs to governments but also indirect costs due to the distortionary effect of taxes.

3.9 The need for innovation support

Whether there is a need for innovation support is difficult to establish using quantitative data. Both the CIS and the Innobarometer 2007 survey (Gallup, 2007) ask firms about their use of public funding with respect to innovation support programmes, but merely using an available programme does not mean that this programme is necessary for a firm to innovate successfully.

Table 3.2 presents evidence from CIS-4 about the use of public funding. On average about one out of four innovating firms have received some form of public funding, mostly from their central government or from local or regional authorities. EU funding is not that important for most innovating firms. Public funding is used by more manufacturing firms than by services firms, but this can be explained by the fact that most funding is directly related to R&D activities, and services firms innovate more by organisational and other types of non-R&D innovation than manufacturing firms. Public funding is used most by innovating firms in

Radio, TV and communication equipment, Textiles and Medical, precision and optical instruments. The CIS-4 survey does not ask firms about the relevance of this public funding for the success of their innovation activities. Many firms could use available funding schemes as a substitute for using own or external funding.

Table 3.2: Use of public funding for innovation (CIS-4)

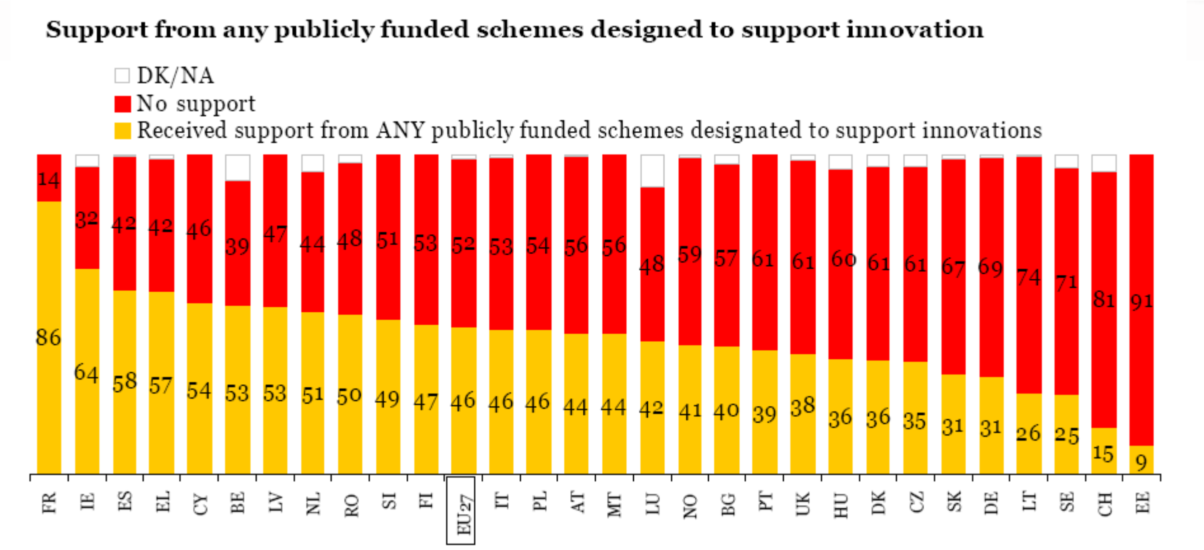
	Enterprise that received funding from the European Union	Enterprise that received funding from central government	Enterprise that received funding from local or regional authorities	Enterprise that received any public funding
inn_tot: All NACE - Core NACE (NACE sections C, D, E, I and J and NACE divisions 51, 72, 74.2 and 74.3)	4	12	12	23
c_d_e: Total industry (excluding construction)	5	14	15	28
d: Manufacturing	5	14	15	28
da15: Food products and beverages	7	12	13	25
db17: Textiles	5	19	20	37
dd20: Wood and of products of wood and cork	4	8	19	27
de21: Pulp, paper and paper products	3	11	9	18
de22: Publishing, printing, reproduction of recorded media	3	8	8	16
dg24: Chemicals and chemical products	6	22	13	31
dh25: Rubber and plastic products	6	13	13	25
di26: Other non-metallic mineral products	5	12	14	26
dj27: Basic metals	6	20	14	33
dj28: Fabricated metal products	4	12	16	26
dk29: Machinery and equipment n.e.c.	5	17	17	32
dl31: Electrical machinery and apparatus n.e.c.	4	14	18	30
dl32: Radio, television and communication equipment	9	29	17	41
dl33: Medical, precision and optical instruments, watches	10	21	20	37
dm34: Motor vehicles, trailers and semi-trailers	6	17	16	33
dn36: Furniture; manufacturing n.e.c.	4	13	14	26
inn_g_to_k: Core G_to_K Services	4	8	7	15
g51: Wholesale trade and commission trade	3	7	7	14
i: Transport, storage and communication	1	5	6	10
j: Financial intermediation	1	3	1	5
inn_k: K: Core coverage (NACE 72, 74.2 and 74.3)	7	15	10	23

Source: CIS-4; own calculations.

