European Innovation Scoreboard - EXIS: An Exploratory Approach to Innovation Scoreboards

EXIS:
An *Ex*ploratory Approach to *I*nnovation *S*coreboards

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1. Introduction

The *European Innovation Scoreboard* (EIS), now in its fourth year, focuses on technical innovation and on economy-wide indicators. The main purpose of the EIS is to benchmark the innovative capabilities of member states and to provide indicators that complement on-going policy developments within the European Commission. To date, the EIS has produced a single composite index that summarizes indicators across the four main thematic groups (human resources, creation of new knowledge, transmission and application of knowledge, and innovation finance, output and markets).

As part of ongoing work to improve the EIS and ensure that it continues to meet evolving policy needs, this report develops an exploratory Innovation Scoreboard (EXIS) that includes several changes compared to the EIS:

1. A focus on firm-level indicators of innovation, rather than on indicators at the national level.
2. A more diverse range of activities relevant to innovation, such as indicators for market demand, innovation governance, and non-technological activities such as marketing and organizational innovation.
3. Sub-composite indices for thematic areas.

Most of the indicators in EXIS are obtained from Eurostat and cover as many of the 25 member states of the European Union as possible. EXIS includes 28 primary indicators, arranged into six themes:

1. Seven indicators for firm-level **innovation diversity** that cover different types of innovation.
2. Four indicators for an **innovation-friendly market**, as shown by customer receptiveness to innovations.
3. Four indicators for **knowledge flows**, or the extent to which firms use external knowledge sources.
4. Five indicators for **innovation investment**, such as the availability of finance, the use of public innovation support programmes, and gross investment in embodied knowledge.
5. Four indicators for **innovation skills** that capture the quality of human resources available to firms in-house.
6. Four indicators for **innovation governance** that measure the ability of government policies to promote innovation.

Due to the focus on firm level activities, EXIS makes greater use of the results of the third Community Innovation Survey (CIS-3) than the EIS. EXIS includes 12 firm-

level indicators from the CIS-3, with one or more indicators for five of the six themes. Other EXIS indicators are obtained from the Continuing Vocational Training Survey (CVTS), the Structural Business Statistics (SBS), consulting reports, intellectual property registration systems (industrial design and trademarks), and the 2004 Innobarometer.

In contrast to the EIS, EXIS includes two CIS-3 indicators that are provided separately for innovative and non-innovative firms because the results vary by innovative status. These are the percentage of firms that find 1) finance and 2) lack of customer responsiveness to be a barrier to innovation[1].

EXIS includes both a summary composite index and thematic composite indices (TCIs) for each of the six themes. Some results are also available for manufacturing sectors only and for selected service sectors, although fewer indicators are available for service sectors than for manufacturing sectors.

2. Overview of indicators by theme

The guiding principles behind the construction of the EXIS scoreboard is to follow the Oslo Manual definitions of innovation and to limit the scoreboard to indicators that are directly relevant to the innovative activities of firms. Therefore, EXIS avoids the use of general economy-wide indicators such as R&D intensity or the percentage of the population with a tertiary education (both of which are included in the EIS). As an alternative to economy-wide R&D data, EXIS divides firms into different *modes* of innovators. Similarly, EXIS replaces population education data with the percentage of private sector employees with a tertiary education.

Full definitions and source for each indicator are given in Table A, while the results are given in Table B for all NACE sectors combined. An Excel file containing separate data for the manufacturing and service sectors is available from the TrendChart datasets. As a guide, appendix Table C identifies indicators that are available separately for manufacturing and/or services. This section provides a brief overview of the indicators included in each of the six themes, plus the indicators on the modes of innovation.

[1] Five other CIS-3 indicators that are only available for innovative firms are weighted by the percentage of innovators in the sample. These include the percentage of firms that are 1) involved in international collaboration, 2) give high importance to public science, 3) source knowledge externally, 4) receive innovation subsidies, and 5) give a high importance to environmental innovation.

2.1 Innovation Diversity

Innovation is a highly diverse activity. Firms can innovate through product, process, organisational or marketing innovation, by adopting new technology developed by other firms, or through intensive in-house research activities. In each case, the capabilities required by the firm to innovate are very different. Consequently, simple aggregate indicators of the percentage of 'innovative' firms in a particular country provide very little information of value to policy. Innovation indicators need to differentiate between styles or *modes* of innovation in order to provide a clear picture of the structure of innovation capabilities within individual countries.

Following Tether (2001) and Arundel (2003) and with the assistance of Eurostat, we used the results of CIS-3 to develop a set of preliminary indicators that assign innovative firms to one of four mutually-exclusive innovation modes. There is also a fifth group for non-innovators. The classification is based on two main criteria: the level of novelty of the firm's innovations, and the creative effort that the firm expends on in-house innovative activities. Due to data limitations, the four innovation modes are limited to technological product and process innovation[2]. Results are available for 19 of the 25 EU member states plus Iceland, Norway and Romania (data are not available for Denmark, Ireland, the UK, Cyprus, Malta, and Poland). A description of the average characteristics of firms in each innovation mode is as follows:

Strategic innovators (21.9% of all innovative firms): For these firms, innovation is a core component of their competitive strategy. They perform R&D on a continuous basis to develop novel product or process innovations. They are the main source of innovations that diffuse to other firms.

Intermittent innovators (30.7% of all innovative firms): These firms perform R&D and develop innovations in-house when necessary or favourable, but innovation is not a core strategic activity. For some, their R&D efforts focus on adapting new technology developed by other firms to their own needs.

Technology modifiers (26.3% of all innovative firms): These firms modify their existing products or processes through non-R&D based activities. Many firms in this group are essentially process innovators that innovate through production engineering.

Technology adopters (21.0% of all innovative firms): These firms primarily innovate by adopting innovations developed by other firms or organisations.

A fifth group of *non-innovators* report no technical innovative activities at all.

[2] The five modes of innovation are limited to technical innovation because CIS-3 did not obtain full information on the innovative activities of firms that only introduced non-technical innovations (primarily organisational and marketing innovations).

Annex B gives details on the methodology for assigning CIS respondents to each of these categories. The distributions are weighted to sum to 100% of all private sector firms in the sampled manufacturing and service sectors in each country.

EXIS includes results for all five innovation modes. However, only the first two modes (strategic and intermittent innovators) are included in the composite indices.

2.1.2 Other innovation diversity indicators

In addition to the two innovation mode indicators of strategic and intermittent innovators, five other measures of the diversity of innovation activities are included under this theme. These include one indicator for non-technical innovation, three indicators for intermediate outputs of different types of innovation (one indicator each for patents, trademarks, and industrial design registration), and an indicator for the percentage of firms that are 'high growth' innovators.

The high growth indicator is obtained from CIS-3. All high-growth innovators are either strategic or intermittent innovators. In addition, they must have either sales or employment growth in the top quartile for all firms. Consequently, these firms both innovate and have experienced rapid sales or employment growth, presumably from their innovative products or services. This suggests that they are able to combine innovative capabilities with marketing their products.

The indicator for non-technical innovation is the percentage of firms that introduced at least one of the following over the three years covered by the CIS-3: 'advanced management techniques', 'new or significantly changed organizational structures', or 'significant changes in the aesthetic appearance or design in at least one product[3]'. The question is asked of all CIS-3 respondents.

2.2 Innovation-Friendly Markets

There are countless examples of innovations that initially failed because the market was not ready for them. In some cases the innovation was not financially feasible for several decades. Unreceptive markets could be an important factor in discouraging innovation investment.

EXIS includes four indicators for the receptiveness of customers to innovation, of which three are limited to the firm's domestic market: the percentage of the

[3] We exclude two other CIS sub-questions on new corporate strategies and on new marketing strategies, since neither necessarily involve innovation.

population that is younger than 25 (youth share)[4], the average time to sales takeoff for a selection of new products, and an index for buyer sophistication. The fourth indicator is based on a CIS-3 question that asks about a 'lack of customer responsiveness to new goods and services' as a factor impeding innovation. The location of the customers is undefined, and could include customers in non-domestic markets[5]. The indicator is asked of both innovative and non-innovative firms.

2.3 Knowledge Flows

Three of the four knowledge indicators are obtained from the CIS and cover the sourcing of valuable knowledge from external sources: the percentage of firms that collaborate on innovation projects with firms or institutions outside their home country, the percentage that give a medium or high importance to the knowledge outputs of the higher education sector, and the percentage that give a high importance to at least one external knowledge source. The fourth indicator, the transnationality index, is a general measure of the supply of new knowledge from abroad.

The collaboration indicator captures the willingness of firms to invest in obtaining useful knowledge regardless of its location. The indicator assumes that a substantial amount of useful knowledge is not located close to the firm. The indicator for the use of the higher education sector covers one area where policy choices have both an enormous impact and where there has been a concerted effort in many European countries to increase the relevance of higher education research relevant to firms.

2.4 Innovation Investment

The five indicators under this theme include a proxy for investment in process innovation (gross investment in machinery and equipment as a percentage of value-added), two indicators for the use of government programmes to support innovation, and two indicators for innovation finance. The indicators cover the range of innovation investments of value to firms, such as their own investment in new equipment, public investment in the firm's innovation activities, and the ability of the firm to raise finance for its innovation activities.

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[4] There is a substantial body of empirical research showing that consumer interest in innovative products declines with age. As an example, in 2000, 90% of Italians between the age of 15 and 24 had a mobile phone, compared to only 30% of Italians over the age of 55 (EUROSCOM, 2001). A French survey in 2003 found that the percentage of individuals that would rather buy an innovative product over a 'quality established' product declined from 24% of respondents under 25 to 7% of respondents over 70 (SESSI, 2004).

[5] The results could be confounded by other factors. In this case, poor customer responsiveness will be due to a combination of true market factors (what we would like to measure) and the technical or other characteristics of the firm's innovation (a confounding factor that we do not wish to measure here).

The first of the two indicators for government support to innovation is the percentage of all firms (innovators and non-innovators combined) that received *any* public financial support for innovation from at least one of three levels of government (local, national and the European Union). The second indicator is derived from Innobarometer 2004 and equals the average percentage of up to eight innovation support programmes that are used by eligible *innovative* SMEs with between 20 and 499 employees. To be eligible, the SME must be involved in an innovation activity that is targeted by the programme and the innovation support programme must be available nationally. For example, a firm that hired new university graduates would be eligible for a national programme to subsidize SMEs that hire new graduates. The firm would not be eligible if it did not hire new university graduates. Consequently, the indicator measures the rate at which SMEs participate in available innovation support programmes[6].

A major policy concern is that imperfect capital markets create financial barriers for innovation. There are two relevant indicators: an index for the availability of finance, and the percentage of innovative and non-innovative firms that find a shortage of finance to act as a barrier to innovation.

2.5 Innovation Skills

A high level of skills is an essential pre-requisite for the ability of firms to innovate. All four indicators for skills cover employment. The first indicator (only available for a restricted set of countries) estimates the share of employment in 'learning jobs' where employees must continually acquire new skills. The second indicator, derived from the CIS, is the percentage of employees with a higher education degree. The remaining two indicators are from the 2000 CVT survey. The first is the percentage of employees that took part in any CVT courses, while the second is the average number of CVT hours per employee per year.

2.6 Innovation Governance

The four indicators under this theme cover the appropriateness of regulatory and government policies to encourage innovation. The first is an index for government waste, assuming that efficient governments will use new technology and organisational methods to improve their efficiency. The second is an index for

[6] In some countries only a few of the maximum of eight innovation support programmes may be available, while in other countries all eight may be available. Since the indicator is the percentage of firms that are eligible to use *available* programmes, the indicator measures the ability or willingness of firms to use those programmes that are on offer and for which they are eligible. This "policy uptake rate" will vary by how well the programmes are advertised to firms, the stringency of participation criteria, and by whether or not eligible firms believe that the benefits from participation outweigh the costs. Of note, this indicator is relevant both to innovation governance and to innovation investment.

appropriate innovation policies. The third is an index for the cost of establishing a new business, which is relevant to new start-ups, while the fourth in an index for product market regulation.

For service sector firms only, the indicators for innovation governance include the percentage of firms that assign a high importance to environmental benefits as a goal of innovation[7].

3. Data Availability

All indicators were obtained from the following sources:

1. The 2000 Community Innovation Survey (CIS-3). CIS-3 refers to innovation activities between 1998-2000 inclusive. The 13 CIS-3 indicators were either calculated by Eurostat or by MERIT using NewCronos. The CIS-3 is limited to firms with more than 10 employees.

2. The CVTS2 was conducted in 2000/2001 with 1999 as the reference year for firm responses. CVTS2 included enterprises with 10 and more employees. The sample size is 76,000 firms. Data are available for the original 15 EU member states and for seven new member states (CZ, EE, HU, LT, LV, PL, SI). The indicators were extracted by MERIT from NewCronos under Theme 3.

3. Structural Business Statistics (SBS) data are available in NewCronos under Theme 4. Data are available for 1995-2001 inclusive for the 25 member states of the EU plus Iceland, Norway, Switzerland, Bulgaria and Romania (there are no data for Turkey). The most detailed sector coverage is at the NACE four-digit level, although for many sectors data are only available at the NACE 2-digit level. The SBS provides the indicator for gross investment in machinery and equipment.

4. The 2004 Innobarometer (European Commission, 2004) covered all 25 EU member states, with a total respondent sample of 4,534 managers of SMEs. The survey asked about their use of eight types of government programmes to support innovation. The indicator used in Theme 4 was obtained from a TrendChart Statistical Report (Arundel, 2004).

[7] This indicator is not used for manufacturing firms because firms in countries with stringent environmental regulations and high levels of past investment give very low importance ratings to this goal, whereas firms in countries with weak environmental regulation until recently give much higher importance ratings. This seriously distorts comparisons between firms in countries such as Finland and Germany and with firms in countries such as Hungary or other new member states. However, this distortion does not occur in the services sector.

