



TrendChart
Innovation Policy in Europe

2006 Trend Chart Methodology Report

Searching the forest for the trees: “Missing” indicators of innovation

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The information contained in this report has not been validated in detail by either the Member States or the European Commission.

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1. Introduction

This is the fifth Trend Chart methodology report. Each methodology report has a specific focus, for example the 2005 report evaluated the methodology of constructing composite indicators and provided a re-assessment of the indicators included in the flagship Trend Chart product, the European Innovation Scoreboard (EIS). The assessment was linked to the composite indicator analysis and sought to determine if there were redundancies in the EIS indicators or areas within each of the main themes that were not fully captured. The 2006 Methodology Report builds on the latter aspect of the 2005 report. The goal is to further explore the different dimensions of innovation and to identify areas that are not covered in the EIS. We both review past Trend Chart research on different aspects of innovation and investigate new areas where indicators could be included into Trend Chart.

The Trend Chart project is proactive – the thematic reports and the EIS are designed to provide indicators and analysis that are relevant to current policy concerns. For example, the selection of EIS indicators for the drivers and characteristics of innovation is partly determined by the policy relevance of these indicators – does the indicator cover a characteristic that can be influenced by policy? As an example, the EIS includes indicators on collaboration as part of the circulation of knowledge, but it does not include an indicator for the importance of supplier/customer linkages. This is because European policy can influence collaboration, but it has very little influence on value-added chains.

The policy influence on the EIS itself is constrained by the need to provide an accurate measure of the innovative capabilities of each EU member state. Consequently, much of the policy analysis has occurred in supplementary thematic reports, such as the 2003 report on National Innovation Systems (NIS), or the 2004 EXIS report. Over time, valuable indicators that have appeared in supplementary reports have been included in the EIS.

The most recent and influential European policy document is the Aho Report¹, which summarizes the results of an Expert Group on how to reinforce European research and innovation performance. The report was published in January 2006 for the Spring European Council.

A core recommendation of the Aho Report is ‘the need for Europe to provide an ‘innovation friendly market for its businesses’. This requires policy actions on ‘regulation, standards, public procurement, intellectual property and fostering a culture which celebrates innovation’. Rather than stressing innovation inputs such as R&D, the Aho Report stresses innovation demand, both from markets and from government procurement, and the myriad of socio-cultural factors that encourage innovation, such as entrepreneurship, risk taking, flexibility and adaptability, and mobility.

Both demand for innovative products and processes and socio-cultural factors that support innovation were covered in the 2003 NIS report and in the 2004 EXIS report. The Aho report suggests that we should revisit these issues and determine if it is

¹ Creating an Innovative Europe: Report of the Independent Expert Group on R&D and Innovation, appointed following the Hampton Court Summit, January 2006, <http://europa.eu.int/invest-in-research/>.

possible to include relevant indicators in future editions of the EIS. We also evaluate other aspects of innovation that might not be adequately covered in the EIS or in supplementary Trend Chart reports.

2. Innovation Theory, Policy, and Indicator Needs

Up until the 1980s, innovation research was largely limited to case studies or data on the creation of new knowledge, as measured by R&D investments, scientific publications, patented inventions, and the stock of scientists and engineers. The dominant perspective viewed innovation as synonymous with R&D to develop technical inventions. Theories of innovation were frequently based on linear science-push models in which inputs of R&D or scientists led to outputs of publications or patents².

In the early 1980s, the re-discovery of Schumpeterian theories led to the development of modern innovation theory based on a broader perspective of innovation. Schumpeter separated invention from innovation and limited the latter to the commercialization of a new product or the implementation of a new process. This definition created two major differences with science push models. First, inventions must be tested in the market for their potential economic value. This introduced demand as a key factor in the innovation process. Second, firms can innovate with limited or even no creative effort on their part, as when a firm purchases new production technology. This highlighted the need for data on actual outputs, such as the diffusion and adoption of new products or productivity enhancing processes. It also raised a lot of questions about the drivers of innovative activity and the innovative strategies that firms use to manage the steps between invention (or technology adoption) and the market. However, there was a lack of high quality data to test Schumpeterian theories of innovation, with most empirical research limited to studies of the diffusion of specific technologies. Innovation outputs and strategies were only addressed in a few small-scale surveys³ or case studies.

One of the main goals of innovation surveys based on the Oslo Manual, such as the four European Community Innovation Surveys (CIS) to date was to provide useful data on the full range of innovative activities undertaken by firms, including both R&D and the many other ways in which firms can innovate. Research using the first CIS⁴ in 1993 provided empirical confirmation of modern innovation theories that stressed the importance of diffusion and incremental innovation. This research also noted that innovation was widespread, rather than concentrated among a small number of R&D performing firms the ‘high technology’ sectors (Smith, 2005).

A few examples of some of the early research using the CIS illustrate these points. Evangelista et al (1997), using CIS-1 data, found that diffusion processes based on technology acquisition accounted for a much higher share of total innovation

² Griliches (1990) provides an excellent review of this approach, including its usefulness for assessing the impacts of R&D and patents on wider economic trends such as total factor productivity.

³ Examples include small-scale surveys of the patenting behaviour of American firms (Mansfield, 1986).

⁴ As an example, see the collection of summary papers for European Commission’s 1996 conference ‘*Innovation Measurement and Policies*’, which provided a showcase for many of the first analyses of the CIS-1 (Arundel and Garrelfs, 1997).

expenditures than R&D, which accounted for only 20% of total expenditures for innovation. In comparison, capital investment in new equipment accounted for 50%, trial production for 11%, production design for 10%, and other activities for 9%. The importance of innovation as diffusion is also shown by the CIS-2 results for the share of all sales from innovative products. In manufacturing, 31% of turnover was from products that were new or improved for the enterprise, while only 7% was from products that were new or improved for the firm's market (Foyn, 1999). The gap of 24% shows the importance of innovation as diffusion, since the 24% difference is due to products that were previously developed by other firms or institutions and marketed elsewhere.

Innovation as diffusion is probably even more important in the service sectors that account for between 60% and 73% of value-added in the EU. Tether's (2001) analysis of the CIS-2 in the UK found that service firms that developed an innovation either in-house or via collaboration spent a higher percentage of their innovation budget on technology acquisition (54%) than equivalent manufacturing firms (40%)⁵.