The Innobarometer 2007 survey does include such a question on the relevance of government intervention. The survey is based on a quota survey for all 27 EU Member States and results are available for 4 395 innovative firms, covering innovative activities over 2005 and 2006 (Gallup, 2007). One of the questions in the survey asks companies if they had applied for or received support from any of the following publicly funded schemes that are designed to support innovation: Direct support to finance R&D based innovation projects; Direct support to finance innovation projects with no R&D involved; Subsidies for buildings or other infrastructure for innovation activities; Subsidies for acquiring machinery, equipment or software; Tax reductions for R&D expenditures; Tax reductions for innovation expenditures other than R&D; Attending or participating in trade fairs or trade; Networking with universities and research institutes; Networking with companies; Information on market needs, market conditions, new regulations, etc. If the answer to any of the above items was positive companies were asked if the support from publicly funded schemes had been crucial to any of their innovation projects such that the innovation would not have been developed or introduced without the support.

Almost half of EU innovating firms made use of at least one publicly funded scheme designed to support innovation (Figure 3.3). But there are huge differences across countries: with as many as 86% of firms in France receiving such support and as few as 9% of firms in Estonia. For the majority of countries, between 30% and 60% of innovating firms receive public support.

Figure 3.3: Use of innovation support programmes

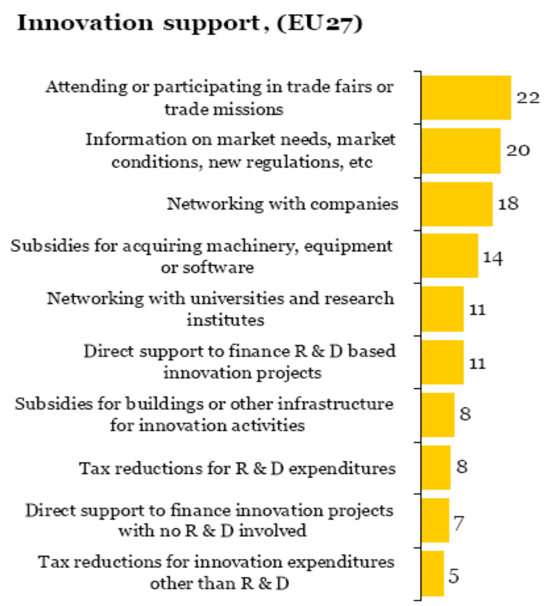


Source: Innobarometer 2007 report (Gallup, 2007).

Of these different types of public support, attending or participating in trade fairs or trade missions are used most by innovating firms (Figure 3.4). Tax reductions for innovation activities other than R&D are used by only 5% of EU innovating firms. The survey does not ask about the size of this public financial support, but those support schemes used relatively less – direct support, subsidies and tax reductions – undoubtedly will use a multitude of the public finance involved as compared with 'softer' support schemes such as attending trade fairs or networking. These support schemes are used most by manufacturing firms, but there is no difference between high- and low-tech firms. Large firms make more use of these support schemes than small firms and medium-sized firms.