5. WIPO (World Intellectual Property Organization) provides the data for industrial design applications and trademark applications. All results are limited to applications by domestic firms (or applicants) only. Foreign applications are not included[8].

6. International organisations and consultants: These are a source of one-off indicators that are not gathered consistently over time. They include indicators from the World Bank, the World Economic Forum, UNCTAD, the OECD, and the Working Conditions Survey.

4. Methodology

Instead of discussing the results for each individual indicator (although these results are available in the tables), EXIS focuses on the thematic composite indices (TCI) for each of the six themes, plus a summary index that averages the results of the TCIs. Only countries with over 50% of the indicators for each theme are included in the relevant TCI. For example, the TCI for the theme 'innovation diversity' is based on seven indicators. Each country must have data for four or more of these indicators to be included in the 'innovation diversity' TCI.

The overall summary EXIS index is only calculated for countries that meet two criteria: available results for four or more of the six TCIs and results for the TCI for the theme 'innovation diversity' because it is given a weight of 0.33 compared to a weight of 0.1334 for each of the remaining five TCIs. This is because 'Innovation diversity' measures key innovative activities and outputs, whereas the other five themes measure innovation inputs or background conditions.

For each country, Table 1 gives the total number of available indicators out of the maximum of 28, the number of TCIs available for the country, and whether or not the country is included in the summary index. The summary index is calculated for 20 of the 33 countries.

[8] The trademark application data are available at www.wipo.int/ipstats/en/statistics/marks_01.xls and the industrial design data are available at www.wipo.int/ipstats/en/statistics/designs_01.xls.

Table 1. Indicator, TCI, and Summary Index availability by country

Country	Available Indicators	Available TCI	Available Summary Index
Germany	28	6	✓
France	28	6	✓
Portugal	28	6	✓
Finland	28	6	✓
Spain	27	6	✓
Austria	27	6	✓
Sweden	27	6	✓
Greece	27	6	✓
Norway	26	6	✓
Belgium	26	6	✓
Netherlands	26	6	✓
Italy	25	6	✓
Denmark	24	6	✓
Czech Republic	24	5	✓
Hungary	24	5	✓
Lithuania	23	5	✓
Slovenia	23	4	✓
Romania	22	4	✓
Estonia	21	4	✓
Luxembourg	20	5	✓
United Kingdom	19	4	
Latvia	19	3	
Iceland	18	3	
Slovakia	18	3	
Ireland	17	3	
Poland	13	1	
United States	11	1	
Switzerland	11	3	
Japan	10	1	
Bulgaria	10	1	
Malta	8	0	
Turkey	7	0	
Cyprus	3	0	

Since many of the indicators are based on different units, they must be rescaled to a common measurement scale. The rescaling method for each TCI and for the summary index is based on the observed minimum and maximum values. The EU mean value is simply an unweighted average of the TCI or summary index for each EU member

state (the EU index excludes the results for Norway, Iceland and other non-EU countries).

The composite indices (CI) for each TCI and for the summary index are calculated in two steps. The first step determines the rescaled value while the second step calculates the composite index:

1) $$y_{ij}^{t} = \frac{x_{ij}^{t} - Min(x_{j}^{t})}{Max(x_{j}^{t}) - Min(x_{j}^{t})}$$

Where x_{ij}^{t} is the value of indicator *j* for country *i* at time *t* and *y* is the rescaled value. Min equals the minimum observed value and Max equals the maximum observed value.

2) $$CI_{i}^{t} = \frac{\sum_{j=1}^{m} q_{j} y_{ij}^{t}}{\sum_{j=1}^{m} q_{j}}$$

Where q_j is the weight given to indicator *j*. In most cases a weight of 1 is given to each indicator in the TCIs, with the exception of matched indicators (available separately for innovators and non-innovators), which are given a weight of 0.5 each. The summary index is based on a weight of 0.333 for the TCI for the theme 'innovation diversity' while the remaining five TCIs have a combined weight of 0.667.

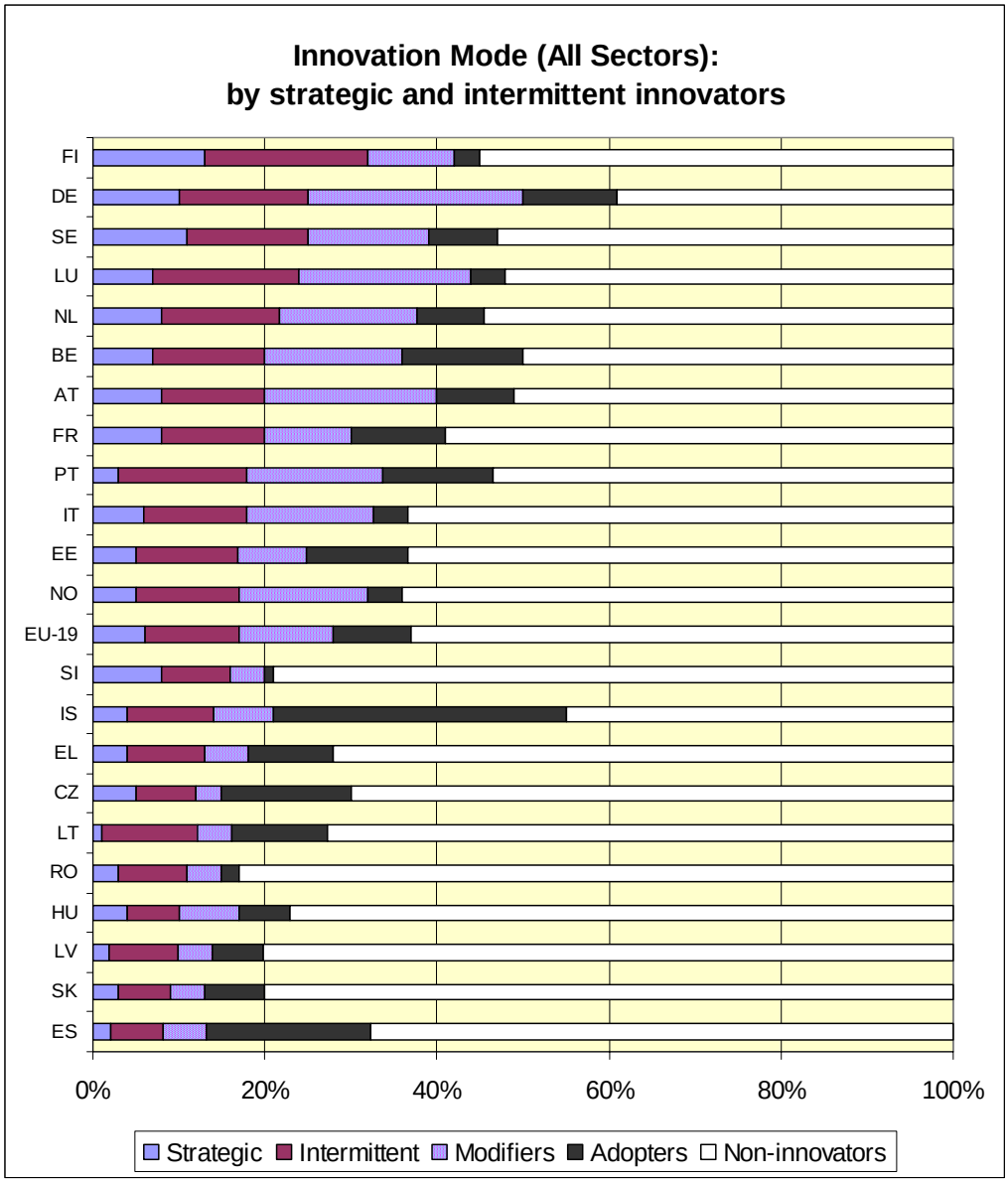
Equation 1 above assumes that higher values of each indicator are better than lower values. This assumption is reversed for four indicators[9]. In this case, the minimum and maximum values are reversed in equation 1 so that the minimum observed value represents the best outcome.

[9] These are the time to sales take-off, poor customer responsiveness as a barrier to innovation, lack of finance as a barrier to innovation, and product market regulation.

5. Results for Innovation Modes

Figure 1 gives the distribution of innovation modes for 22 countries for all sectors combined (all manufacturing and a selected group of service sectors) plus for the 19 EU countries for which data are available. The results are organised in descending order by the percentage of strategic and intermittent innovators combined out of the total firm population. By country, the sum of each of the five innovation modes adds to 100% of all firms with 10 or more employees and active in a sector surveyed by CIS-3.

Figure 1



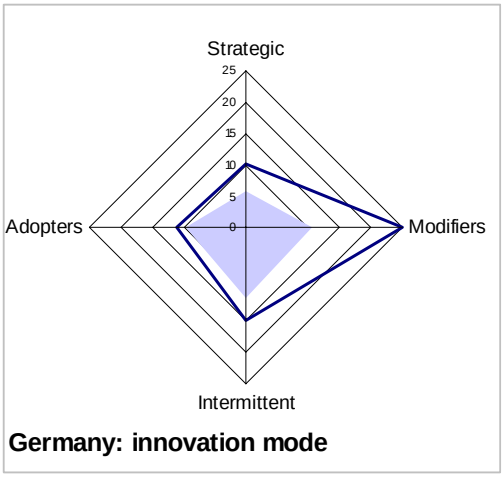
An important caveat is that there is no optimal distribution by innovation mode, nor is one mode necessarily superior to another from the perspective of the *firm*. For example, from the firm perspective buying-in innovations that were developed by other firms (technology adoption) may be far more economically viable and lead to faster growth in employment, market share and profits than investing in activities to develop innovations in-house. Conversely, the economic dynamism and growth of a region or nation may depend on a diversity of innovation modes, including some firms that are strategic or intermittent innovators that develop innovations in-house.

Figure 1 shows the well-known differences in the percentage of non-innovative firms across countries, ranging from a high of 83% in Romania to a low of 45% in Iceland. However, of greater interest is the distribution of innovation firms by their mode of innovation. This shows that Iceland's excellent performance for innovative firms is largely due to a very high percentage of technology adopters (34%). In contrast, only 3% of firms in Finland are technology adopters, whereas 32% of Finnish firms are either strategic or intermittent innovators (both of which perform R&D).

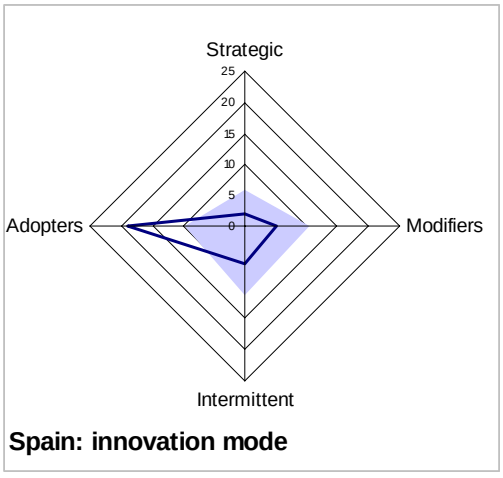
Figure 2 gives examples of the distribution of innovation modes among *innovative* firms only for all sectors combined. The four examples represent countries with very different patterns of innovation. The scale is the percentage of all firms by each of four innovation modes. Since non-innovative firms are excluded, the size of the area covered by each country (within the black line) represents the percentage of innovative firms out of the total firm population. For example, the area within the black line is much greater for Germany than for Spain because 61% of German firms innovate, compared to 33% of Spanish firms. For comparison, each figure includes the EU-19 average (the central shaded area).

Finland represents the case of a country that is squeezed on the vertical axis, with above average shares of strategic and intermittent innovators, while Spain is typical for countries that are squeezed on the horizontal axis, with a below average share of strategic and intermittent innovators and a relatively high share of technology adopters or modifiers. Germany is the case of a country with an above average share of each type of innovator, but it is particularly advantaged by a high percentage of technology modifiers. France is close to the EU average on all modes and shows roughly equivalent shares of each type.