One implication of the CIS results, combined with data on the industrial structure of European countries, is to highlight the fact that a marked increase in innovative capabilities in Europe requires both increasing R&D and the innovative capacity of low and medium technology manufacturing sectors, the service sectors, and the public sector. Innovation in these sectors is strongly influenced by diffusion and using existing knowledge in new ways, rather than creating new knowledge (EC, 2004).

Surprisingly, the implications of modern innovation theory and the early CIS results have not been fully adopted by the policy community and by academics interested in innovation. Both groups continue to think of innovation as primarily based on *invention*, with R&D the key factor. Although the European policy community has consistently stressed the central role of innovation to European competitiveness, a close reading of many major policy documents shows that the concept of innovation in use is primarily that of R&D activities⁶.

There are several reasons why the policy community has failed to fully adopt modern innovation theory. Perhaps the most important reason is that the main innovation policy instruments in all European countries either subsidize R&D or are linked to R&D, such as support for intellectual property rights or the commercialisation of inventions made in public research institutions. A second reason is that the main indicators for measuring innovation inputs and outputs are also linked to R&D, including indicators based on patent counts and R&D expenditures. This problem also affects the EIS. Due to a lack of good diffusion indicators, the EIS provides considerably better coverage of innovation as a creative activity than innovation as a process of diffusing new technologies and knowledge.

⁵ Tether also reports that firms spent very little on training directly linked to innovation, suggesting that most acquired technologies could be absorbed 'with ease'.

⁶ The countless announcements of the death of the science-push or linear model of innovation, based on R&D, and its presumed replacement with 'systemic' models using Schumpeterian definitions of innovation, are decidedly premature. The science-push model based on R&D is probably the dominant model in use today by both academics and the policy community. Its continued success is partly due to its successful incorporation of many of the features of modern innovation theory. These include shifting final outputs from patents to market indicators and evaluating the effect of a range of business strategies. The disadvantage is that this model largely ignores innovation that is not based on R&D.

The Strata – Foresight report on *European Research and Innovation Policy* provides a useful overview of both innovation policy and innovation theory over the past 30 years and points to several areas of weakness in policy and in indicators (EC, 2004). The report argues that policy needs to support four features of innovation: 1) the supply of knowledge, particularly through R&D subsidies; 2) diffusion, with the need to create links between the production of knowledge and its use, 3) demand for innovation, and 4) systemic networks and clusters. With the exception of indicators for the supply of knowledge, each of the other three features of innovation is poorly covered by currently available indicators, with many gaps or ‘missing’ indicators. We would also argue that diffusion is dependent on other factors such as entrepreneurship, venture capital and innovation management, and that organisational innovation is an important driver of productivity improvements.

3. “Missing” Indicators

Our ability to assess national (and sectoral) innovation performance is hampered by a limited number of indicators for several important facets of innovation activities: the diffusion of productivity-enhancing technologies, entrepreneurship, organisational innovation, and demand conditions. In addition, national innovative performance could be influenced by systemic factors that have been receiving a substantial amount of policy interest, including human mobility and the commercialization of publicly-funded research. These factors are systemic because they encourage far-reaching linkages between different parts of an innovation system. A final area where there is a marked lack of data is innovation in the public sector, even though this sector accounts for over 30% of GDP in many EU countries.

In this section we evaluate several possible methods of filling in the gap for missing indicators. One option is to reanalyze the CIS to create new indicators. Although we suggest several possible methods of creating new indicators from the CIS, *all such indicators would need to be carefully evaluated to determine their robustness and to ensure that they add a new dimension to existing indicators*. In addition, we identify alternative indicators from other sources that might either fill the gap or be used as a model for future surveys. Annex Tables 1 to 3 summarize the suggestions for new indicators.

3.1 Innovation diffusion

As noted in section 2, a long-standing problem is that available innovation indicators largely measure inputs such as R&D, or intermediate outputs of R&D such as patents. Innovation surveys based on the Oslo Manual, including the CIS, were developed to correct this problem, but the indicators derived from these surveys still focus on R&D-based activities to create new products and processes (Salazar and Holbrook, 2004).

There are two aspects of innovation diffusion that are important: the uptake and successful adoption of new technology by firms and by the public sector (embodied technology diffusion), and the diffusion of knowledge, such as the capabilities to efficiently use new technology (disembodied knowledge diffusion).

Disembodied knowledge diffusion is partially covered in the EIS by the educational indicators (group 1) and by indicator 3.2 on the percentage of SMEs that collaborate with other organizations over innovation. However, the educational indicators are not a direct measure of knowledge diffusion, as they only capture the opportunity for firms to employ individuals with the capacity to apply new technology. The CIS indicator for collaboration captures knowledge diffusion for creative innovation processes within the firm, rather than the development of ‘absorptive capacity’, which may or may not be linked to creative innovation.

3.1.1 Disembodied knowledge diffusion

As shown in Figure 1 for product innovations, the CIS questions on ‘who’ innovates (asked in CIS-4 for both product and process innovations) can provide a measure of the share of firms that rely on the diffusion of knowledge for creative innovation (second item ‘your enterprise together with other enterprises or institutions’). The question would be more suitable as a diffusion indicator if it asked the respondent to tick *all* appropriate boxes, rather than selecting one option only. This would permit one to determine the share of firms that rely, in part, on the sharing of knowledge. This change could be considered for future CIS surveys.

Figure 1

2.2 Who developed these product innovations?		<i>Select the most appropriate option only</i>
Mainly your enterprise or enterprise group		<input type="checkbox"/>
Your enterprise together with other enterprises or institutions		<input type="checkbox"/>
Mainly other enterprises or institutions		<input type="checkbox"/>

An interim indicator for knowledge diffusion, based on the current structure of CIS-4 could be constructed from the percentage of firms that give a positive response to introducing *either* a product or process innovation that was developed by ‘your enterprise together with other enterprises or institutions’ (option 2 in Figure 1) or developed mainly by ‘other enterprises or institutions (option 3 in Figure 1). This will miss firms that mainly innovate in-house, but which also develop innovations together with other firms. One option is to also define firms that give a positive response to the CIS-4 question (6.2) on any form of collaboration: “Did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?”

3.1.2 Embodied knowledge diffusion

The third option in Figure 1 shows that the CIS can be used to identify firms that *only* innovate through the adoption of innovations developed outside their firm (the ‘mainly other enterprises or institutions’ option). Unfortunately, the question does not tell us anything about the success of the innovation to their firm – are they capable of efficiently using it? One option is to combine the results for item 3 with the results of CIS-4 question 7.1 on the effects of innovation (see Figure 2).