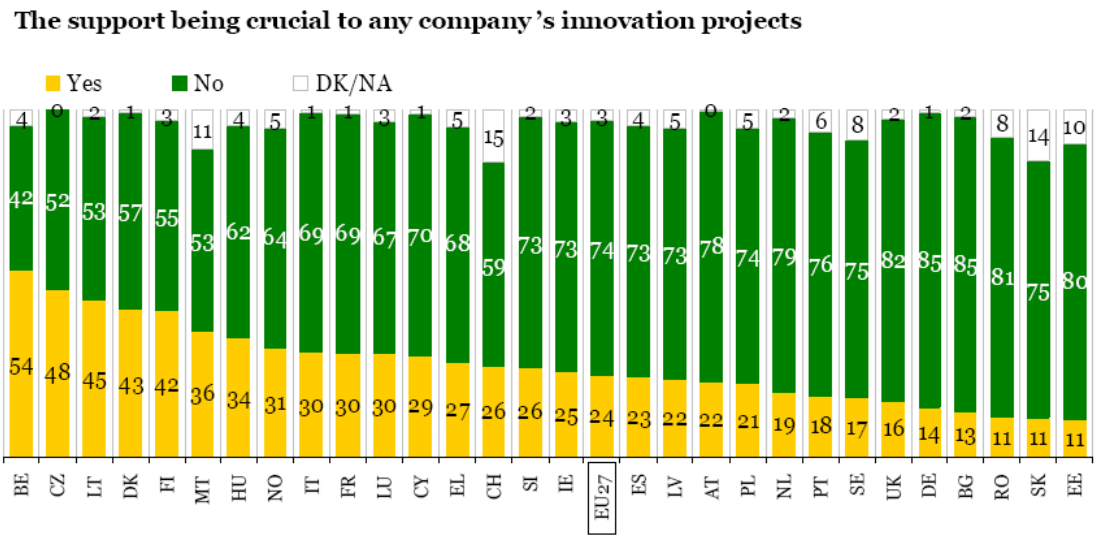
The results in Annex III show that there are large differences in the use of these support schemes at the industry level with an intensive use of at least one of these schemes by 80% or more of innovating firms in Medical, precision and optical instruments (NACE 33), Automotive (NACE 34) and Financial intermediation and Auxiliary activities (NACE 65 and 67). Less than 1 out 4 innovating firms make use of these support schemes in Basic metals (NACE 27), Machinery and equipment (NACE 29), Electrical machinery (NACE 31), Radio, TV and communication equipment (NACE 32), Supporting and auxiliary transport activities (NACE 63) and Real estate (NACE 70).

Figure 3.4: Use of innovation support programmes



Source: Innobarometer 2007 report (Gallup, 2007).

Figure 3.5: Relevance of innovation support programmes



Source: Innobarometer 2007 report (Gallup, 2007).

Publicly funded support schemes were crucial for the innovation activities of 24% of EU innovating firms, although we observe large national differences from as high as 54% in Belgium to as low as 11% in Estonia (Figure 3.5). These national differences can partially be explained by differences in the NACE 2-digit industry composition. Of those firms that use at least one publicly funded support scheme, this support was in particular crucial in Tanning and dressing of leather (NACE 19), Fabricated metal products (NACE 28) and Supporting and auxiliary transport activities (NACE 63) where for at least 60% of firms innovation activities would not have been successful without this support.

For most firms that have received some form of publicly funded innovation support, this support was not crucial for their innovation activities. Differences across sectors are large and the industries can be divided into four groups as shown in Figure 3.6 with above or below average use of public support and above or below average relevance of public support. Some remarkable facts emerge from Annex III. For Automotive (NACE 34) and Financial intermediation and Auxiliary activities (NACE 65 and 67) innovation support is not crucial although between 80% and almost 100% of innovators in these sectors receive some form of innovation support. For Tanning and dressing of leather (NACE 19) and Supporting and auxiliary transport activities (NACE 63) a relatively small share of innovators receives publicly funded innovation support, but for the majority of these firms that support was crucial.

An interesting question is if for those sectors where the received public support has not been crucial for innovation, it would have been more efficient to use this support for those sectors where public support is highly relevant for innovation. Sectoral differences might depend on the type of innovation support programme, but the Innobarometer 2007 data do not allow for an analysis of relevance for each individual support programme as for the majority of firms at least one support scheme has been used.

4 Conclusions

Innovation is one of the drivers of productivity growth in western economies. Innovating firms are assumed to be at the heart of productivity improvements. Because of market failures in various markets and of system failures, investments in innovation may fall short of the socially optimal level. This mini-study on the policy rationale for innovation support has tried to provide answers to several questions.

Which persisting barriers hamper enterprises to innovate?

Cost factors and lack of own and external funds are seen by most firms as highly important factors hampering their innovation activities. But also market factors and knowledge factors are important. There are significant differences in the relative importance of these barriers across countries and across industries.

What major market failures are affecting innovation (cf. Table 4.1)?

Market failures resulting from externalities and spillovers are more common in innovation resulting from R&D investments. Government intervention is also liable to failures as a result of crowding-out effects, inelastic supply of R&D workers and a lack of information on the size of private innovation's social returns.

Market failures resulting from imperfect and asymmetric information are more common in the financial market and the education market. The financial market to some extent counteracts these failures by the introduction of banks which act as a screening and monitoring facility.

Market failures resulting from market power are more common in product markets. More competition drives innovation up to a certain point, after which more competition will lower innovation. But there are significant differences between industries and governments might not be able to identify the inflexion point.