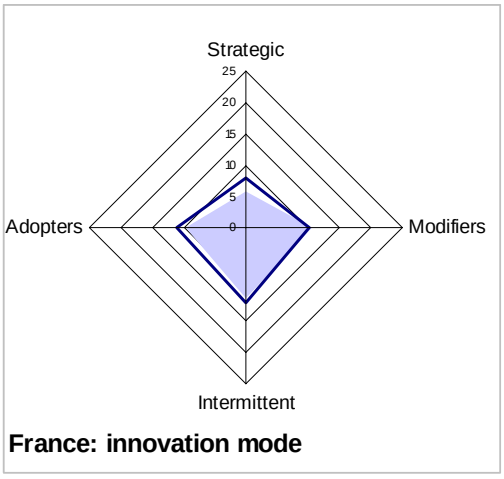
Figure 2: Distribution of innovation modes for all sectors compared to the EU-19 average (shaded area): Innovative firms only



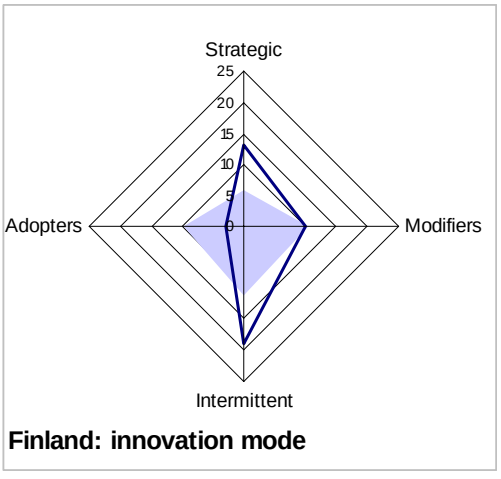
Germany: innovation mode



Spain: innovation mode



France: innovation mode



Finland: innovation mode

6. Results for the EXIS Summary Index

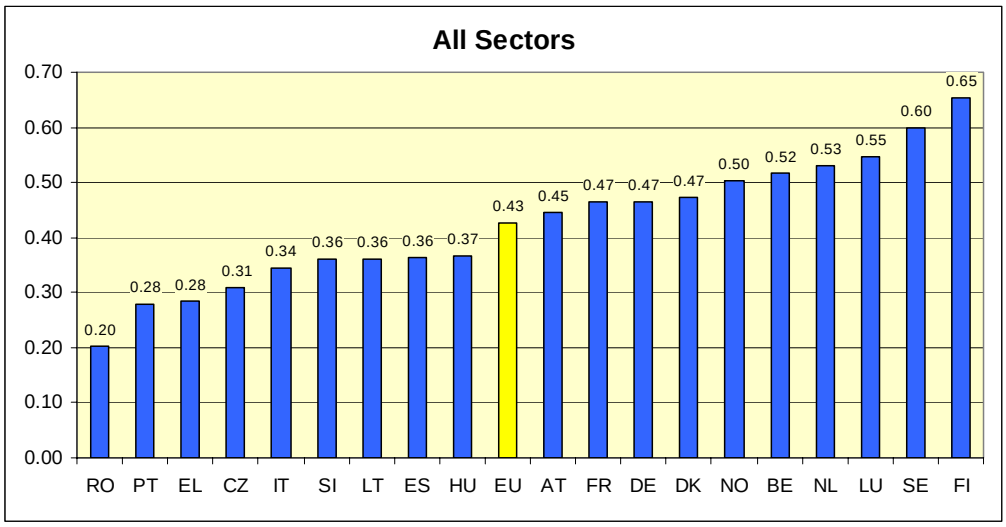
The EXIS summary index provides an overview of the level of all types of innovation within each country and background conditions to encourage innovation. Figure 3 gives the EXIS summary index for up to 20 countries for all manufacturing and business service sectors combined, for manufacturing sectors only, and for business service sectors only. There are few differences between the results for each sector group. The R^2 values are 0.87 between all sectors and the business service sector, 0.97 between all sectors and the manufacturing sector, and slightly less, at 0.80, between the manufacturing and service sectors[10]. Hungary and Norway perform better in services than in manufacturing, while Austria performs better in manufacturing than in services. Otherwise, the differences between the service and manufacturing sectors are minor. As with the EIS, Finland and Sweden are the leading performers, while several of the new member states, Portugal, Greece, Spain and Italy lag behind the EU country average of 0.43 for all sectors combined.

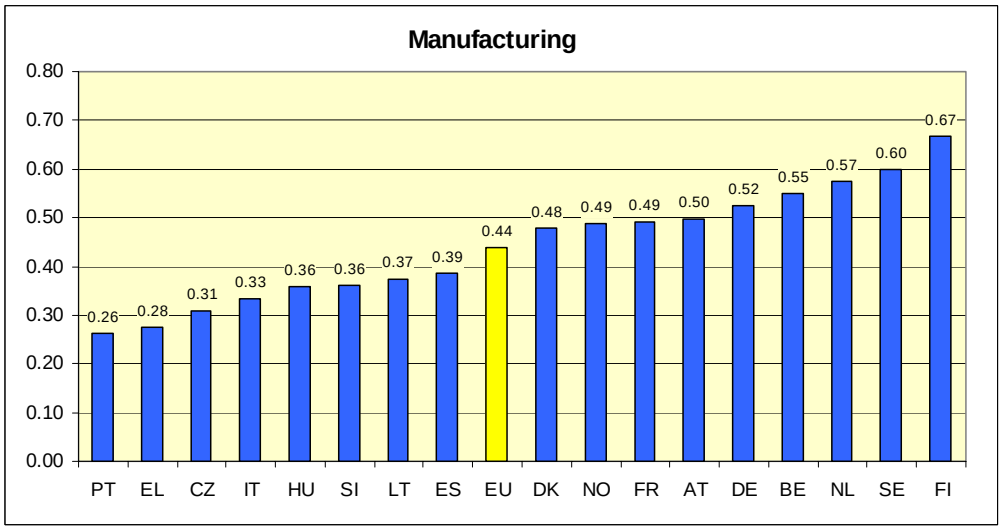
There is a moderate correlation between the EXIS summary index for all sectors combined and the EIS Summary Innovation Index, with a R^2 value of 0.71. Figure 4 graphs national results for the EXIS summary index versus the EIS summary index, plus the ranking for 17 EU countries with results for both the EXIS and EIS summary indices. Countries that are above the diagonal line perform better on the EXIS index than on the EIS, while countries below the line perform better on the EIS. In contrast to the EIS, Luxembourg performs very well – in third place on the EXIS index, while Germany, Denmark, Finland and Sweden perform comparatively worse on the EXIS index than they do on the EIS Summary Innovation Index. The surprisingly good result for Luxembourg is partly due to a few missing indicators, but it is also due to very good performance on 'innovation investment', non-technical innovation, and an 'innovation friendly market'.

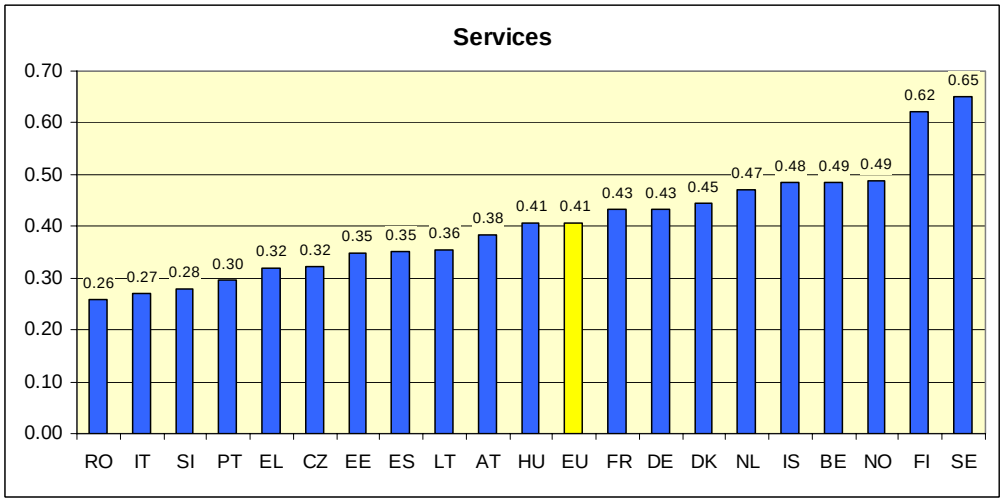
A notable difference between the EXIS and EIS summary indices is that the differences between the best and worst performers are much less using the EXIS indicators. For example, there is a 5.1 fold difference between the worst (Romania) and best (Sweden) performer on the EIS, compared to only a 3.25 fold difference between the worst (Romania) and the best (Finland) on the EXIS scoreboard.

[10] The high correlations are partly due to the use of the same indicators for both manufacturing and service firms when the indicator applies to all firms, regardless of sector. These indicators are identified in Annex Table C. Theme 1 (innovation diversity) uses separate results for manufacturing and services for six of the eight indicators, but two indicators are identical: trademarks per million population and industrial designs per million population, although the latter is not used in the summary index for the service sector. The number of identical indicators for both manufacturing and services per theme are as follows: three out of four indicators for theme 2 (innovation-friendly market), one out of four indicators for theme 3 (knowledge flows), one out of four indicators for theme 4 (innovation investment), one out of four indicators for theme 5 (innovation skills), and four out of five indicators for theme 6 (innovation governance).

Figure 3: EXIS Summary Index

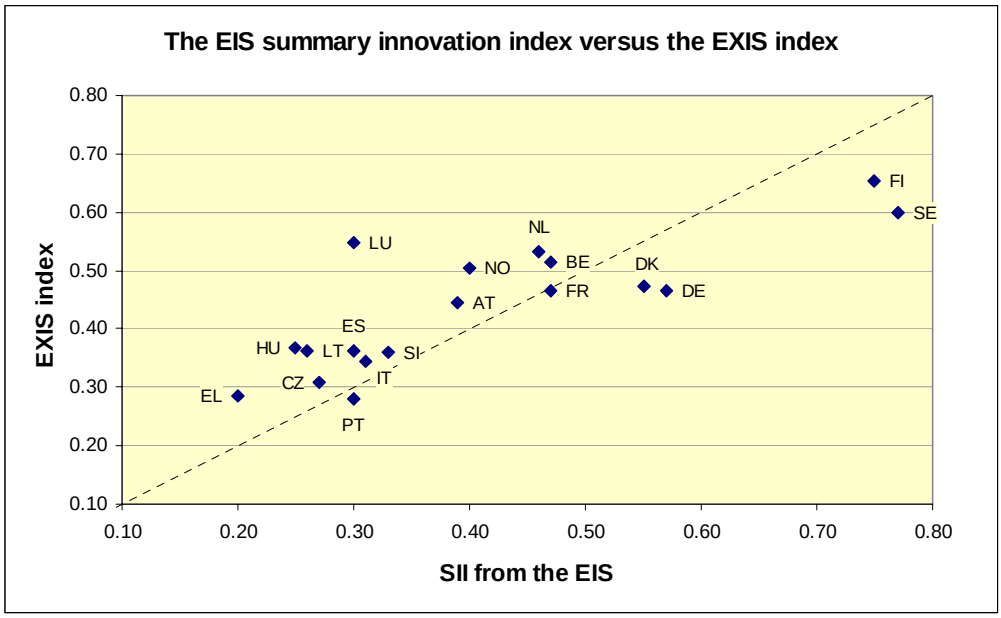






The main reason for this is that the EXIS indicators cover a much broader range of innovation activities than the EIS, plus EXIS includes more indicators for background conditions, such as the receptiveness of the domestic market to innovative products and innovation governance. In addition, the ten new member states perform well on the thematic indices for 'knowledge flows' and an 'innovation-friendly market' (see section 7.7 below), whereas their performance on the EIS is consistently poor compared to many of the EU-15 countries. Section 7.7 below further discusses some of the reasons why performance can differ on the EIS and EXIS summary indices.

Figure 4



Rank of 17 EU countries with data for both the 2004 EIS and EXIS summary indices 1 = best performance

	EIS	EXIS		EIS	EXIS
Greece	17	16	Austria	8	9
Hungary	16	10	Netherlands	7	4
Lithuania	15	12	Belgium	6	5
Czech Republic	14	15	France	5	8
Spain	13	11	Denmark	4	6
Luxembourg	12	3	Germany	3	7
Portugal	11	17	Finland	2	1
Italy	10	14	Sweden	1	2
Slovenia	9	13			

7. Results for the Thematic Composite Indices (TCI)

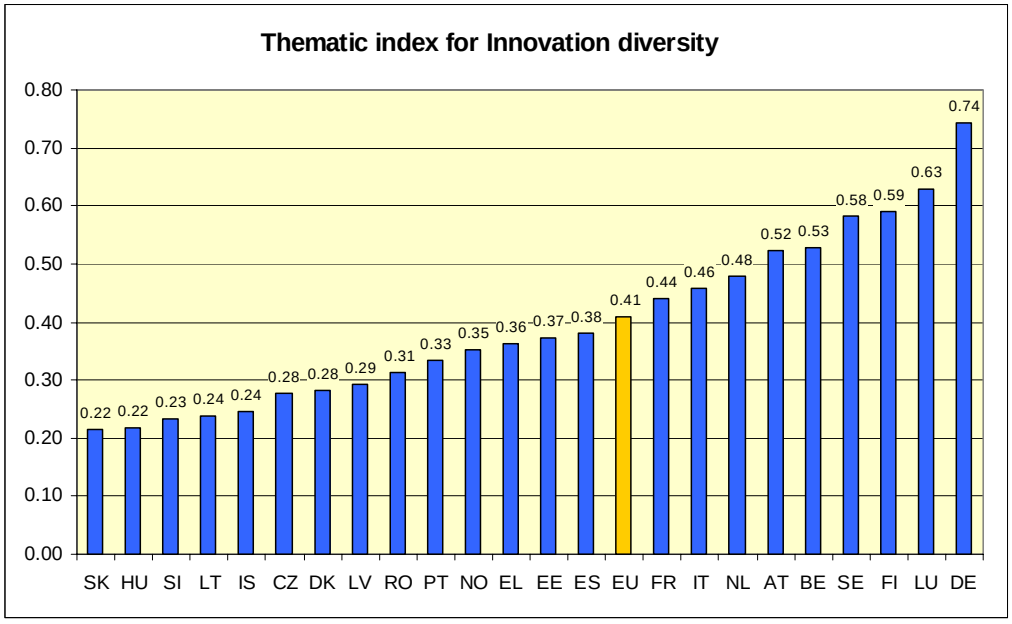
Figures 5 through 9 give the thematic indices, for all sectors combined, for each of the six themes for countries with data for more than half of the relevant indicators within each theme.

7.1 Innovation Diversity

Good performance on this theme requires a diversified innovation performance, rather than exceptional performance on a few R&D based indicators. Good performance within each country requires:

1. R&D based technical innovation (high share of strategic and intermittent innovators).
2. Diffused patenting activity (high share of firms that apply for at least one patent) that may or may not be linked to R&D.
3. Good performance for three types of non-technical innovation, including 1) organisational, management or design innovation; 2) marketing innovation as measured by the number of trademarks per million population, and 3) design innovation as measured by industrial designs per million population.
4. Above EU average share of high growth (employment or sales) innovators.