For firms that adopt a product innovation from an external source, a response of a ‘high’ degree of an observed effect for either ‘Entered new markets’ or ‘Improved quality’ could be assumed to provide a proxy measure of the firm’s ability to effectively implement adopted product innovations. We exclude the option ‘increased range of goods or services’ because this question provides no information on the

success of an increase in range. For firms that adopt a process innovation from an external source, a ‘high’ response to any of the four process effects could proxy for successful adoption.

Figure 2

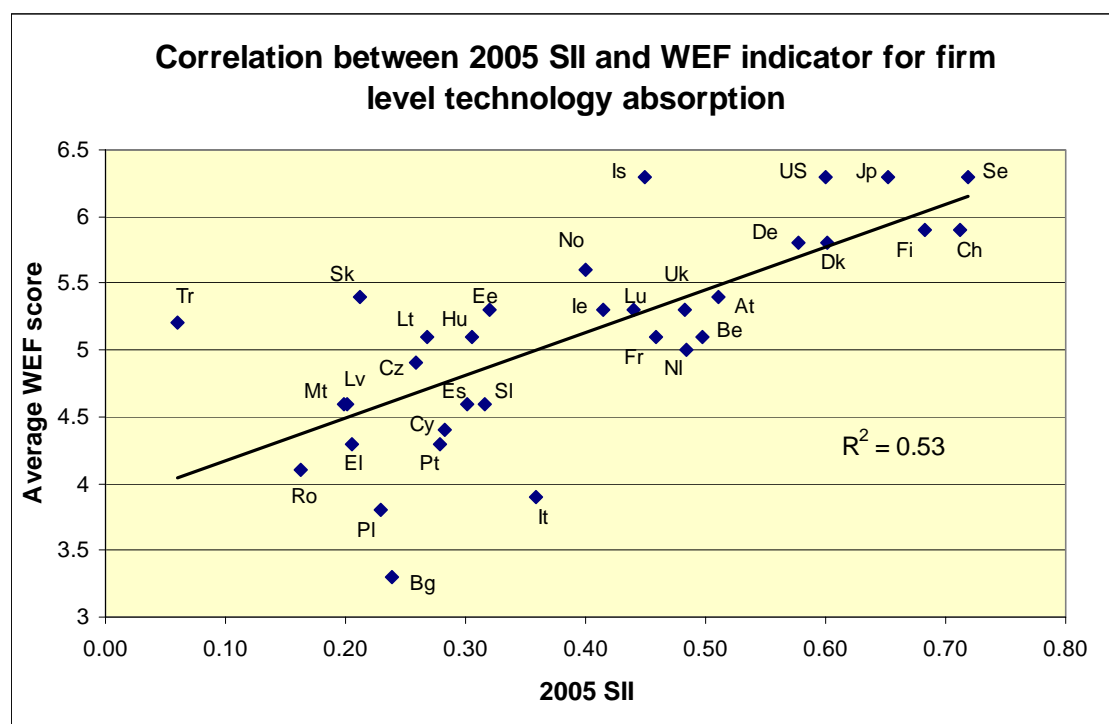
		Degree of observed effect			
		High	Medium	Low	Not relevant
Product oriented effects	Increased range of goods or services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Entered new markets or increased market share	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Improved quality of goods or services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Process oriented effects	Improved flexibility of production or service provision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Increased capacity of production or service provision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Reduced labour costs per unit output	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other effects	Reduced materials and energy per unit output	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Reduced environmental impacts or improved health and safety	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Met regulatory requirements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The World Economic Forum (WEF) published a relevant indicator of embodied knowledge diffusion in its 2005 *Global Competitiveness Report*. The indicator gives the mean score of the CEO answers to the question ‘Companies in your country are (1 = not interested in absorbing new technology, 7 = aggressive in absorbing new technology)⁷. In general, the WEF methodology is problematic because it asks CEOs about conditions in their country, rather than in their firm. Nevertheless the results are intriguing, as shown in Figure 3, which plots the mean score to this question against the 2005 EIS Summary Innovation Index (SII), using results for 33 countries⁸. As shown, there is a positive relationship between the SII measure of innovation capabilities and firm-level technology absorption. Of interest, the variation in the WEF scores is much greater for countries with poor performance on the SII than for countries with good performance. For example, Slovakia (Sk) and Bulgaria (Bg) have similar performance on the SII but differ markedly in their WEF score for interest in absorbing new technology. This type of result, if accurate, would suggest that Slovakia should have fewer difficulties in developing innovative capabilities than Bulgaria. It also suggests that the policy challenge in Bulgaria is first to develop an interest in new technology, possibly through developing a network of innovation centres, whereas in Slovakia the challenge is to ensure sufficient capital for investment and that firms have the in-house knowledge to make good choices in acquiring new technology. These potential benefits for policy development suggest that it would be worthwhile to develop a robust indicator to capture this dimension of innovation.

⁷ See Table 3.02, page 467 of the 2005 *Global Competitiveness Report*.

⁸ The EU-25 plus Bulgaria, Iceland, Japan, Norway, Romania, Switzerland, Turkey and the United States.

Figure 3



For country identifier codes, see Annex Table A4.

3.2 Entrepreneurship

Entrepreneurship is possibly one of the most important drivers of innovation and one of the most difficult to measure. It involves individual attitudes to risk, opportunities that reduce risk, receptiveness to new ideas, and access to capital. Most indicators of entrepreneurship either measure individual attitudes, such as the Flash Eurobarometer measure of attitudes to starting a financially risky business, or attitudes to self-employment. There are no indicators for entrepreneurship within existing firms, such as the rate of formation of new spin-off firms or the rate of introduction of new products (the latter would require a question on the number of significantly new products that were marketed, which might not produce reliable responses). In addition, indicators of individual attitudes to entrepreneurship do not differentiate between establishing a ‘mom and pop’ shop and establishing a firm with an innovative business strategy. For the latter reason, we do not propose using existing indicators of individual attitudes to entrepreneurship, but focus on indicators for the establishment of innovative firms.