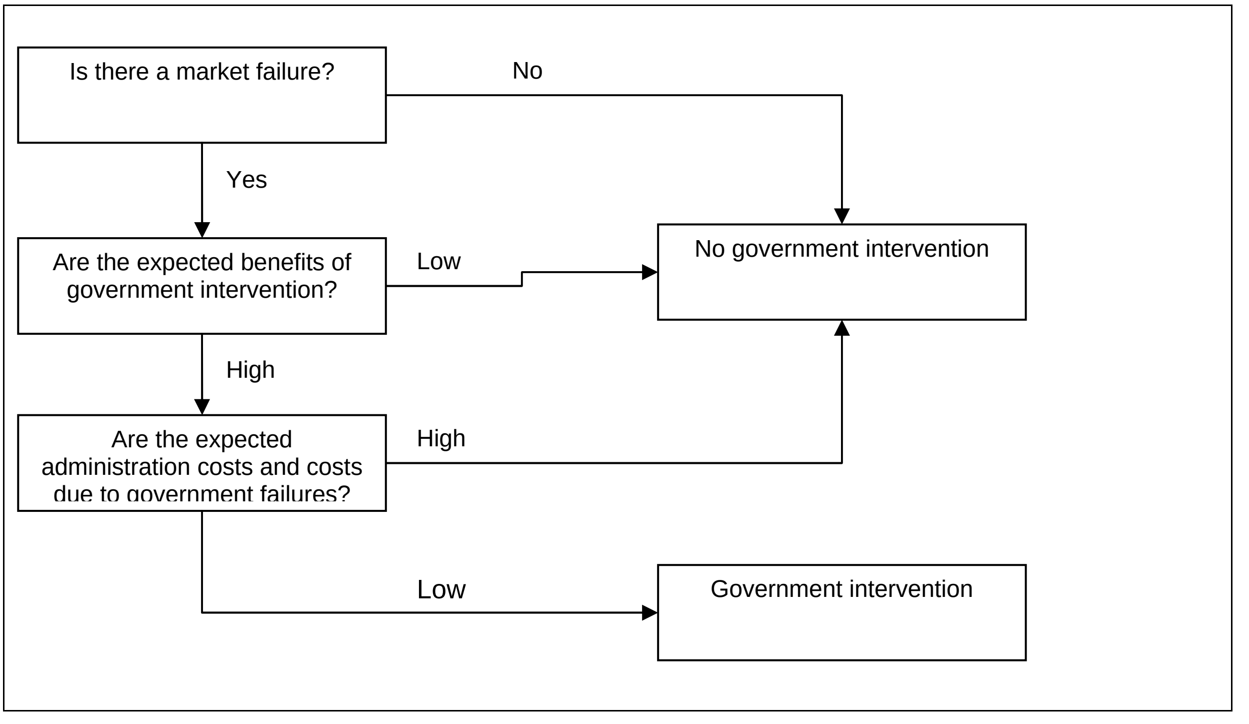
Table 4.1: The occurrence of market and government failures in 5 different markets

	Externalities and spillovers	Imperfect and asymmetric information	Network failures	Market power	Government failures when correcting for market failures
Technology market	Knowledge spillovers; rent spillovers; business-stealing-effect; duplication Self-correcting mechanisms: R&D co-operation and networks		Due to system failures		Crowding-out; wage increases; lack of information; high administrative costs
Product market				Inverted U shaped relation between competition and innovation, but not in all industries	Lack of information
Financial market		Adverse selection; moral hazard Self-correcting mechanisms: banking sector			
Labour market		Poaching externalities; hold-up problems			Reduced incentives from income-equality policies
Education market					

Which needs for innovation support are supported by empirical evidence?

Empirical evidence from the Innobarometer 2007 survey shows that publicly funded innovation support is not crucial for most innovators.

Policy-makers need to better understand the impact of the various market failures, so that they weigh the potential benefits against the costs of implementing innovation support measures. The following gives a very simplified decision model:



Government will have to take several decisions based on incomplete information which could result in unnecessary government intervention. Only when the expected benefits of government intervention are substantial and when the expected costs resulting from government failures are low, governments should clearly intervene. In all other cases it is unclear as costs might be higher than the expected revenues. Of course, there are many more gradations in the degrees of expected benefits and costs which are reflected in the above scheme, but the overall conclusion is clear. Governments will need to better explain the need for intervention, with a clear and sound message on the rationale and expected benefits of such intervention that contributes to make it plausible and logical to target the public opinion. The risk is that due to incomplete information governments may not be able to make such evaluations; in particular as it will be very difficult to understand what the potential impact and thus expected benefit is of a market failure on different types of firms all operating in a private market.