Figure 5



As shown in Figure 4, Germany has the most diversified innovative performance in the EU, due to good performance on all seven indicators with the exception of trademarks. Germany is followed by Luxembourg, Finland and Sweden. Luxembourg's good performance is due to indicators that play less of a role in the EIS or R&D based innovation indices: non-technical innovation and high-growth innovators. Denmark is a surprising under-performer, largely due to low rates for each of three indicators of non-technical innovation (organisational and management innovation, trademarks and industrial design). The poor results for organisational and

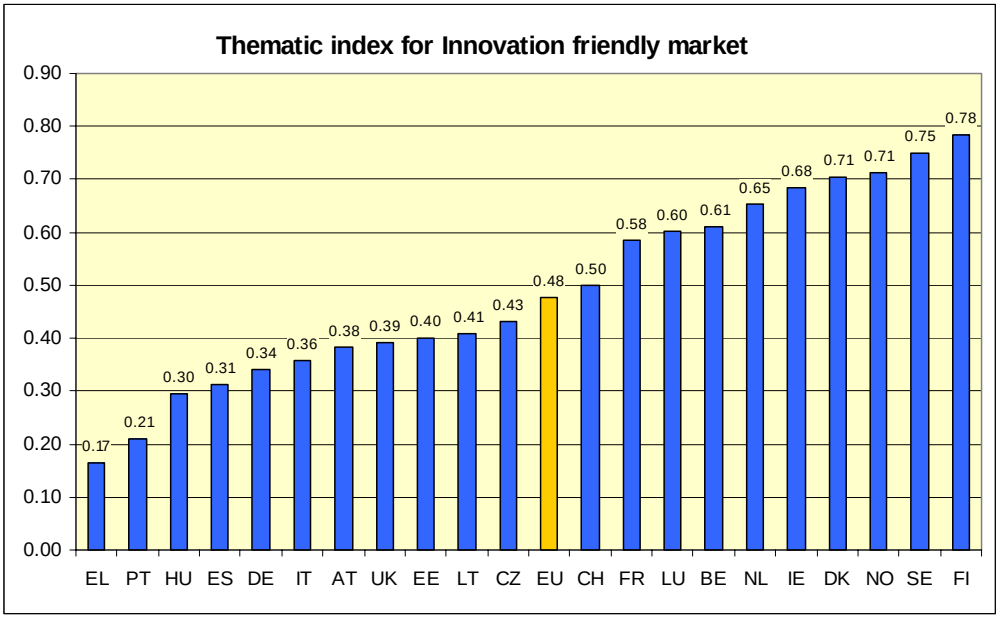
management innovation are probably due to the fact that Danish firms went through a period of organisational change in the 1980s and early 1990s and consequently few firms needed to revise their organisational structures in the late 1990s.

7.2 Innovation Friendly Market

This indicator is limited to the domestic market, which for many firms may not be their most important market. Performance on this indicator is improved by a population that is receptive to innovative products and services. The latter is proxied by a youthful population, a history of rapid sales take-off for consumer products, high levels of buyer sophistication for innovative products, and a low percentage of both innovative and non-innovative firms that find a 'lack of customer responsiveness to new goods or services' to be of high importance as a barrier to innovation.

The sub composite index for objective 2 is given in Figure 6. The best performers in the EU are the Scandinavian countries of Finland, Sweden and Denmark, with Norway also performing very well. Germany performs poorly on this indicator, due to a low youth share and consistently low performance on consumer responsiveness to innovative products and services. The results suggest that Germany cannot rely on a domestic 'lead market' to help guide the development of innovations. Instead, Germany's strengths lie in close links with customers in its export markets. The poor performance of Italy is partly due to a very low youth share, while the explanation for the UK is due to the high percentage of firms that state that low market interest in innovations is a reason not to innovate.

Figure 6

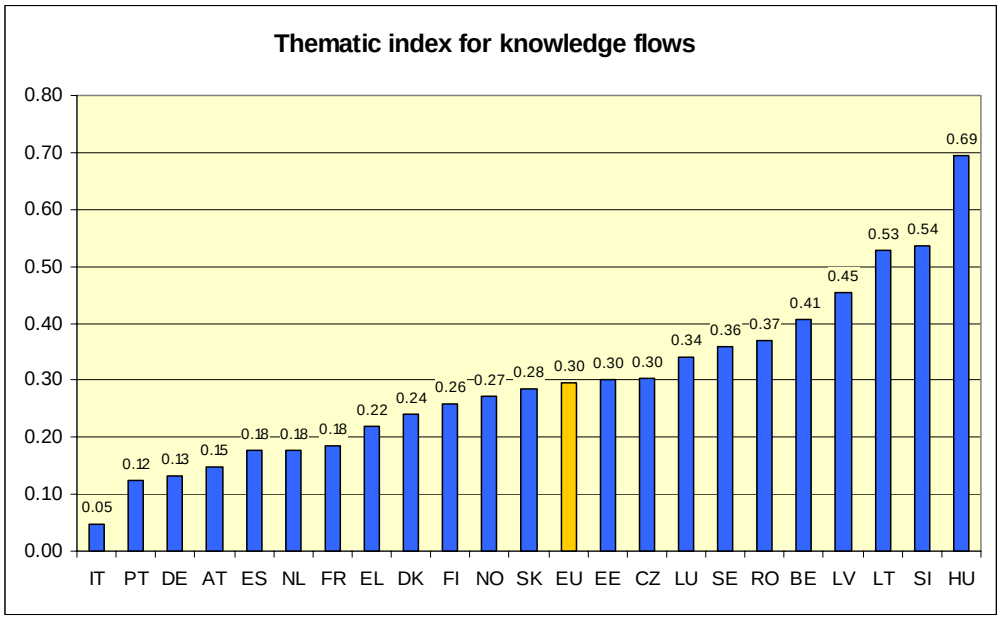


7.3 Knowledge Flows

This composite indicator measures the uptake by firms of knowledge from external sources – it is essentially an indicator of the diffusion of knowledge, rather than its production within the firm. Good performance is based on a high rate of international collaboration, a high value attached to information from the higher education sector and to all external knowledge sources, and a high level of openness to intangible knowledge (as measured by the transnationality index).

The results, given in Figure 7, stand in sharp contrast to the other sub-composite indices in this scoreboard and with the EIS. The best performers in the EU are all from the ten new member states: Hungary, Slovenia, Lithuania, and Latvia. Only one of the ten new member states (Slovakia) is below the EU average. The first member of the EU 15 to appear is Belgium, at fourth place, due to a very open economy. In contrast, the three largest EU economies included in this sub composite index (there are no data for the UK) are well below the EU average. The explanation for this pattern is due to the crucial role of innovation diffusion for the new member states. In contrast, firms in the larger EU economies and in the more innovative EU economies (Sweden and Finland) are less reliant on external knowledge sourcing.

Figure 7

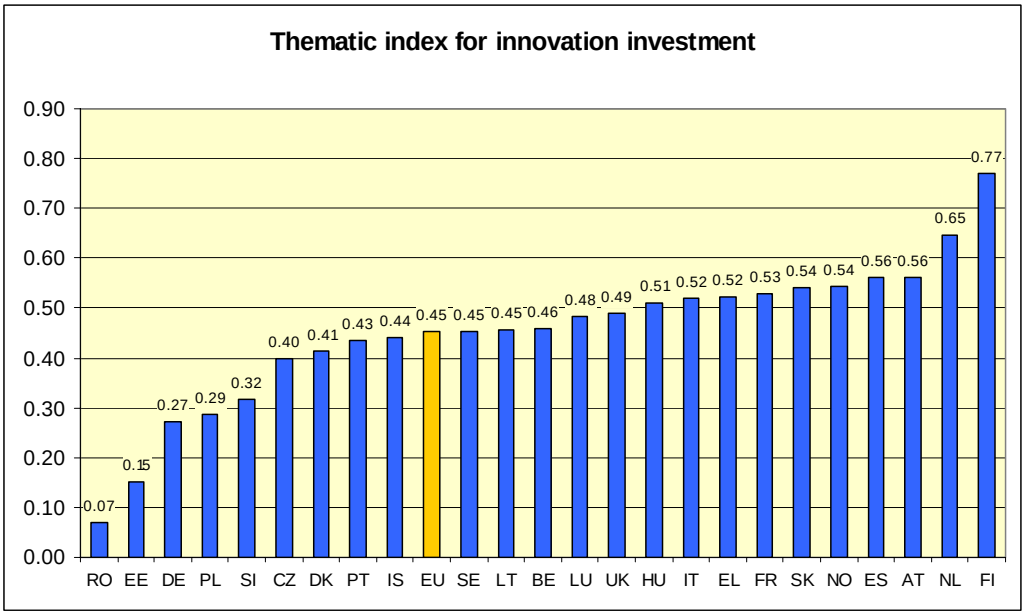


7.4 Innovation Investment

This composite indicator measures the availability of capital to firms for innovation from both public and private sources, investment in machinery and equipment (a large share of which will be related to innovation, but not all), and a lack of finance as a barrier to innovation. As shown in Figure 8, the best performers are Finland, the

Netherlands, Austria and Spain. The good performance of the latter two countries is due to a relatively high proportion of firms that take part in public programmes to support of innovation. Luxembourg's above average performance is due to a high rate of available finance from private sources and to very few firms reporting that a lack of finance was a barrier to innovation. However, Luxembourg's good performance is partly an anomaly that is based on low rates of technical innovation, as shown by a very low percentage of firms that receive public support for innovation. Germany's very poor performance is due to consistently low scores on the availability of private finance, low use of public programmes to support innovation, and a high percentage of both innovative and non-innovative firms that report that a lack of finance is a barrier to innovation.

Figure 8



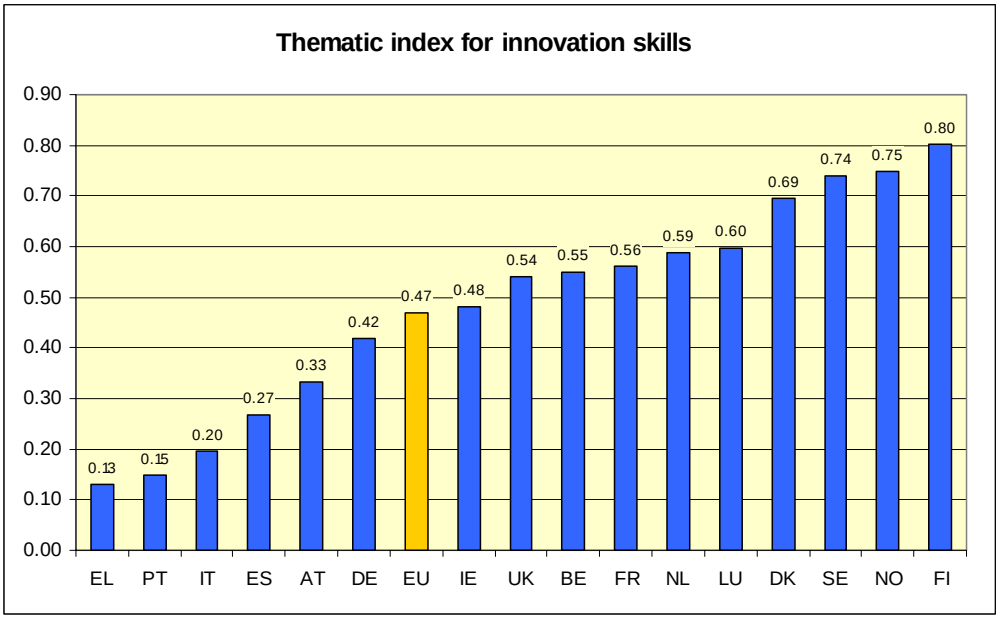
7.5 Innovation Skills

Good performance on this indicator requires a high percentage of jobs where continual learning is required, a highly educated employed workforce, and high participation rates in ongoing training supported by the employer. Unfortunately, the indicator is only available for the 15 EU member states plus Norway. The results are given in Figure 9.

The best performers on the skills index are the Scandinavian countries (Finland, Norway, Sweden and Denmark), followed by the Netherlands and Luxembourg. The worst performers are the Mediterranean countries (Greece, Portugal, Italy, and Spain). This is an established pattern that is due to the high investment in Scandinavia in

workforce skills and a corporate culture that emphasises worker involvement and flatter organisational structures with a low number of management levels.

Figure 9



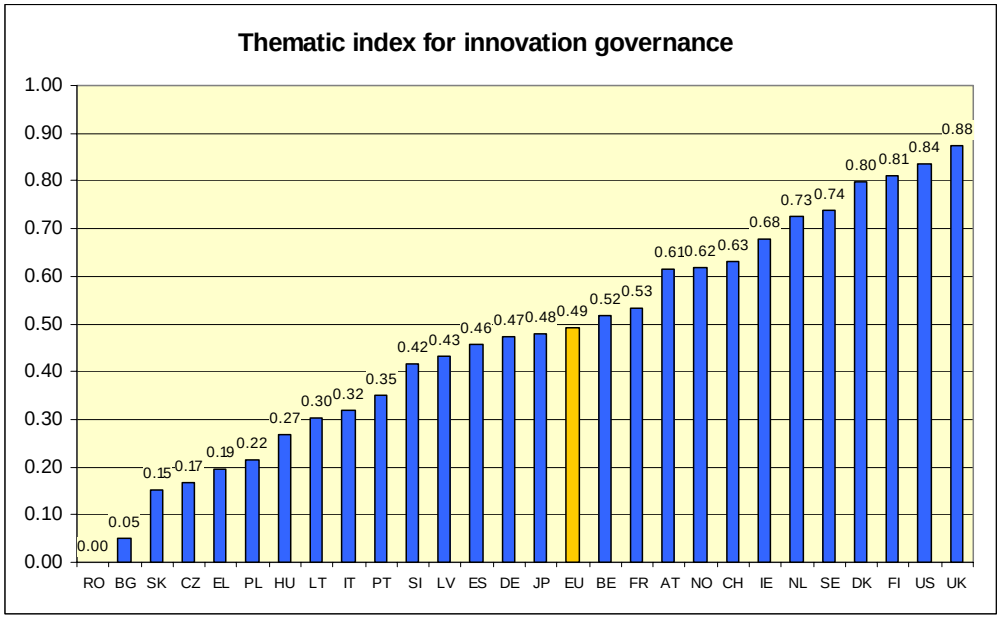
7.6 Innovation Governance

For all sectors combined[11], this composite indicator covers four aspects of innovation governance: good government based on supportive policies for innovation, an efficient low-waste government, low regulatory barriers for starting a new business, and low levels of regulation for introducing product innovations onto the domestic market. The results are given in Figure 10.