3.2.1 Creative destruction

A primary characteristic of creative destruction is the continual entry of new firms and the exit of established firms that no longer provide competitive advantages – or what is called ‘churn’. This process assists productivity growth and increases in value-added from product innovation. Blanchard (2004) provides data to show that one of the main explanations for the rapid improvement of productivity in the United States versus France in the late 1990s was due to much higher churn rates in the retail sector in the United States than in France. New firm formation is part of

entrepreneurship, although firm exit is often dependent on the regulatory environment.

A previous version of the EIS included an indicator for enterprise churn, but this indicator was dropped because the necessary data were only available for a limited number of EU countries⁹. Better coverage would permit this indicator to be used again.

3.2.2 Spin-offs

Although we are not aware of any data on spin-off formation by existing firms, several projects have been conducted in the EU to gather data on spin-offs from universities and research institutes. The OECD (2003) coordinated a pilot survey in 2001 to gather such data in eight EU countries, but the survey was not repeated in a later year. A major problem with the OECD survey was a lack of consistency across countries and the failure to collect adequate data for constructing comparable indicators. This was due to different national groups being responsible for the survey in each country, which led to differences in the survey methodology and questionnaire.

Since the OECD study, two surveys have collected data on European spin-offs from universities and public research institutes by surveying technology transfer offices (TTOs). The PROTON study (Conesa et al, 2004) obtained responses from 16 EU countries, although 57% were from Spain and Italy. They were able to construct an indicator for the number of spin-offs companies created in 2004 per 1,000 academic staff, but they did not provide the indicator by country or an average for the EU. Instead, the indicator is only provided for individual reporting institutes.

In the Spring of 2006, the Association of Science and Technology Professionals (ASTP) ran a survey of members representing public research institutions in order to replicate data obtained on a regular basis by the Association of University Technology Managers (AUTM) for the United States (Arundel and Bordoy, 2006). The survey results show that it is feasible to obtain data on spin-offs at a relatively low cost, but the ASTP membership does not include the majority of European universities and research institutes. The ASTP results permit the calculation of an indicator of the number of spin-offs per million PPP\$ of R&D expenditures, which can be directly compared to equivalent AUTM data, and per 1,000 researchers, which is similar to the PROTON approach. A different indicator, the level of research expenditures required to produce one spin-off, is given in Table 1 for the ASTP and AUTM respondents. Surprisingly, given the widely accepted view that European academics are less entrepreneurial than American academics, the results show that European universities and public research institutes are more efficient at producing spin-offs than their American counterparts¹⁰.

⁹ An indicator for churn can be created from two New Cronos indicators: er081 for new enterprise establishments and er082 for enterprise exits. The total can be standardized by dividing by GDP in millions of Euros. Or we could combine indicators v97010 Birth rate: number of enterprise births in the reference period (t) divided by the number of enterprises active in t and v97110 Death rate: number of enterprise deaths in the reference period (t) divided by the number of enterprises active in t.

¹⁰ This is not due to selection bias. In fact, the AUTM sample for the United States contains a higher proportion of the best-performing American universities in terms of commercialisation activities than the ASTP sample for Europe.

This is an area where there is a strong policy justification for the collection of annual, high quality statistics. A survey of TTOs serving universities and public research institutes should be conducted at the European level because with only about 1,000 universities in Europe, the target population is not large enough to be efficiently surveyed at the national level. Furthermore, a centralized European survey would avoid many of the problems due to national differences in survey design and methodology that plagued the OECD study. Such a survey could also provide many other indicators for the commercialization of publicly funded research (see section 3.8 below).

Table 1. Million PPP\$ in research expenditures in 2004 to create one spin-off from American and European public research institutes

	ASTP (Europe)	AUTM (United States)
Universities only	35.7	90.9
Universities and other public research institutes combined	62.5	90.9

3.2.3 Fast growing gazelles

In addition to the role of entrepreneurship in establishing firms, the policy goal is for these firms to succeed and grow rapidly. The CIS is the only possible source of data that can identify innovative fast-growing firms. The first step is to use the CIS to identify highly innovative SMEs. The second step is to either link the CIS results to financial data sources to identify the ‘gazelles’, or alternatively to use existing CIS information on employment growth. The former option is only available at the National level, but the latter technique could be applied to Eurostat data. Gazelles can be identified as all SMEs in the top quintile of employment or sales growth over a three year period (in CIS-4 between 2002 and 2004).

The difficulty is to define ‘highly innovative SMEs’. We would suggest that it would be more informative to identify different types of highly innovative Gazelles, rather than limit the indicators to fast-growing SMEs with very high R&D intensities (above 5% and above 10%). Instead, indicators for different types of innovative Gazelles should also be constructed, such as Gazelles that score highly on the efficient adoption of new technology (see 3.1.2 above). Depending on national conditions, the fastest growing Gazelles might be R&D intensive, technology adopters, or possibly firms that rely heavily on knowledge diffusion over in-house creative activities.