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Annex I: General conclusions from the Oxera (2005) report

General conclusions from the Oxera (2005) report are summarised in Table A.1 where for large and small firms, for R&D activities, the stage in the life-cycle of the firm and sector of activity the likelihood of occurrence for each of four innovation market failures has been indicated. Spillovers are likely to occur across all dimensions, but in particular related to the basic and applied research activities of both small and large firms, in all life cycles phases of high-tech SMEs and for large firms in high-tech sectors. Appropriability failures are less likely to occur, with the exception of basic research activities by small firms and during the start-up phase of high-tech SMEs. Coordination or network failures are common, in particular for basic and applied research activities for small firms, for high-tech SMEs in their start-up phase and for small firms in high-tech sectors. Financial market failures are common for basic and applied research activities for small firms, for high-tech SMEs in their start-up and growth phase and for small firms in high-tech sectors.

Table A.1: The likely occurrence of innovation market failures

R&D activity: Small firms	Spillovers	Appropriability[1]	Coordination/ network	Financial
Basic research	√	√	√	√
Applied research	√	(√)	√	√
Development				
R&D activity: Large firms	**Spillovers**	**Appropriability[2]**	**Coordination/ network[3]**	**Financial**
Basic research	√		(√)	
Applied research	√		(√)	
Development				
Life cycle: High-tech SME	**Spillovers**	**Appropriability**	**Coordination/ network**	**Financial**
Seed/start-up	√	√	√	√
Growth	√	(√)	(√)	√
Maturity	√			(√)
Life cycle: Low-tech SME	**Spillovers**	**Appropriability**	**Coordination/ network**	**Financial**
Seed/start-up[4]	(√)		(√)	(√)
Growth			(√)	
Maturity				
Sector: Small firms	**Spillovers[5]**	**Appropriability[6]**	**Coordination/ network[7]**	**Financial**
Low tech	(√)		(√)	(√)
High tech	√	(√)	√	√
Sector: Large firms[8]	**Spillovers**	**Appropriability**	**Coordination/ network**	**Financial**
Low tech	(√)		(√)	
High tech	√		(√)	(√)

A tick indicates that innovation market failures are likely to arise. A tick in parentheses indicates that innovation market failures might arise depending on the circumstances.

1 Regarding appropriability, protecting intellectual property is important, but is probably most important at the early stages of the R&D process. Patents are very important for small firms in the biotech (or high-tech more generally) sectors.

2 Large firms are more able to use the intellectual property rights (IPR) system effectively. However, patents are neither a necessary nor sufficient condition for innovation. Patents are important in biotech and high-tech more generally, but questionable patents may also be a problem.

3 Coordination failures are not generally problematic unless coordinated R&D is required—large firms tend to have sufficient networking and potential access to the science base. Clusters and incubation appear to be less relevant to larger firms.

4 A number of the issues faced by innovative start-ups are not faced by start-ups or SMEs in general. Although financial constraints and inadequate networking (including business-to-business) relationships may lead to problems for the generality of start-ups, these are unlikely to be as severe as for innovative start-ups. Lifestyle SMEs should not suffer from appropriability concerns, and innovation spillover effects are likely to be limited.

5 Many different types of firm innovate, but the role of knowledge spillovers is more limited in low-tech or traditional sectors. These tend to use others' innovation (input users).

6 Patents are crucial to high-tech SMEs (especially start-ups).

7 All SMEs may lack access to networks, but life-style SMEs in low-tech sectors should not face the same difficulties as innovative SMEs in attracting finance, are less likely to require the same level of financing, and are more likely to have retained earnings. Spillovers are higher in high-tech sectors, appropriability is more important (especially at early stages), networking is crucial, and financial market failures are higher.

8 Large firms face fewer financing problems than smaller firms. Spillovers are higher in high-tech sectors. Appropriability is important in high-tech sectors, but larger firms have a good awareness of the IPR system, and patenting is neither a necessary nor sufficient condition for innovation (e.g., networking is more important). Also, in high-tech sectors, questionable patents are more common. Coordination failures are not generally problematic unless coordinated R&D is required—large firms generally have sufficient networking and potential access to the science base. Clusters and incubation are less relevant to larger firms. For larger firms, financial market failures would not be expected to occur, except where the projects are particularly large and risky.

Source: Oxera (2005).