The EU leader is the UK, followed by Finland, Denmark and Sweden, due to very low regulatory burdens and to good government. This is one of the few indices for which results are available for the United States, which ranks second after the UK. None of the ten new member states are above the EU average. Germany and Italy are both below the EU average. The poor performance for Germany is due to above average costs for starting a new business.

[11] A fifth indicator for environmental innovation is included for the service sector only.

Figure 10



7.7 Thematic indices and the EIS

Table 2 gives the R^2 results for correlations between the EIS and each thematic index in EXIS.

Table 2. Correlations between each TCI and the 2004 EIS and the EXIS summary index

	EIS		EXIS index	
TCI objective	**R^2**	**N**	**R^2**	**N**
1. Innovation diversity	0.32	23	0.42	19
2. Innovation friendly market	0.44	21	0.78	17
3. Knowledge flows	0.06	22	0.00	19
4. Innovation investment	0.12	22	0.35	19
5. Innovation skills	0.56	16	0.74	16
6. Innovation governance	0.59	27	0.77	19

N: Number of countries with data for both the TCI and the EIS summary index.

The correlations between each TCI and the EXIS summary index, with the exception of 'knowledge flows', are higher than the correlation between each TCI and the EIS because the EXIS summary index is calculated as the average of the TCIs. The result for innovation diversity has a moderate correlation with the EXIS and EIS summary

indices. It is surprising that the correlation is not stronger with the EXIS summary index because this thematic index contributes to one-third of the EXIS summary index.

The low correlations between the TCIs and the EIS for 'knowledge flows' are due to good performance by the ten new member states for 'knowledge flows'. This reflects the need for firms in these countries to source knowledge externally, including from firms based in other countries. This also illustrates how the EXIS indicators cover a wider range of the factors that can influence innovation, and the methods of innovating, than the EIS.

For both the EIS and EXIS, the highest correlations are for an innovation friendly market, innovation skills, and innovation governance, all of which capture background conditions for the innovative activities of firms, rather than firm level innovation inputs (such as R&D, innovation investment, or knowledge flows) or outputs (such as innovation sales shares in the EIS or trademarks in EXIS). The TCIs for 'innovation skills' and 'innovation governance' show the strongest correlations with the EIS, while all three have similar correlations with the EXIS summary index[12]. These results, although very preliminary, are of interest because they suggest that innovation policy should consider background socio-economic conditions that favour innovation. One possibility is that good governance plays a key role in national innovative capabilities, possibly through creating favourable conditions for long-term investment. However, more research on the links between background conditions and innovation performance is required in order to investigate the role of confounding. It is also possible that the strong correlation for innovation governance, for example, could be an artefact of confounding by other causal factors, such as between per capita income and good governance.

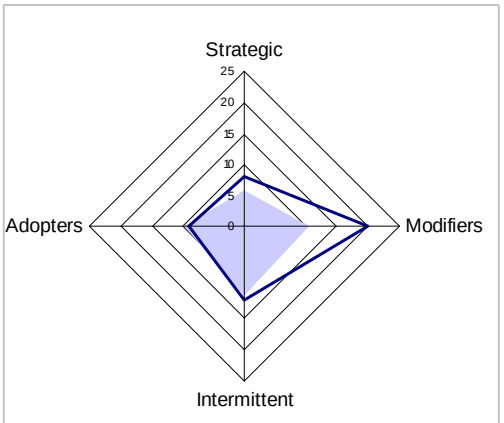
8. Country Results

This section provides summary results for 15 countries for which there are data for the innovation mode, the EXIS summary index, and the EXIS thematic indices for innovation diversity plus four of the remaining five themes. For each country, we give a radar diagram of the results for both the EXIS thematic indices and for the innovation mode. In both radar diagrams, the central section in blue gives the EU average for comparison. The EU average for both the innovation mode and the EXIS themes is an unweighted average where each country contributes equally. The average for innovation mode is based on results for 19 EU countries while the EXIS average is for 16 EU countries plus Norway.

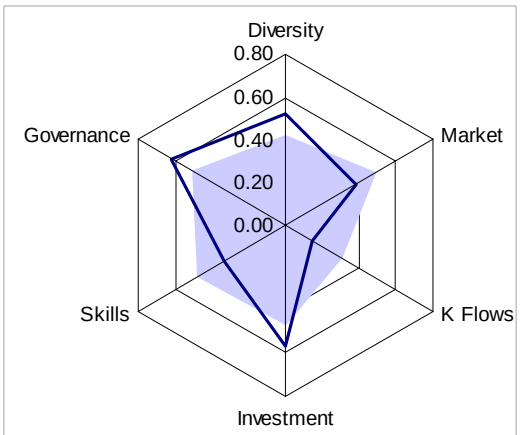
[12] The above average correlation for skills and the EIS is partly due to the fact that this indicator is only available for the EU-15 plus Norway.

The radar diagrams are simple to interpret and show, at a glance, the relative strengths and weaknesses of each country for the EXIS indicators and the modes used by *innovative* firms.

Austria



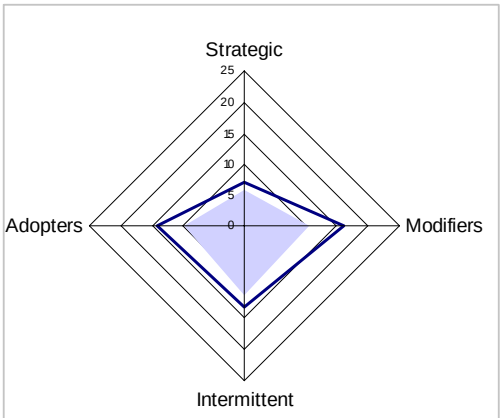
Austria: innovation mode



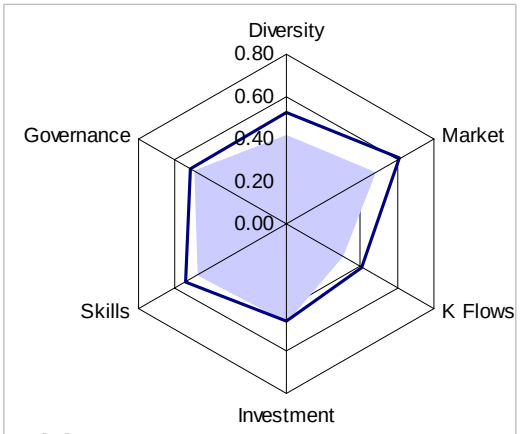
Austria: EXIS

The results for innovation mode for Austria show an average share of technology adopters and intermittent innovators, an above average share of strategic innovators, and a very high share of technology modifiers, compared to the EU average. The EXIS results show that Austrian performance is above average for three of the six themes but below average on another three (skills, innovation friendly market, and knowledge flows), with a marked weakness in knowledge flows. The results for 'market' may not be a serious problem f if Austria can rely on export markets, but the low performance on skills and knowledge flows could create problems in the future.

Belgium



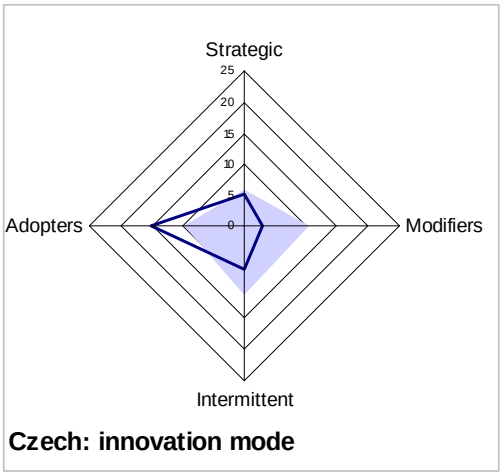
Belgium: innovation mode



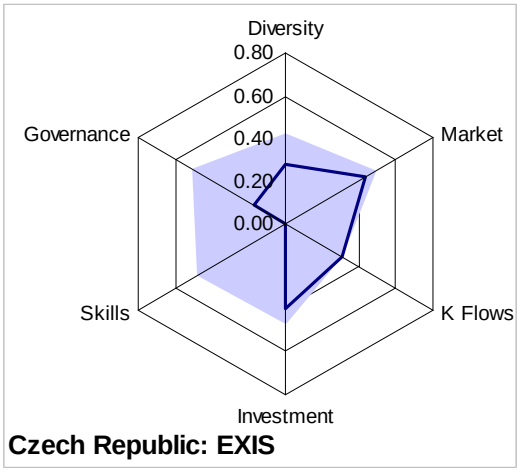
Belgium: EXIS

The results for innovation mode show that Belgium has an above average performance on all four types of innovation, although it has greater strengths in the two modes related to innovation diffusion (adopters and modifiers) than for the creation of new technology (strategic and intermittent modes). The EXIS results show a relatively well-balanced picture, with above average performance on five of the six themes, and an average performance for investment. For a highly developed economy, however, Belgium lags behind expectations for governance because of higher levels of product regulation.

Czech Republic (no data for skills in EXIS)



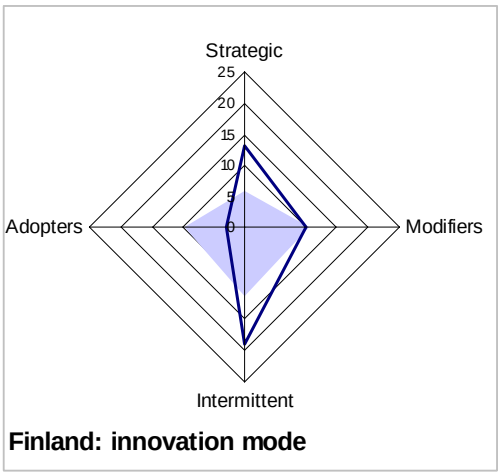
Czech: innovation mode

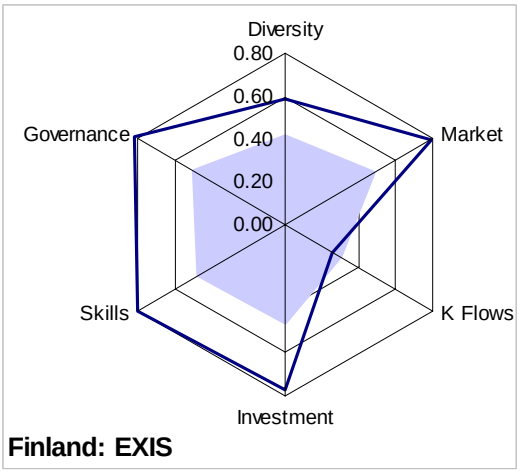


Czech Republic: EXIS

As shown by the results for innovation mode, the innovative pattern in the Czech Republic is dominated by the adoption of innovations developed by other firms, although the proportion of strategic innovators is close to the EU-19 average. There are no data for skills on EXIS. Investment, knowledge flows, and an ‘innovation friendly market are close to the EU average, but the Czech Republic is underperforming on governance, due to a poor score on innovation policies and excessive government waste.

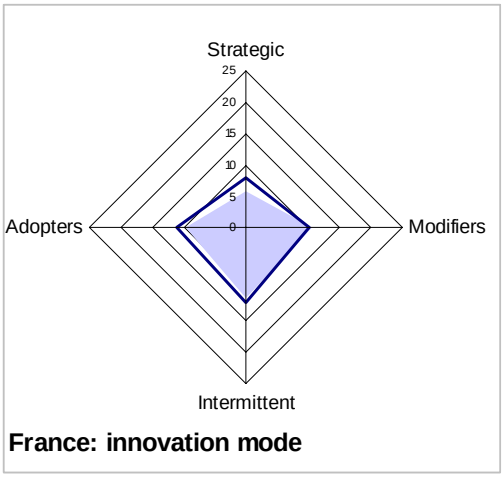
Finland

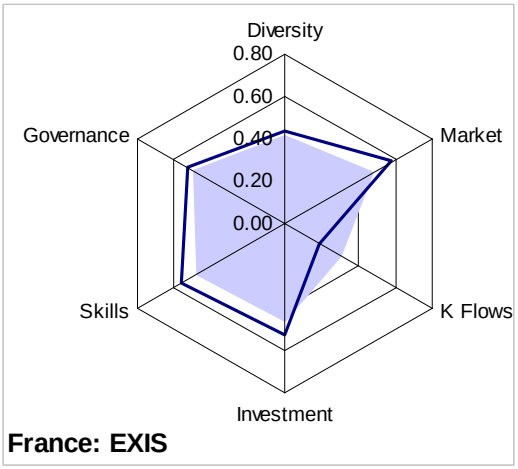




Finland is a star performer on both innovation mode and on EXIS. On the former, Finnish firms have largely shifted away from a focus on innovation diffusion (with particularly low percentages of firms that only adopt innovations) and towards developing innovations in-house (strategic and intermittent innovators). Finland performs far above average on five of the six EXIS themes. The weakness on knowledge flows could be due to an over-reliance on a few large firms for innovation combined with low rates of inward foreign direct investment. In addition, Finnish firms under- perform on sourcing knowledge externally.