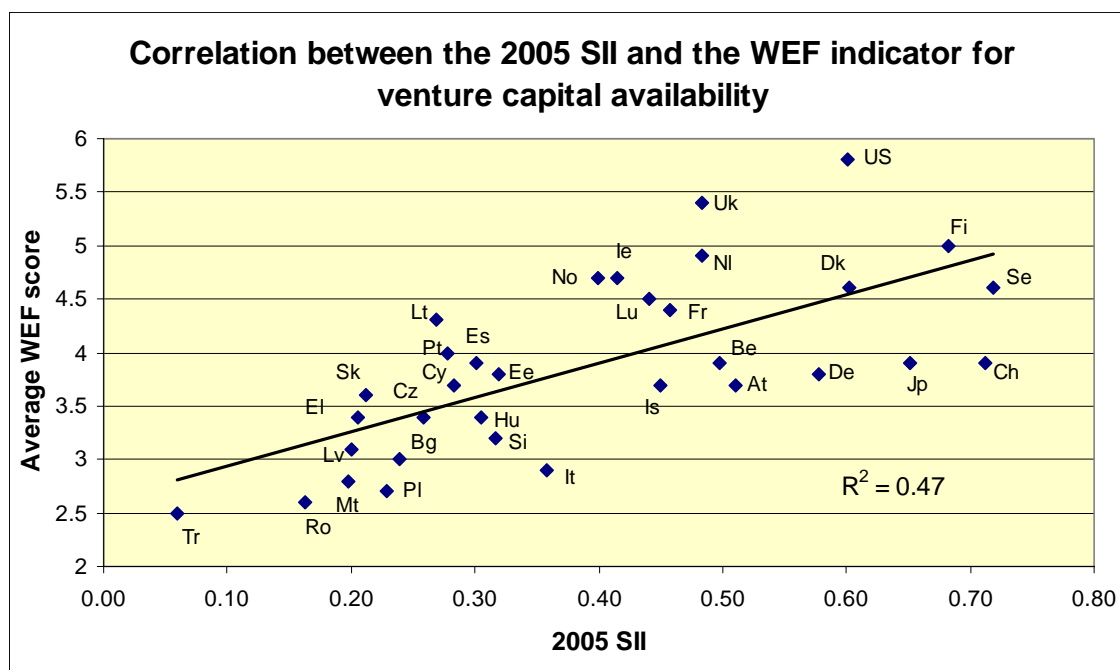
3.3 Venture capital availability

The EIS includes an indicator for venture capital, which measures total early-stage venture capital as a percentage of GDP. The indicator has two drawbacks: it is not limited to innovative proposals and it does not measure the key issue of importance to entrepreneurship, which is the availability of venture capital. Total venture capital does not provide this measure because a country could have a very high use of early stage venture capital, but if there are a large number of good ideas, a very high percentage of them could fail to receive funding.

The WEF includes an indicator that gets to the heart of the issue. It is based on answers to the question “ Entrepreneurs with innovative but risky projects can generally find venture capital in your country (1 = not true, 7 = true). This is an exceptional case in which it might be better to obtain data from experienced CEOs for conditions in their country than from managers for their own firm. The latter might either have no experience of the availability of venture capital, or base their evaluation on their own experience, without a realistic appraisal of the quality of their own innovative projects¹¹.

Figure 4 correlates the results of the WEF indicator for venture capital availability with the 2005 SII for 33 countries. The relationship is of middling strength, suggesting that it would be worthwhile pursuing indicators for venture capital availability, rather than the more limited idea of venture capital supply.

Figure 4



For country identifier codes, see Annex Table A4.

3.4 Innovation Management

Venture capitalists and Technology Transfer Officers at universities and research institutes frequently complain that the problem in Europe is not a lack of ideas for the formation of innovative new firms, but a lack of experienced managers who can guide the development of an invention through to commercialization. We are not aware of any indicators that cover the availability or quality of such managers. The WEF report includes an indicator for the quality of national management schools, but this does not provide an indicator for the supply of high quality management (partly because

¹¹ The best option might be to survey the managers of Venture Capital firms about both the availability of capital and the quality of funding proposals.

managers can be trained in other countries), nor a measure of the supply of entrepreneurial managers. Several options are possible:

1. Survey venture capital firms to obtain data on the supply of suitable managers.
2. Survey universities and research institutes to determine whether or not S&E students take classes on establishing a new business to develop an invention.

3.5 Organizational innovation

Organizational innovation can be a key factor in both productivity growth (Brynjolfsson and Hitt, 2000; Murphy, 2002) and the ability of firms to profit from product and process innovation. CIS-4 introduces several new options for constructing indicators on organizational innovation on 1) knowledge management, 2) organization of work, and 3) relationships with other firms or public institutions. CIS-4 also asks about the effect of any of these types of organizational innovation on four types of outputs of organizational innovation, so it might be possible to determine which of the three types of organizational innovation have the greatest impact on quality or production costs by comparing the results for those firms which have introduced only one of the types of organizational innovation.

Furthermore, CIS-4 breaks down the questions on process innovation into three types: 1) new methods of manufacturing or producing goods and services (the traditional measure of process innovation), 2) new logistics, delivery or distribution methods, which can often require organizational innovation, and 3) supporting operational activities. Cross-tabulating the three types of process innovations with the three types of organizational innovations could produce potential indicators for different organizational innovation 'regimes'.

Unfortunately, the CIS questions on organizational innovation are poorly designed for cross-country comparisons, which is a major function of the EIS. The problem is due to the nature of organizational innovation itself, which is relatively inexpensive and has a much longer life cycle compared to technical innovation. Consequently, many of the new member states have higher rates of organizational innovation than EU countries such as Denmark and the Netherlands, where many firms implemented major organizational innovations in the 1990s¹². In order to improve comparability, it could be necessary in future CIS surveys to either ask respondents if they did not introduce an organizational innovation because they had previously gone through a phase of reorganization, or adopt a business practice approach in which respondents are asked about the use of specific organizational forms and if in use, when they were first adopted¹³.

In the future, it would also be worth including questions in the CIS that cover two other important aspects of organizational innovation:

1. The percent of employees affected by the innovation. This is probably the simplest and most accurate measure of the impact of organizational innovation on the firm.

¹² For an extensive discussion of the problem of international comparisons of organisational innovation, see the 2006 Trend Chart report "Can we measure and compare innovation in services?"

¹³ For detailed recommendations of the project "Pattern of Organisational Change in European Industry (PORCH)" for the measurement of organisational innovation in large-scale surveys see Annex A5.

2. Whether innovation in the organization of work led to an increase, decrease or no change in the responsibilities of employees. Current research suggests that high employee responsibility is a driver of innovative capabilities. In its current form, the CIS-4 question on innovation provides no information on the effect of innovation in work organization on employee responsibilities.

3.6 Demand for innovation

Almost all current innovation indicators focus on supply factors for the development of innovations, particularly innovation inputs such as R&D, other innovation expenditures, human resources, and knowledge sources. Even though demand for innovative products and processes are viewed in economic theory as a crucial driver of innovation, there are almost no relevant indicators. As many demand factors could be influenced by policy, it would be worthwhile to develop indicators for different aspects of the demand for innovations.