Annex II: Factors hampering innovation activities

Innovators, small firms (10-49 employees)

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		REASONS NOT TO INNOVATE	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
European Union	23	16	25	11	5	6	8	13	12	5	6
Belgium	20	12	21	14	2	6	7	14	9	2	3
Bulgaria	26	21	27	9	6	6	12	16	15	4	5
Czech Republic	23	12	18	8	2	4	3	20	11	3	4
Denmark	24	10	13	7	3	4	3	10	12	4	5
Germany	15	14	19	4	1	3	4	8	5	8	7
Estonia	30	21	21	24	3	2	6	19	11	6	7
Ireland	29	14	21	21	4	15	5	12	12	1	1
Greece	31	31	40	22	15	16	22	20	22	5	6
Spain	31	28	43	18	12	10	13	21	22	6	12
France	32	10	31	16	4	6	11	15	17	3	6
Italy	21	20	27	11	5	5	10	14	13	5	4
Cyprus	26	24	31	17	5	3	9	11	9	3	2
Latvia	13	18	15	20	39	32	27	16	19	34	43
Lithuania	26	17	19	15	8	9	9	21	12	7	1
Luxembourg	12	6	6	12	--	3	4	17	12	3	4
Hungary	29	21	29	8	1	4	5	18	17	1	3
Malta	17	--	21	10	--	9	--	17	20	4	4
Netherlands	19	11	13	7	4	3	2	5	8	2	2
Austria	21	18	21	12	5	5	9	14	9	3	3
Poland	31	26	32	8	5	4	--	--	15	--	--
Portugal	12	14	8	24	32	29	19	20	18	27	25
Romania	8	30	31	17	8	0	18	22	18	6	4
Slovenia	36	30	27	21	4	7	12	29	7	--	7
Slovakia	25	19	21	11	2	5	9	17	13	--	--
Finland	17	12	12	10	4	6	9	8	9	5	4
Sweden	24	15	15	9	3	3	6	21	13	2	3
United Kingdom	--	--	23	11	3	5	--	13	13	--	--
Iceland	21	19	18	15	0	5	10	16	14	7	9
Norway	15	13	18	7	3	3	2	6	9	1	1

Percentages show shares of innovating firms acknowledging the factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

Innovators, medium-sized firms (50-249 employees)

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		REASONS NOT TO INNOVATE	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
European Union	17	12	20	9	5	5	7	12	11	4	4
Belgium	16	8	15	14	5	5	3	16	10	2	3
Bulgaria	21	19	23	8	6	5	9	13	13	4	3
Czech Republic	22	13	18	14	2	3	4	18	13	2	3
Denmark	15	8	9	6	2	2	--	7	10	4	4
Germany	7	8	18	5	2	3	2	5	4	4	5
Estonia	24	14	21	21	6	5	6	9	9	5	5
Ireland	15	10	17	15	7	9	3	15	15	1	0
Greece	31	38	37	26	24	24	29	28	28	6	6
Spain	23	22	29	11	8	7	10	16	18	4	5
France	27	9	23	14	4	5	8	16	14	3	4
Italy	13	16	21	8	5	4	10	12	10	5	3
Cyprus	29	23	35	10	4	3	11	10	9	3	1
Latvia	21	17	21	24	40	40	31	27	28	41	43

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		REASONS NOT TO INNOVATE	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
Lithuania	23	21	25	12	5	5	6	18	8	2	2
Luxembourg	11	5	16	12	1	3	6	11	12	--	--
Hungary	26	17	22	7	2	3	5	11	12	2	3
Malta	--	--	--	--	--	--	--	--	--	--	--
Netherlands	14	6	9	6	5	5	4	5	8	3	2
Austria	13	8	17	9	2	4	5	9	7	3	5
Poland	33	27	33	7	5	5	--	--	18	--	--
Portugal	16	17	12	25	38	35	26	24	20	29	22
Romania	--	30	30	--	6	0	13	20	14	5	4
Slovenia	29	19	22	21	7	11	10	23	13	--	3
Slovakia	24	15	25	7	3	3	6	11	11	--	--
Finland	10	8	9	8	5	5	4	7	10	5	3
Sweden	15	8	14	9	4	5	4	14	9	1	3
United Kingdom	--	--	20	8	3	5	--	13	13	--	--
Iceland	--	--	--	--	0	--	--	--	--	0	0
Norway	11	9	13	4	2	3	1	4	7	1	1

Percentages show shares of innovating firms acknowledging the factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

Innovators, large firms (250 or more employees)