France

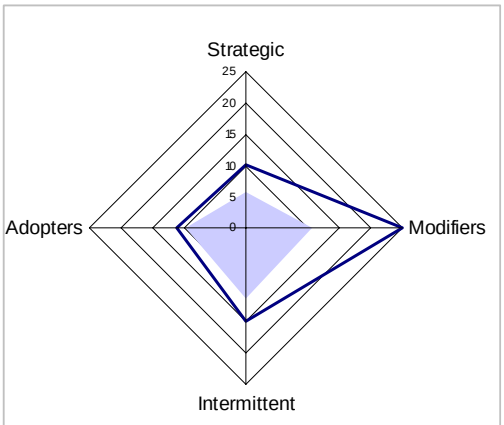




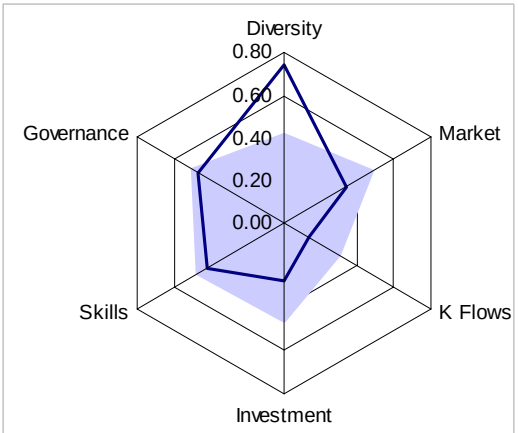
Other than an above average percentage of strategic innovators, France is close to the EU average for innovation mode, including the percentage of non-innovative firms. On EXIS, France performs below the average for knowledge flows and close to the

average for governance and innovation diversity. Its main comparative strengths are for skills, investment and an 'innovation friendly market'.

Germany



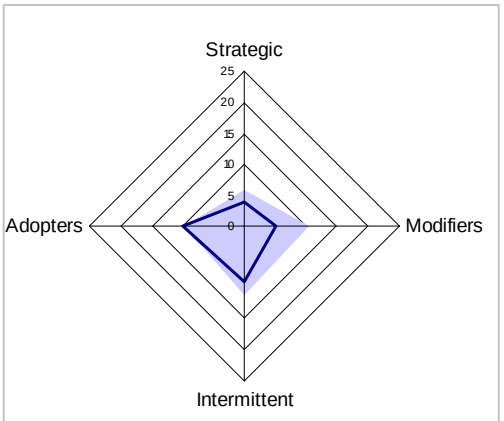
Germany: innovation mode



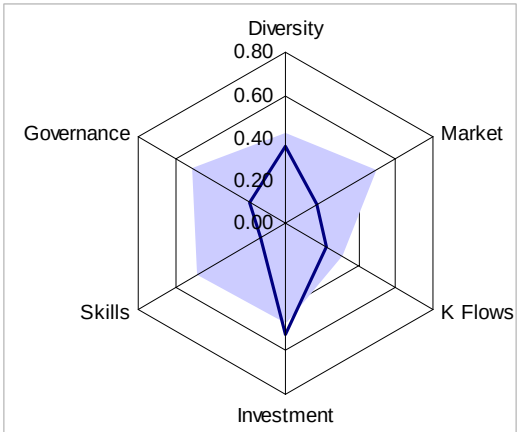
Germany: EXIS

Germany has almost twice the share of strategic innovators than the EU average and an exceptionally high share technology modifiers. Unfortunately, Germany is below the EU average for many of the EXIS themes, with he exception of innovation diversity, where Germany is an exceptional performer. Below average performance on skills and investment could create problems for Germany in the future. The poor performance on knowledge flows could be due to the size of the German economy, which means that innovative firms do not have to seek knowledge in other countries. Similarly, German firms can overcome poor results for an 'innovation friendly' market by maintaining good contacts with foreign customers.

Greece



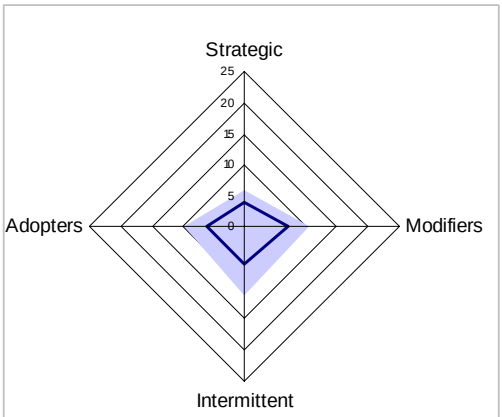
Greece: innovation mode



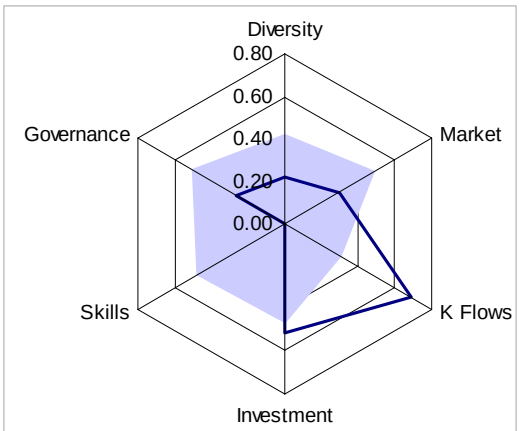
Greece: EXIS

The results for innovation mode give a discouraging picture of the capabilities of Greek firms. The fact that the dark line is largely within the shaded area marking the EU average shows that Greece has a below average share of innovative firms. Those that do innovate are more likely to adopt technology from other sources than to develop innovations in-house. On EXIS, Greece performs very poorly on skills, governance, and on an innovation friendly market. All three suggest that structural factors are likely to prevent Greece from improving its innovative capabilities in the near future. The only bright sign is an above average rate of investment.

Hungary (no data for skills in EXIS)



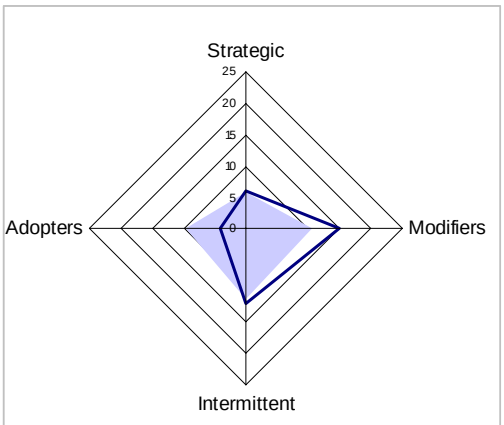
Hungary: innovation mode



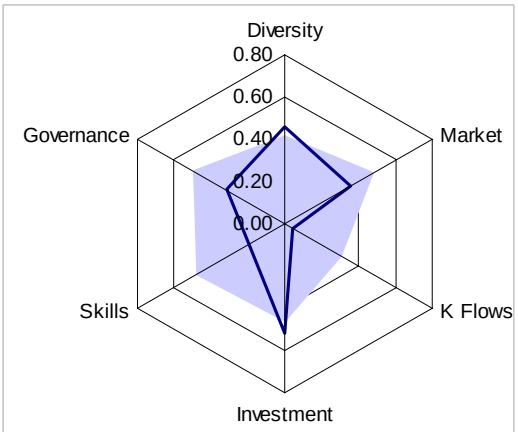
Hungary: EXIS

Hungary consistently performs below the EU average on each of the four types of innovation modes, and has an above average share of non-innovative firms. The results for EXIS show that poor performance on governance and an innovation friendly market could hold back improvement in the near future. In contrast, Hungary has above average performance on investment and on knowledge flows, possibly due to foreign subsidiaries.

Italy



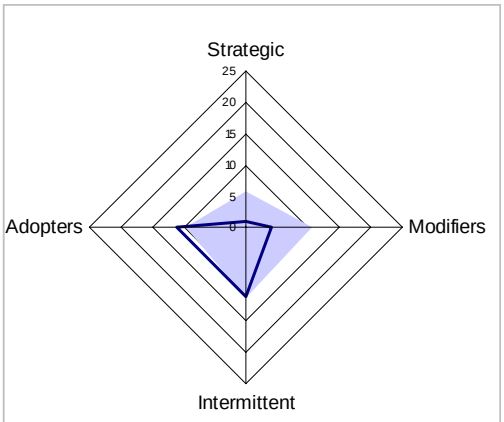
Italy: innovation mode



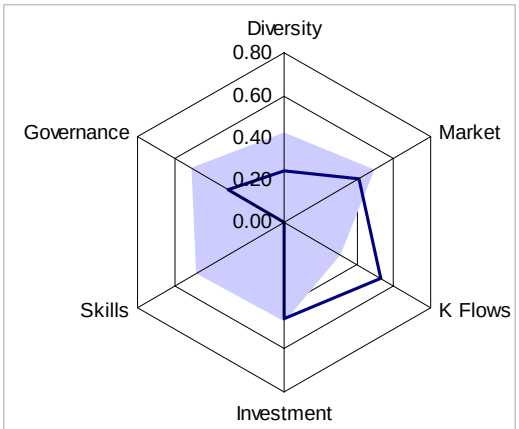
Italy: EXIS

Italy has a low percentage of technology adopters, with a shift towards technology modifiers. The proportion of creative innovators (strategic and intermittent innovators) is close to the EU average. On EXIS, Italy is slightly above average for innovation diversity and investment, but performs exceptionally badly on knowledge flows. Performance is also well below average for skills and governance, and below average for an innovation friendly market. Given the structural problems confronting innovation in Italy, as shown in EXIS, the Italian performance on innovation mode is above expectations. This suggests that serious policy effort to improve governance, skills and knowledge flows could have large payoffs in terms of the innovative capabilities of Italian firms.

Lithuania (no data for skills in EXIS)



Lithuania: innovation mode

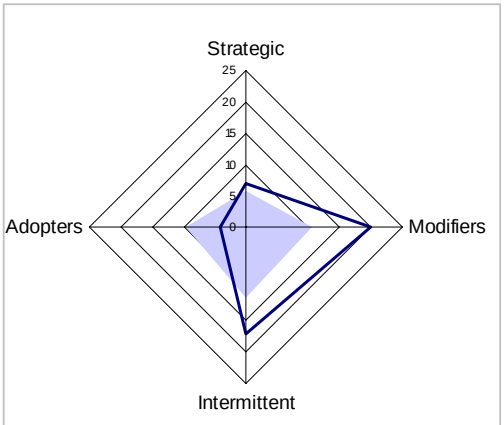


Lithuania: EXIS

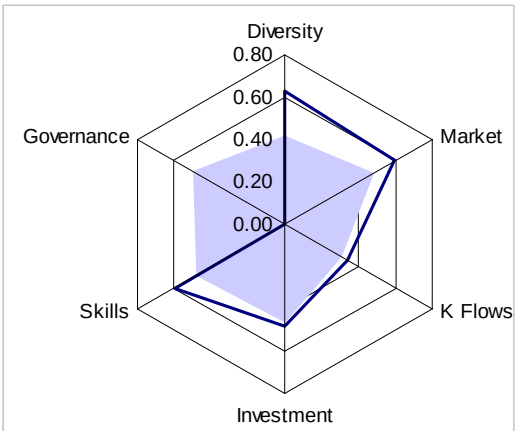
Lithuania has developed an unusual pattern for innovation mode, with average shares of firms that adopt innovations or develop them in-house, but with very few strategic

innovators and technology modifiers. As with a few other new member states, Lithuania is performing well above average for knowledge flows and has an average performance for investment. The most pressing need that can be addressed by policy is to improve governance conditions.

Luxembourg (no data for governance)



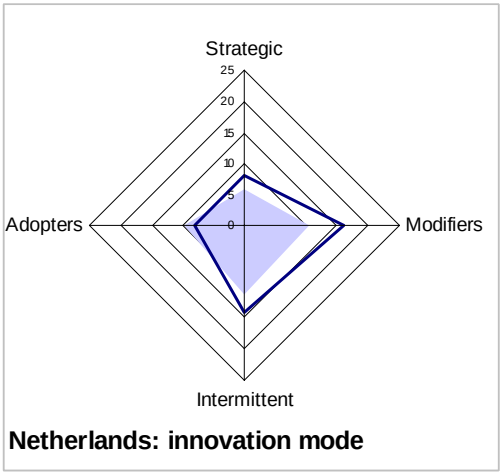
Luxembourg: innovation mode



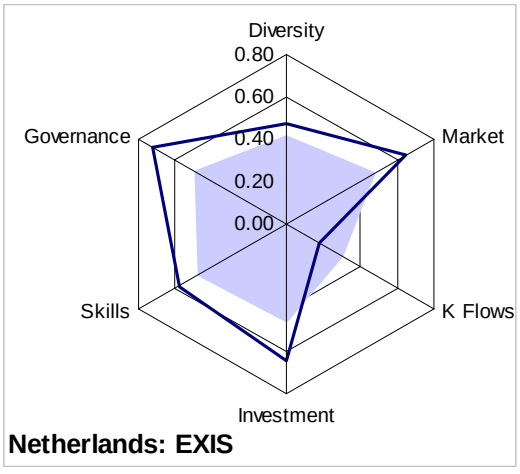
Luxembourg: EXIS

Luxembourg performs comparatively well on innovation mode, with technology adopters replaced by modifiers with greater levels of in-house capabilities. It is only just above the average for strategic innovators. On EXIS, the main problems facing Luxembourg is poor flows of knowledge from other countries, which could be crucial given the small size of the Luxembourg economy. Investment levels are only average. One of Luxembourg's strengths is an innovation-friendly market, but the economy could be too small for innovative firms in Luxembourg to be able to profit from this advantage.