3.6.1 Sophisticated local demand

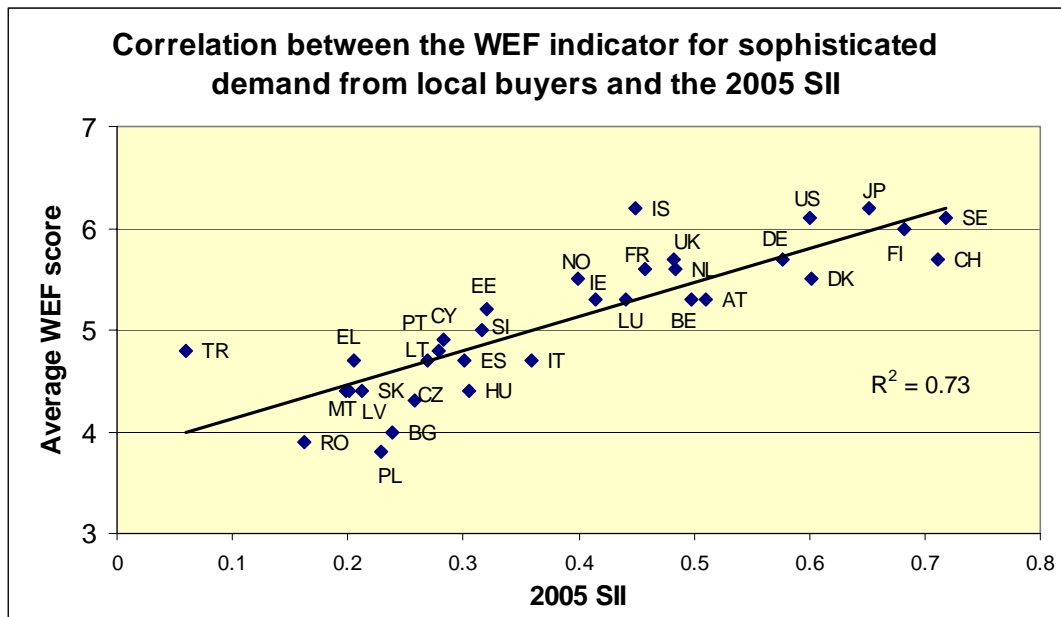
A substantive body of literature, starting with Porter in the early 1990s, argues that sophisticated *domestic* demand for innovative products is an essential driver of innovation. This theme is also reiterated in the Aho Report. Nevertheless, if this was true, it would be difficult to explain the excellent export performance of several countries, including Japan and Sweden, where many innovative products were infrequently sold domestically (Japan) or where the size of the domestic market was too small to provide an adequate number of sophisticated buyers to justify investment in innovation (Sweden). The issue of demand for innovative products could be more closely linked to the firm's market, no matter where located. If true, the problem for Europe might lie more in encouraging firms to enter global markets than a lack of domestic demand.

Figure 5 correlates a relevant WEF indicator against the 2005 SII. The relationship is strong and positive. The WEF question is "Buyers in your country are (1 = slow to adopt new products and processes, 7 = actively seeking the latest products, technologies and processes)". The results suggest that Porter and the Aho Report are correct – sophisticated local demand could be a major driver for national innovative capabilities.

Although sophisticated domestic markets appear to play a strong role in national innovative capabilities, it would also be worth exploring the effect of other markets. The CIS data could permit a closer analysis of the role of different markets, through an analysis of three sets of questions:

1. The firm's market. CIS-4 asks the respondent to indicate which of four markets they are active in: local, national, Other EU, and international (outside EU), while CIS-3 asks the respondent to identify their most important market.
2. Whether or not the firm did not innovate because of poor market conditions. The formulation of this question could be better in CIS-4 than in CIS-3 for our purposes. The question was directed to non-innovative firms.
3. The importance of a lack of demand for innovative goods and services as a hampering factor among firms that innovate.

Figure 5



For country identifier codes, see Annex Table A4.

These questions, including their variations in CIS-3 and CIS-4, could be used to explore different methods of constructing an indicator for the effect of markets on the firm’s innovative status. One possibility is that innovative firms active in international markets could be much less likely than firms that are only active in local or national markets to find a lack of demand for innovations to be an important hampering factor. Conversely, local demand conditions could be essential to weakly innovative firms. If international demand (or EU level demand) is an important factor, this also suggests using the CIS to construct an indicator for the share of firms that are active in international markets.

3.6.2 Government procurement

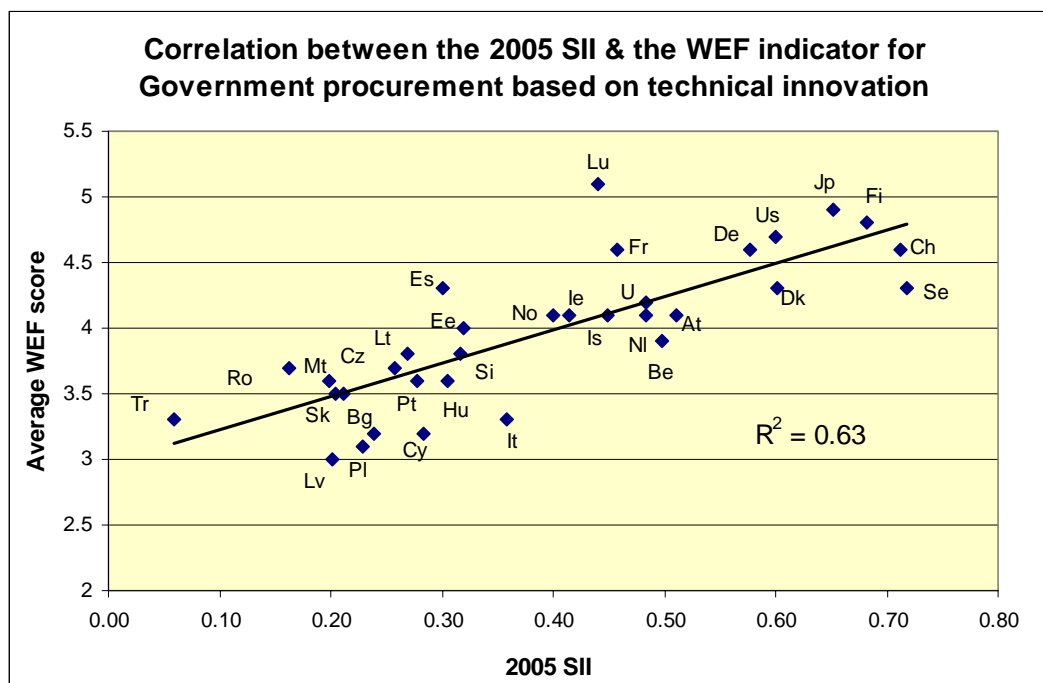
The CIS does not divide markets into individual consumers, other businesses, and governments, but government forms a major buyer of products and services. This creates a potentially important role, noted by the Aho Report, for government procurement policies to encourage innovation.

The WEF report includes an indicator (table 3.09) of the role of procurement in encouraging innovation, by asking “Government purchases for the procurement of advanced technology products are based on technology and encourage innovation” (equals 7, whereas 1 = purchase depends solely on price)”. Figure 6 graphs the procurement indicator against the SII. There is a moderately strong relationship, with a positive correlation between the 2005 SII and a high score for government procurement based on technology and innovation.