	COST FACTORS			KNOWLEDGE FACTORS				MARKET FACTORS		REASONS NOT TO INNOVATE	
	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
European Union	15	11	19	8	4	5	5	11	12	4	5
Belgium	14	9	13	8	1	3	4	15	14	2	6
Bulgaria	22	23	25	10	6	8	12	11	13	4	5
Czech Republic	18	8	18	10	3	4	3	18	13	3	3
Denmark	11	5	12	6	3	2	--	11	12	3	6
Germany	9	5	22	8	2	3	1	5	7	5	7
Estonia	23	11	19	22	10	11	5	12	9	4	2
Ireland	11	7	12	4	2	1	1	9	10	8	5
Greece	47	41	48	39	39	36	35	36	41	6	6
Spain	17	18	22	7	5	4	7	15	14	4	5
France	20	8	21	9	3	5	6	15	16	2	4
Italy	12	15	13	6	4	4	6	11	10	5	2
Cyprus	27	23	14	14	5	5	--	9	9	--	5
Latvia	22	26	17	34	44	41	38	24	35	44	41
Lithuania	20	20	30	12	6	6	11	15	14	4	2
Luxembourg	19	3	25	11	4	6	8	10	15	--	--
Hungary	23	15	21	4	3	2	2	5	9	2	2
Malta	--	--	--	--	--	--	--	--	--	--	--
Netherlands	15	4	9	9	2	6	4	4	11	2	1
Austria	13	7	13	9	3	4	3	8	10	3	4
Poland	27	26	30	4	4	4	--	--	16	--	--
Portugal	20	17	14	28	34	37	27	23	29	26	26
Romania	--	31	27	--	6	0	14	22	15	2	4
Slovenia	20	15	16	13	2	11	6	22	11	--	4
Slovakia	20	13	17	4	2	3	4	10	9	--	--
Finland	12	2	5	8	3	3	4	7	11	5	3
Sweden	15	5	9	7	2	4	2	17	13	2	3
United Kingdom	--	--	23	7	3	5	--	10	12	--	--
Iceland	--	--	--	--	--	--	--	--	--	0	0
Norway	10	10	10	5	2	2	2	3	7	2	2

Percentages show shares of innovating firms acknowledging the factors as a high important factor of hampering innovation activities. Source: CIS-4; own calculations.

Annex III: Use of publicly funded innovation support schemes

NACE	Industry	Direct support to finance R&D based innovation projects	Direct support to finance innovation projects with no R&D involved	Subsidies for buildings or other infra-structure for innovation activities	Subsidies for acquiring machinery, equipment or software	Tax reductions for R&D expen-ditures	Tax reductions for innovation expenditures other than R&D	Attending or participating in trade fairs or trade missions	Networking with univer-sities and research institutes	Networking with compa-nies	Information on market needs, market conditions, new regula-tions, etc	Support from any publicly funded schemes designed to support innovation	The support being crucial to any of the company's innovation projects
1	Agriculture, hunting and related service activities	5%	0%	9%	9%	5%	0%	9%	0%	9%	9%	14%	63%
5	Fishing, fish farming and related service activities	--	--	--	--	--	--	--	--	--	--	--	--
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction	--	--	--	--	--	--	--	--	--	--	--	--
12	Mining of uranium and thorium ores	--	--	--	--	--	--	--	--	--	--	--	--
15	Manufacture of food products and beverages	10%	2%	11%	13%	5%	7%	30%	6%	12%	27%	48%	33%
16	Manufacture of tobacco products	--	--	--	--	--	--	--	--	--	--	--	--
17	Manufacture of textiles	4%	7%	2%	7%	3%	5%	50%	14%	29%	30%	56%	8%
18	Manufacture of wearing apparel; dressing and dyeing of fur	1%	5%	2%	2%	20%	20%	57%	22%	2%	40%	64%	26%
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddles, harnesses and footwear	6%	1%	0%	27%	0%	0%	8%	6%	2%	21%	30%	72%
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	3%	10%	9%	34%	9%	1%	24%	1%	31%	31%	66%	28%
21	Manufacture of pulp, paper and paper products	0%	0%	0%	38%	0%	0%	38%	0%	0%	0%	38%	0%
22	Publishing, printing and reproduction of recorded media	1%	1%	1%	23%	1%	1%	4%	21%	4%	4%	48%	43%
23	Manufacture of coke, refined petroleum products and nuclear fuel	--	--	--	--	--	--	--	--	--	--	--	--
24	Manufacture of chemicals and chemical products	24%	18%	1%	13%	18%	2%	27%	20%	23%	41%	55%	26%
25	Manufacture of rubber and plastic products	16%	20%	15%	35%	34%	34%	37%	15%	35%	37%	60%	4%
26	Manufacture of other non-metallic mineral products	5%	0%	0%	8%	3%	0%	49%	3%	28%	7%	57%	14%
27	Manufacture of basic metals	5%	4%	9%	10%	6%	3%	5%	5%	4%	8%	21%	46%
28	Manufacture of fabricated metal products, except machinery and equipment	6%	9%	4%	15%	8%	6%	14%	37%	44%	45%	69%	61%
29	Manufacture of machinery and equipment n.e.c.	3%	0%	0%	2%	6%	0%	8%	3%	5%	5%	13%	26%
30	Manufacture of office machinery and computers												
31	Manufacture of electrical machinery and apparatus n.e.c.	12%	2%	8%	2%	2%	1%	17%	8%	9%	6%	21%	21%
32	Manufacture of radio, television and communication equipment and apparatus	2%	0%	1%	1%	1%	0%	3%	1%	2%	18%	21%	6%
33	Manufacture of medical, precision and optical instruments, watches and clocks	39%	14%	15%	41%	9%	1%	56%	6%	37%	33%	94%	48%
34	Manufacture of motor vehicles, trailers and semi-trailers	10%	1%	0%	14%	6%	1%	3%	6%	69%	6%	85%	1%
35	Manufacture of other transport equipment	--	--	--	--	--	--	--	--	--	--	--	--
36	Manufacture of furniture; manufacturing n.e.c.	22%	15%	18%	16%	19%	10%	47%	11%	40%	28%	73%	17%
40	Electricity, gas, steam and hot water supply	0%	0%	0%	0%	0%	0%	0%	0%	32%	32%	32%	0%