Netherlands



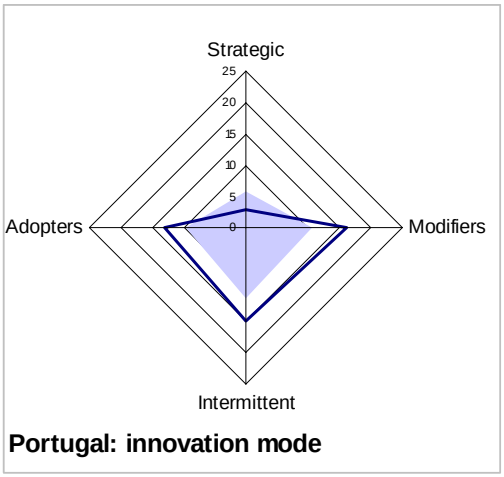
Netherlands: innovation mode



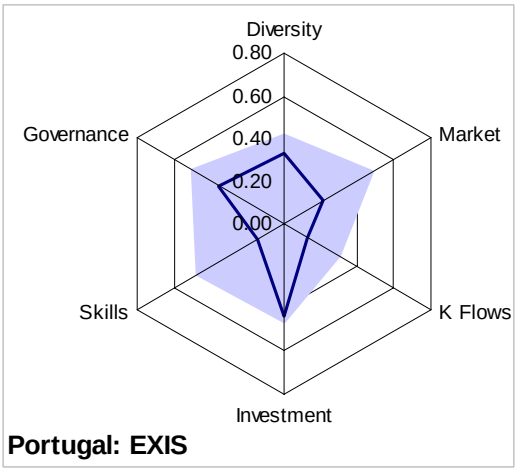
Netherlands: EXIS

The Netherlands does comparatively well on both innovation mode and on EXIS. It has a below average percentage of technology adopters, but this is due to above average shares of the other three types of innovation modes. EXIS performance is well above average on five of the six themes, with the only weakness due to knowledge flows. This is due to poor performance on the use of external knowledge sources, particularly linkages with the public research sector.

Portugal



Portugal: innovation mode

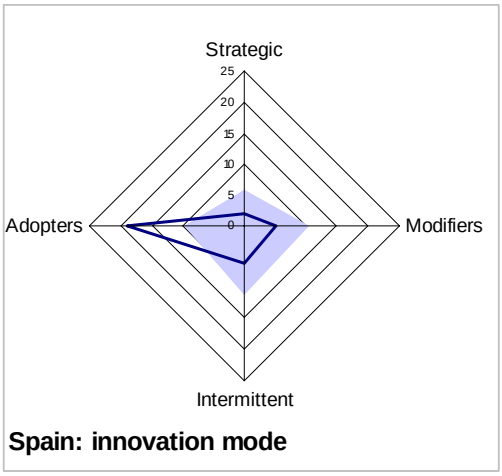


Portugal: EXIS

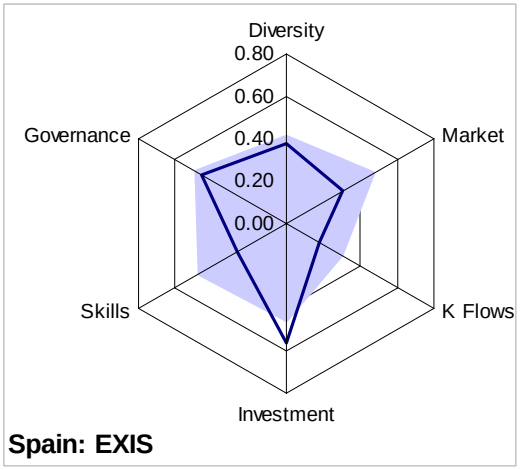
For innovation mode, Portugal has an above average share of adopters, modifiers, and intermittent innovators. The challenge is to increase the share of strategic innovators that rely on innovation as a core business strategy. This is unlikely to happen until some of the structural conditions are improved, such as a marked improvement in the supply of skills and better governance. Portugal also has a below average score for knowledge flows due to an undeveloped public research sector and comparatively low

levels of knowledge transfer through foreign investment. The domestic market is hampered by unsophisticated customers that are not interested in innovative products.

Spain



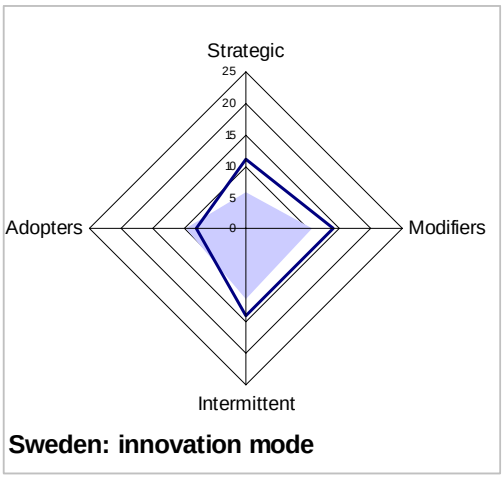
Spain: innovation mode

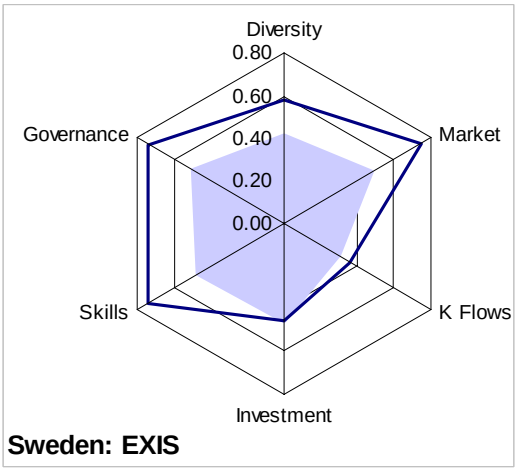


Spain: EXIS

The results for innovation mode show that Spain's innovative capabilities are strongly dominated by technology adopters, with weak results for in-house capabilities. Although investment rates are above average and governance and diversity are close to the EU average, Spain lags behind in skills, knowledge flows, and an innovation friendly market. The poor results for knowledge flows are due to an underdeveloped public research sector and little international collaboration. A major problem for the development of skills is a very low percentage of 'learning jobs', possibly due to a reliance on hierarchical organisational forms.

Sweden





Along with Finland, Sweden is a star performer on both innovation mode, with good performance on three modes that stress in-house capabilities, and on EXIS. The only comparable weakness in EXIS is for investment, which is only at the EU average, and for knowledge flows, which is above the EU average but less developed than other themes. A remarkable result is the high innovation friendliness of Sweden's domestic market.

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Annex A: Tables

Table A. Indicator definitions, sources and reference year		
Indicator	**Source**	**Ref year**
Theme 1: Innovation Diversity		
1. Percentage of all firms that are strategic innovators	CIS-3	2000
2. Percentage of all firms that are intermittent innovators	CIS-3	2000
3. Value-added as a percent of turnover	STAN	2002
4. Percentage of all firms that are non-technical innovators (introduced an organizational, design or advanced management technique)	CIS-3	1998 - 2000
5. Percentage of firms that applied for one or more patents	CIS-3	2000
6. Number of domestic community trademarks per million population	WIPO	2001
7. Number of domestic industrial designs per million population	WIPO	2001
Theme 2: Innovation friendly market		
1. Percentage of total population under age 25	SBS population statistics	2001
2. Average time to sales takeoff for consumer products	Tellis et al, 2003	1950 - 1994
3. Index for the sophistication of local buyers (actively seeking the latest products, technologies, and processes)	World Economic Forum (table 8.04)	2003
4. Percent of innovative and non-innovative firms (separately) that give a high importance to a lack of customer responsiveness to new goods or services as a barrier to their ability to innovate.	CIS-3	1998 - 2000

Table A. Indicator definitions, sources and reference year

Indicator	Source	Ref year
Theme 3: Knowledge flows		
1. Percentage of all firms collaborating internationally on innovation	CIS-3	1998 - 2000
2. Share of all firms finding higher education knowledge sources to be of medium or high importance to their innovation activities.	CIS-3	1998 - 2000
3. Share of all firms giving a high importance to at least one external source of knowledge for their innovation activities.	CIS-3	1998 - 2000
4. Transnationality Index (indicator of inward flows of embodied and tacit knowledge) for 2000 (average of FDI inflows as a percent of gross fixed capital formation 1998-2000, FDI inward stock as a percent of 2000 GDP, value added of foreign affiliates as a percent of GDP in 2000, and employment of foreign affiliates as a percent of total 2000 employment	UNCTAD, World Investment Report 2003	1998 - 2000
Theme 4: Innovation investment		
1. Composite index for finance availability based on loan access and venture capital availability	World Economic Forum, 2004	2003
2. Gross investment in machinery and equipment as a percentage of total value added	SBS	2002
3. Share of firms that receive public subsidies to innovate	CIS-3	1998 - 2000
4. Policy uptake rate, or average percent of all eligible innovation support programmes used by innovative SMES (20-499 employees)	Innobarometer 2004	2004
5. Percent of innovative and non-innovative firms (separately) that give a high importance to either innovation costs or lack of finance as a barrier to innovate.	CIS-3	1998 - 2000

Table A. Indicator definitions, sources and reference year

Indicator	Source	Ref year
Theme 5: Innovation skills		
1. Percent private sector employees whose job requires continual learning. From the Third European WCS of 8081 randomly selected individuals in all EU-15 countries. Private sector employees are divided into four groups depending on their job characteristics: learning, lean production, Taylorism, and traditional/craft.	Working Conditions Survey, Lorenz 2003	2000
2. Percent of all employees with higher education	CIS-3	1998 - 2000
3. Percentage of employees that have participated in Continuing Vocational Training (CVT), defined as training measures or activities financed by the enterprise, partly or wholly, for employees with a working contract.	CVTS	1999
4. Average hours of CVT per employee.	CVTS	1999
Theme 6: Innovation governance		
Indicator	**Source**	**Ref year**
1. Composite index for government waste based on responses to 1) do government subsidies to business in your country keep uncompetitive industries alive artificially or do they improve the productivity of industries?, 2) how common is the diversion of public funds to companies, individuals or groups due to corruption?, and 3) how high is the public trust in the financial honesty of politicians? The higher the number of the index, the *less* waste. Therefore, we could call this a government efficiency index.	World Economic Forum, 2004	2003
2. Composite index for innovation policies based on measures of the 1) effectiveness of IPRs, 2) size and availability of R&D tax credits and subsidies (3.07), 3) costs of tariff restrictions.	World Economic Forum, 2004	2003
3. Composite index for the cost of starting a business based on four indicators (number of procedures, time in days, cost as a percentage of average income, minimum capital required as a percentage of average income)	World Bank	2003
4. Composite index for domestic product regulation (inward oriented policies), including economic and administrative regulation.	Nicoletti et al (OECD)	1998
5. Percent of all firms that give a high importance to environmental benefits from technical innovation.	CIS-3	2000

Table B. Indicator data for all NACE sectors

		Mode of innovation					1. Innovation diversity					2. Innovation friendly market				
	No indi-cators	strategic	Intermittent	Tech modifiers	Tech adopters	Non – innovator	High growth innov	% non tech innov:	% patent:	trademark applications	Industrial design applications	Youth pop share	Sales take-off	buyer sophisti-cation	all innov: cust response	% all non-innov: cust response
		0.1	0.2	0.3	0.4	0.5	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4aa	2.4ab
BE	**27.0**	7.0	13.0	16.0	14.0	50.0	91.1	51.0	8.0			29.7	5.1	5.5	4.9	4.2
DK	**25.0**		16.0	7.0	21.0	56.0	80.0	27.0	6.5	680.4	92.0	29.9	3.8	5.7		
DE	**29.0**	10.0	15.0	25.0	11.0	39.0	126.7	66.0	11.2	773.5	642.1	26.8	6.4	5.0	6.4	10.0
EL	**27.0**	4.0	9.0	5.0	10.0	72.0	111.1	59.0	1.9	535.9		29.2	9.0	4.6	9.3	10.8
ES	**28.0**	2.0	6.0	5.0	19.0	67.0	108.9	47.0	4.9	1820.4	64.7	28.8	7.1	5.0	10.9	9.3
FR	**29.0**	8.0	12.0	10.0	11.0	59.0	68.9	25.0	14.0	1022.4	100.3	31.8	7.4	5.4	1.9	1.7
IE	**16.0**								10.7	235.4	31.5	38.8	4.8	5.1	10.8	
IT	**26.0**	6.0	12.0	15.0	4.0	64.0	88.9	50.0	5.9			25.8	6.7	5.2	5.2	9.4
LU	**21.0**	7.0	17.0	20.0	4.0	52.0	100.0	74.0	4.3			30.5		5.6	4.8	4.4
NL	**27.0**	8.0	14.0	16.0	8.0	55.0	77.8	40.0	6.5			30.4	5.4	5.4	2.5	0.8
AT	**28.0**	8.0	12.0	20.0	9.0	51.0		59.0	9.0	938.4	287.3	28.8	5.9	4.6	4.9	6.7
PT	**29.0**	3.0	15.0	16.0	13.0	54.0	73.3	52.0	4.1	697.8	20.9	30.5	9.3	4.8	7.9	12.1
FI	**29.0**	13.0	19.0	10.0	3.0	55.0	104.4	48.0	10.2	554.2	67.4	30.8	4.6	5.9	3.1	0.0
SE	**28.0**	11.0	14.0	14.0	8.0	53.0		46.0	16.0	734.8	123.4	29.9	4.3	6.0	4.6	3.1
UK	**19.0**								6.1	860.7	61.8	31.0	8.5	5.9	13.8	11.4
CH	**11.0**									1059.7	92.8	28.9	5.3	5.3		
IS	**19.0**	4.0	10.0	7.0	34.0	45.0	44.4	56.0	2.8		45.3	38.3		6.2	1.5	0.0
NO	**28.0**	5.0	12.0	15.0	4.0	64.0	82.2	39.0	7.0	734.0	72.2	32.0	4.0	5.5	4.0	4.3
US	**12.0**									636.4	39.0	35.3		6.1		
JP	**11.0**									822.2	292.1	29.4		5.7		
BG	**10.0**									444.5	53.3	29.3		3.7		
CY	**2.0**											38.1				
CZ	**25.0**	5.0	7.0	3.0	15.0	70.0	100.0	41.0	2.5	792.3	40.8	31.2		4.8	4.1	5.9
EE	**22.0**	5.0	12.0	8.0	12.0	64.0	108.9	54.0	4.0	668.6	15.4	32.3		5.1	9.6	10.2
HU	**25.0**	4.0	6.0	7.0	6.0	77.0	113.3	31.0	2.0	466.7	46.8	31.1		4.5	15.5	0.4
LT	**23.0**	1.0	11.0	4.0	11.0	72.0	124.4	32.0	1.9	380.6	17.0	34.1		4.5	5.5	6.9
LV	**19.0**	2.0	8.0	4.0	6.0	81.0	133.3	37.0		452.7	23.4	31.7		4.9		
MT	**7.0**									994.9	12.7	34.9		4.8		
PL	**13.0**									325.1	32.0	35.8		4.5		
RO	**23.0**	3.0	8.0	4.0	2.0	83.0	117.8	78.0	1.3	246.1	36.3	34.0		3.6	3.6	8.0
SI	**23.0**	8.0	8.0	4.0	1.0	79.0	35.6	53.0	2.1	506.0	37.1	30.2		4.9	6.2	10.1
SK	**19.0**	3.0	6.0	4.0	7.0	80.0	137.8	12.0		401.2	28.8	36.2		4.9		