One advantage of an indicator of this type is that it is also relevant to countries that are not at the leading edge of demand, as the criteria for government procurement is probably relative to the average in each country. Therefore, the main factor could be

whether or not each national government demands innovative characteristics that are above the national average.

Figure 6



For country identifier codes, see Annex Table A4.

3.6.3 Business demand

A potential aggregate measure of demand by businesses is Gross Fixed Capital formation (GFCF), which consists of the acquisition of fixed capital by firms and institutions (due to purchases or production by the firm or institution itself) minus disposals (sales, depreciation and losses) of fixed capital. The result gives the change in fixed assets during a given period. GFCF includes the acquisition less disposals of buildings, other structures, machinery and equipment, computer software, literary or artistic originals and major improvements to land such as the clearance of forests or the discovery of new mineral deposits. The indicator was used in the 2003 Trend Chart National Innovation Systems (NIS) report as a proxy for the level of demand for innovative products, in terms of the amount spent on acquiring or producing new capital.

The value of GFCF as a measure of demand for innovative products depends on the reasonable assumption that almost all new capital equipment will contain technical improvements over existing stock. The disadvantage of GFCF is that it includes expenditures that are not related to innovation, particularly land improvements and buildings (although new buildings might contain innovative, productivity-enhancing features) and improvements to land. It would be much more useful to have an indicator for GFCF that is limited to capital equipment.

The CIS contains a relevant question on innovation expenditures to acquire “advanced machinery, equipment and computer hardware or software to produce new or

significantly improved products and processes'. In the past, the innovation expenditure data have not been used, except in the aggregate, because of concerns over data reliability due to low response rates to these questions. Although all results are not yet in for all EU-25 countries, several countries have reported substantial improvements in these response rates for CIS-4. This opens up the possibility of using this data as an indicator for both innovation investment and demand in the future. The relevant question is expenditures on:

“Acquisitions of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products or processes”

The CIS question does not capture all aspects of innovation demand for capital equipment because it stresses capital expenditures to produce *innovative* products and processes. New capital could be used only to produce existing products or to expand existing processes. This should be captured by the extension of the question to processes, but the question is poorly phrased for this purpose. It might be improved by asking “...to produce new or significantly improved products or for use in new or significantly improved processes”.

3.7 Systemic indicators

Systemic indicators capture linkages between different actors in an innovation system. An example is the EIS indicator, derived from the CIS, of the percentage of SMEs that collaborate with other firms or institutions over innovation. The CIS could be adapted to query participation in innovation networks, but it is unclear how much additional value would be added by such a question over the existing questions on collaboration. An alternative approach to systemic indicators is to identify linkages through the mobility of scientists and engineers.

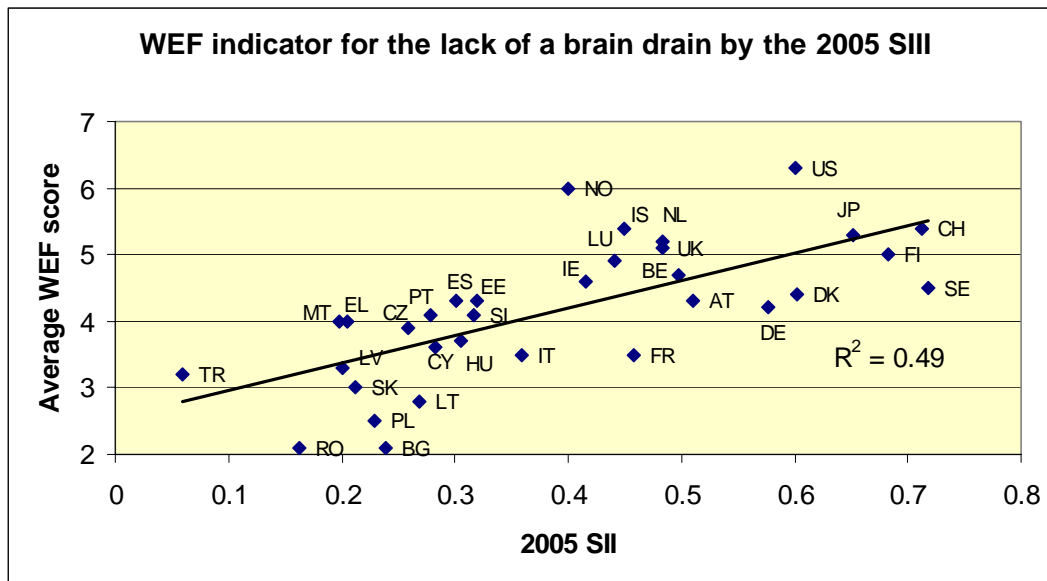
3.7.1 Mobility

The mobility of Scientists and engineers – between firms, countries and between firms and the public research sector – is commonly believed to diffuse knowledge and consequently support innovative capabilities. Mobility is stressed by the Aho report, which sets a target for 10% of scientists and engineers moving in each year.

Mobility between countries

Mobility has a negative side: highly skilled people can leave a country, or too much mobility could be economically inefficient. The WEF has a relevant indicator for the impact of the first negative factor. The question asks ‘Your country’s talented people (1 = normally leave to pursue opportunities in other countries, 7 = almost always remain in your country). The higher the WEF score, the less likely talented people are to leave the country (the United States ranks highest on this indicator). As shown in Figure 6, the relationship is positive, or conversely, the more serious the “brain drain”, the lower the country’s performance on the 2005 SII.

Figure 6



For country identifier codes, see Annex Table A4.

Several countries either actively promote the in-migration of skilled scientists and engineers (for example the United States) or are considering adapting their immigration policies to encourage immigration by the highly skilled. Figure 7 explores the effect of the presumed advantages of mobility through in-migration. The WEF question is “Labour regulations in your country (1 = prevent your company from employing foreign labour, 7 = do not prevent your company from hiring foreign labour)”. There is no relationship at all with the 2005 SII. However, the WEF question is not the best measure of the possible benefits of immigration because 1) it is not limited to scientists and engineers, 2) it refers only to labour regulation, rather than to all types of regulation, including immigration policy, that could discourage cross-border mobility, and 3) in the European context the question would need to be limited to non-EU nationals.