NACE	Industry	Direct support to finance R&D based innovation projects	Direct support to finance innovation projects with no R&D involved	Subsidies for buildings or other infra-structure for innovation activities	Subsidies for acquiring machinery, equipment or software	Tax reductions for R&D expen-ditures	Tax reductions for innovation expenditures other than R&D	Attending or participating in trade fairs or trade missions	Networking with univer-sities and research institutes	Networking with compa-nies	Information on market needs, market conditions, new regula-tions, etc	Support from any publicly funded schemes designed to support innovation	The support being crucial to any of the company's innovation projects
41	Collection, purification and distribution of water	1%	1%	29%	0%	0%	0%	1%	1%	1%	1%	30%	0%
45	Construction	7%	16%	10%	10%	5%	2%	10%	4%	2%	9%	39%	15%
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	0%	2%	8%	7%	0%	1%	31%	1%	15%	24%	42%	21%
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	6%	0%	4%	11%	3%	2%	25%	10%	22%	19%	36%	15%
52	Retail trade, except of motor vehicles and motor-cycles; repair of personal and household goods	4%	2%	2%	37%	3%	2%	22%	2%	23%	23%	43%	44%
55	Hotels and restaurants	14%	8%	4%	23%	0%	2%	38%	8%	16%	28%	58%	19%
60	Land transport; transport via pipelines	2%	4%	5%	5%	15%	18%	10%	1%	17%	15%	43%	10%
61	Water transport	--	--	--	--	--	--	--	--	--	--	--	--
62	Air transport	--	--	--	--	--	--	--	--	--	--	--	--
63	Supporting and auxiliary transport activities; activities of travel agencies	1%	1%	20%	20%	1%	1%	1%	1%	1%	1%	22%	92%
64	Post and telecommunications	--	--	--	--	--	--	--	--	--	--	--	--
65	Financial intermediation, except insurance and pension funding	0%	0%	0%	0%	44%	44%	48%	48%	92%	96%	96%	0%
66	Insurance and pension funding, except compulsory social security	0%	5%	0%	0%	0%	0%	23%	2%	22%	2%	30%	1%
67	Activities auxiliary to financial intermediation	66%	3%	2%	65%	4%	9%	67%	3%	4%	67%	80%	2%
70	Real estate activities	1%	1%	0%	0%	0%	1%	0%	0%	0%	2%	3%	13%
71	Renting of machinery and equipment without operator and of personal and household goods	--	--	--	--	--	--	--	--	--	--	--	--
72	Computer and related activities	28%	1%	0%	8%	8%	0%	9%	12%	22%	1%	42%	20%
73	Research and development	8%	10%	9%	9%	0%	0%	50%	51%	51%	43%	53%	27%
74	Other business activities	7%	7%	7%	1%	10%	13%	17%	12%	17%	16%	45%	8%
75	Public administration and defence; compulsory social security	--	--	--	--	--	--	--	--	--	--	--	--
80	Education	23%	8%	24%	23%	0%	0%	32%	18%	26%	9%	55%	1%
85	Health and social work	3%	4%	11%	10%	2%	1%	8%	6%	6%	6%	14%	44%
90	Sewage and refuse disposal, sanitation and similar activities	--	--	--	--	--	--	--	--	--	--	--	--
91	Activities of membership organisations n.e.c.	--	--	--	--	--	--	--	--	--	--	--	--
92	Recreational, cultural and sporting activities	8%	7%	3%	7%	1%	0%	7%	2%	9%	13%	18%	21%
93	Other service activities	--	--	--	--	--	--	--	--	--	--	--	--

Source: Innobarometer 2007; own calculations.