Table B. Indicator data for all NACE sectors (continued)

	3. Knowledge everywhere				4. Invest in innovation						5. Skills for innovation				6. Innovation governance				
	Int. collab.	higher educ sources	external Knowldge sources	Transnat index	Finance avail index	Gross invest mach equip as % VA:	Firms w subsidies:	Policy uptake rate by SMEs	H imp lack of finance	all non-innov: H imp lack finance	Percent learning jobs	% emps with higher ed:	particp in CVT:	Hours CVT training	Gov. waste index	Inno policy index	cost of starting a business	market regulation	enviro innov effects
	3.1a	3.2a	3.3a	3.4	4.1	4.2	4.3	4.4	4.5a	4.5b	5.1	5.2	5.3a	5.4a	6.1	6.2	6.3	6.4	6.5
BE	7.5	8.0	28.0	76.0	4.2	21.5	11.5	10.1	10.4	6.3	38.9	21.0	41.0	13	3.9	5.2	0.68	2.6	10.0
DK		6.7	27.4	36.0	4.8	22.6	4.0	12.1			60	5.7	53.0	22	5.6	5.2	0.92	1.9	6.7
DE	2.3	8.2	23.0	19.0	3.6	20.8	7.7	9.2	23.7	17.7	44.3	15.0	32.0	9	3.7	5.3	0.38	1.9	4.7
EL	0.0	10.1	48.2	8.0	3.7	26.4	22.9	17.5	33.0	26.1	18.7	12.8	15.0	6	3.3	4.5	0.24	2.8	21.6
ES	2.7	6.7	34.8	17.0	4.0		18.3	16.2	19.8	12.6	20.1	13.9	25.0	11	4.1	4.8	0.52	2.1	14.1
FR	8.9	6.5	30.1	11.0	4.3	21.8	14.9	11.3	7.7	5.7	38	14.6	46.0	17	3.6	5.4	0.71	2.6	13.0
IE				47.0	4.9			14.1	15.5		24		41.0	17	3.6	5.0	0.94	1.1	
IT	2.6	3.8	23.0	6.0	3.7	21.1	26.0	11.5	16.1	12.0		6.4	26.0	8	3.2	4.6	0.70	3.4	17.9
LU	18.2	4.7	33.3		4.9		8.0	7.2	8.8	4.0	42.8	24.6	36.0	14	5.4				8.3
NL	7.7	4.4	18.7	34.0	4.7	23.2	17.8	13.8	6.9	2.5	64	8.3	41.0	15	5.1	5.3	0.78	1.8	10.5
AT	6.6	7.7	22.4	15.0	3.5	23.5	20.1	20.8	19.7	17.6	47.5	5.1	31.0	9	4.5	5.2	0.64	1.8	6.1
PT	4.3	4.9	28.1	13.0	3.8	30.3	15.9	9.6	26.0	23.4	26.1	8.1	17.0	7	2.8	4.7	0.55	2.1	11.3
FI	14.3	11.6	22.0	16.0	5.3	21.3	23.0	16.3	8.1	0.0	47.8	29.6	50.0	18	5.8	5.6	0.87	2.3	4.4
SE	10.6	12.2	33.9	35.0	4.8	18.6	10.3	9.1	11.9	6.4	52.6	15.8	61.0	18	4.8	5.1	0.92	1.7	8.0
UK				19.0	5.2	13.8		14.0	20.9	14.3	34.8		49.0	13	4.8	5.4	0.91	0.3	
CH				17.0	3.9										4.7	4.9	0.84	2.1	
IS	5.9	2.3	9.9		4.0		3.9		7.5	0.0		25.6	48.0	16		4.9	0.88		2.3
NO	11.5	7.7	37.8	14.0	4.7	19.5	14.0		14.3	4.7					4.6	4.8	0.88	2.2	8.3
US				9.0	5.0	14.4									4.4	5.5	0.96	1.0	
JP				1.0	2.9								13.0	4	3.0	5.0	0.67	1.8	
BG				18.0				20.0							2.3	3.4	0.62		
CY					2.6			7.1					42.0	10					
CZ	7.0	9.8	41.3	24.0	3.1	30.5	8.6	7.9	7.6	4.9			19.0	6	2.6	4.1	0.51		10.5
EE	16.0	5.8	31.4	25.0	3.9		4.3	10.9	27.6	29.4			12.0	5	3.9	4.4			8.3
HU	18.5	24.6	66.2	28.0	3.3	25.9	23.9	8.9	26.8	1.6			10.0	4	3.5	4.5	0.34		37.7
LT	23.0	31.0	25.9	13.0	4.4		5.6	5.5	1.7	4.3			12.0	4	2.9	4.1	0.73		9.4
LV	26.7	8.9	41.3	17.0	4.5			13.6							3.9	4.2	0.75		11.3
MT					3.2			10.6					16.0	4	4.0	4.1			
PL				13.0	3.3	22							8.0	3	2.7	3.9	0.67		
RO	11.6	13.3	49.0	10.0	3.1		8.3	11.3	29.8	31.5			32.0	8	2.0	2.8	0.84		23.2
SI	23.7	18.2	52.1	8.0	3.4		15.4	11.3	24.1	25.1					3.7	4.6	0.58		17.4
SK	13.6	9.6	34.4	12.0	3.3	33.4		13.7							2.7	4.0	0.49		8.0

Table C. Available Indicators by sector

	All sectors	Manufacturing	Services
Theme 1: Innovation diversity			
1. Strategic innovators	MS	M	S
2. Intermittent innovators	MS	M	S
3. Share of high growth innovators	MS	M	S
4. Non technical innovators	MS	M	S
5. Percent firms applying for at least one patent	MS	M	S
6. Trademarks per million population	All	All	All
7. Industrial design per million population	All	All	NR
Theme 2: Innovation friendly market			
1. Percent population under 25	All	All	All
2. Time to sales take-off	All	All	All
3. Index for sophistication of local buyers	All	All	All
4. Lack of customer response to innovations	MS	M	S
Theme 3: Knowledge flows			
1. Percent firms collaborating internationally	MS	M	S
2. Higher education knowledge sources important	MS	M	S
3. High importance of external knowledge sources	MS	M	S
4. Transnationality index	All	All	All
Theme 4: Innovation investment			
1. Index for finance availability	All	All	All
2. Gross investment in machinery and equipment	MS	M	S
3. Receipt of public subsidies to innovate	MS	M	S
4. Policy uptake rate for SMEs	All	All	All
5. Lack of finance/costs as a barrier to innovate	MS	M	S
Theme 5: Innovation skills			
1. Private sector employees with learning jobs	All	All	All
2. Employees with higher education	MS	M	S
3. Employee participation in CVT	MS	M	NA
4. Average hours of CVT per employee	MS	M	NA
Theme 6: Innovation governance			
1. Index of government waste	All	All	All
2. Index for innovation policies	All	All	All
3. Index for cost of starting a business	All	All	All
4. Index for domestic product regulation	All	All	All
5. Importance of environmental innovation	NR	NR	S

MS = calculated from separate data for manufacturing and service sectors; M = manufacturing sector only, S = service sector only, All = data do not differentiate by sector, NA = data not available, NR = not relevant.

Annex B: Innovation Modes

TrendChart, in collaboration with Eurostat, classified all innovative CIS respondent firms into four mutually exclusive innovation modes (there is also a fifth group for non-innovators). The classification system is dependent on the types of variables available in the CIS and is limited to variables with a reasonably high response rate. Consequently, the four innovation modes do not cover all types of innovation of interest to policy and it is certainly possible to imagine better classification systems.

The classification system for innovation modes is based on two main criteria: the level of novelty of the firm's innovations, and the creative effort that the firm expends on in-house innovative activities. The most novel innovations are assumed to require R&D, but R&D is not essential for intermittent innovators. There are clear shortfalls in this distinction, since firms can develop exceptional innovations without R&D, but the CIS lacks the information required to identify these firms (as discussed below).

As an example of an important limitation, the four modes are limited to technological product and process innovation. Firms that largely innovate via organizational and logistical methods, such as Wal-Mart or Dell Computers in the United States, would probably be classified as non-innovators (Wal-Mart) or as intermittent innovators (Dell).

The classification system
The assignment of each innovative respondent CIS-3 firm to one of four innovation modes depends on each firm's responses to up to eleven questions or variables. The name of each variable, and its description, are given in Table A-1. Not all variables are used in each assignment, but there are four key factors:

1. Whether or not the firm developed a product or process innovation through some in-house activities (InpdtW or InpcsW equals 1 or 2).

2. Whether or not the firm performed R&D (rrdIN = 1), and if yes if this was on a continuous (rrEng = 1) or occasional (rrEng = 2) basis.

3. Whether or not the firm competes on national or international markets where there is likely to be greater competition than on local or regional markets (SigMar = 3 or 4).
4. Whether or not the firm has introduced at least one product that is new to its market (InMar = 1).

Table B-1. CIS-3 variables for calculating innovation modes

Variable	Description
InOn	1 = firm had ongoing innovation activities
InAB	1 = firm had abandoned innovation activities
Inpdt	1 = Introduced a new or significantly improved product
InpdtW	How the product innovations were developed: 1 = mainly by the firm or its group 2 = in cooperation with other firms 3 = mainly by other firms or institutions
Inpcs	1 = Introduced a new or significantly improved process
InpcsW	How the process innovations were developed: 1 = mainly by the firm or its group 2 = in cooperation with other firms 3 = mainly by other firms or institutions
RrdIn	1 = performs in-house R&D
RDEng	Type of engagement in R&D 1 = continuously 2 = occasionally
SigMar	Firms most significant market 1 = local 2 = local/regional 3 = national 4 = international
InMar	1 = firm introduced new or improved products that were new for its market
Co	1 = firm had collaborative activities for innovation

The description of each innovation mode is as follows:

Strategic innovators (21.9% of all innovative firms): These firms have introduced a product or process innovation (Inpdt = 1 or Inpcs = 1) that they developed at least partly in-house (inpdtW = 1 or 2 or inpcsW = 1 or 2), they perform R&D on a continuous basis (RrdIn = 1 and RdEng = 1), they have introduced at least one product that is new to their market (InMar = 1), and they are active in national or international markets. These firms will be the source of many innovative products and processes that are adopted by other firms throughout their domestic economy and internationally.

Intermittent innovators (30.7% of all innovative firms): All of these firms develop innovations at least in part in-house (inpdtW = 1 or 2 or inpcsW = 1 or 2) and have introduced new-to-market innovations (InMar = 1). But, they are unlikely to develop innovations that diffuse to other firms. The class includes three sub-groups:

1. The firms meet the identical requirements of the key creative innovators except that they only perform R&D on an occasional basis (RdEng = 2). This group would include firms that innovate in-house intermittently when required by a new product line. One example would be small firms that supply components to major assemblers. These small firms, often with the assistance of their customer, would innovate as needed in response to a request for improved quality or functional characteristics of their products.
2. Continuous R&D performers that are only active on local or regional markets are also classified as second-stream innovators. These firms probably make only minor adjustments to products or processes that are largely acquired from other firms.
3. Firms that do not perform R&D but which have introduced new-to-market innovations to a national or international market. The novelty of their innovations is likely to be at least as high as the first two categories since the innovation must compete in a larger market.

Technology modifiers (26.3% of all innovative firms): All of these firms have developed an innovation at least in part in-house (inpdtW = 1 or 2 or inpcsW = 1 or 2) but none of them perform R&D. They differ from the final group of technology adopters by having some in-house innovative activities. If they are active on national or international markets, they have not introduced a new to market innovation (otherwise they would be classified as a second-stream innovator). If they are active in local and regional markets, they may have introduced a new to market innovation and have slightly modified it for this market. Many firms that are essentially process innovators that innovate through production engineering probably fall within this group.

Technology adopters (21.0% of all innovative firms): All of these firms have innovated, but depend on adopting innovations developed by other firms (inpdtw = 3 and/or inpcsw = 3). These firms innovate through diffusion.

Firms that only have unfinished or abandoned innovation activities (InOn = 1 or InAb = 1) are also assigned to each of these four innovation modes, using the variables for R&D (RrDin and RdEng). In addition, there are complex routines to deal with missing data for each variable. When no information is available for both inpdtW and inpcsW, information on innovation collaboration (Co) is used as a proxy. In general, when information is missing, the criteria for reaching the highest level are stricter (key creative versus second-stream etc).

The main limitation with this classification system is the assignment of the third group of intermittent innovators. Some of these firms could develop key innovations through non-R&D based activities, while others could differ very little from the technology modifiers, particularly if they are active in an undeveloped national market. Firms that meet these criteria are assigned to the intermittent group by default – there is not enough evidence in CIS-3 to assign them to the strategic innovator mode or enough evidence to assign them to the technology modifier mode.