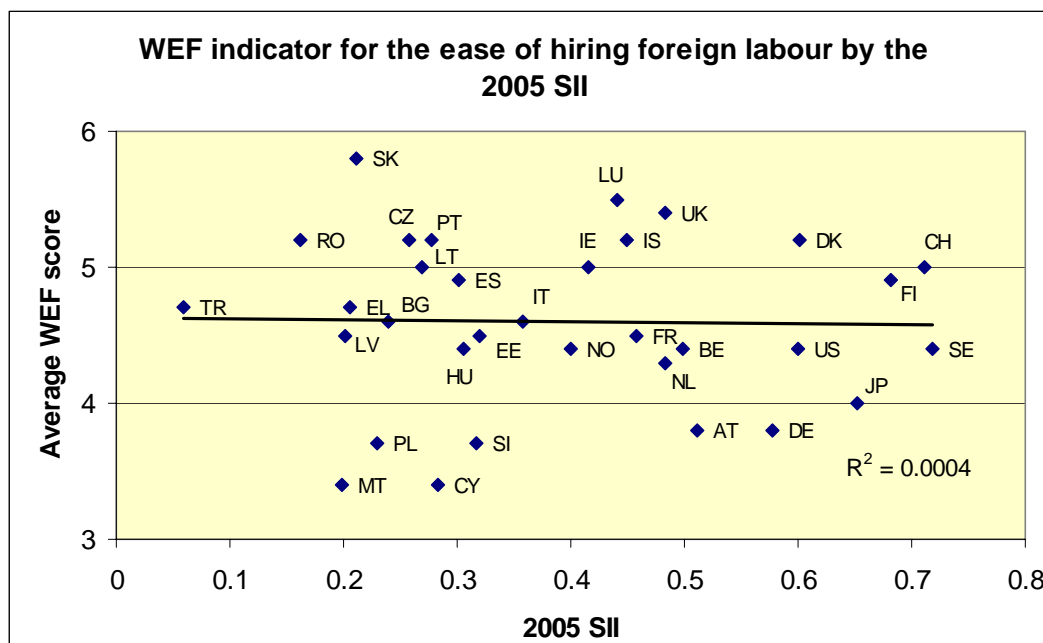
A noted weakness of the CIS is that it lacks questions on human resources, other than a single question under the hampering factors (question 8.2, item 4) on the ‘lack of qualified personnel’. The CIS could be used to gather data on mobility as part of a series of questions on human resources, but this would considerably lengthen the current survey questionnaire. The alternative is to seek alternative methods of obtaining mobility indicators.

Other cross border mobility indicators:

Several indicators are available in New Cronos on cross-border mobility, but they are limited to students. Nevertheless, foreign students, particularly at the PhD level, could form an important source of supply for hiring scientists and engineers. Eurostat’s New Cronos database (indicator (ed2czh97) includes data on foreign PhD students (ISCED 6) as a percentage of total PhD enrolment, and after mid 2006 this indicator should be available by country of origin. Second, New Cronos data can be used to construct an indicator of the share of foreign students out of all tertiary education (ISCED 5 and 6) students. The indicator for all tertiary foreign students includes data on the country of origin, so students from other EU countries can be identified. The disadvantage of

these two indicators is that 1) they refer to all tertiary or all PhD students, rather than specifically S&E students, and 2) there is no information on whether or not the students remain in the country after graduation.

Figure 7



For country identifier codes, see Annex Table A4.

Mobility between firms

Mobility between firms is a method of knowledge diffusion. New Cronos includes an indicator for the job-to-job mobility of employed human resources in science and technology (HRST) (hrst_mob). As shown in Figure 8, there is no relationship between short-term job mobility of HRST employees and the 2005 SII. The relationship could be more complex, requiring an adjustment for mobility across different sectors.

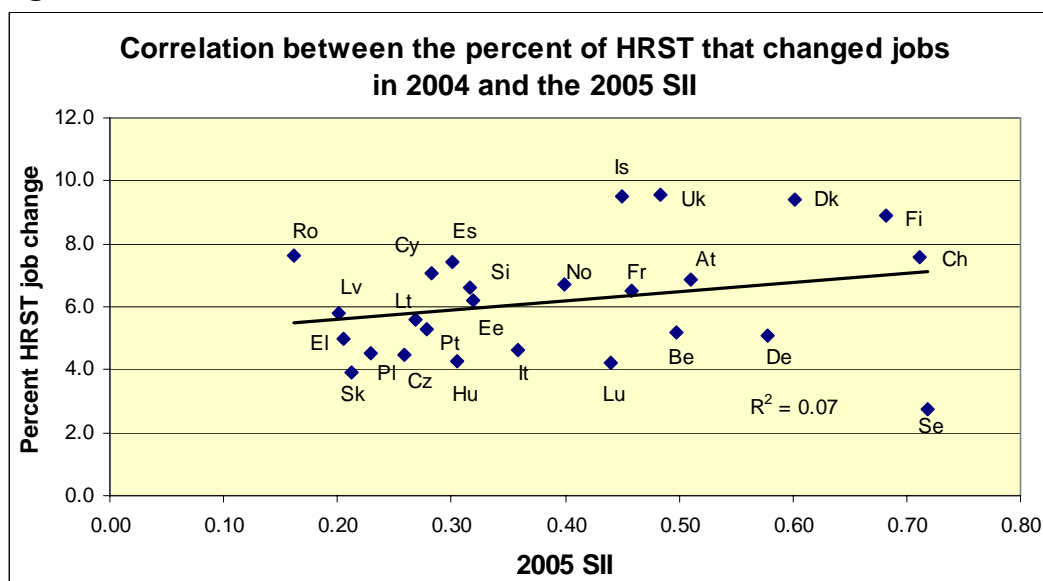
Mobility between firms and the public research sector

The main interest is in measuring knowledge flows between the public research sector and firms. This can occur in many different ways, one of which is the movement of research staff to take up positions in private firms. A question on this could be added to a CIS module on human resources, but as the number of firms who have hired research staff is likely to be very small, this would not be an efficient use of space in the CIS questionnaire.

A further issue is how much the physical movement of people matters, and if this movement needs to be long-term. Alternative methods for knowledge to flow between the research sector and firms include open science, temporary exchanges, informal contacts during conferences, etc. If a direct measure of physical mobility is desirable, it might be worth either 1) surveying a random sample of research staff to determine the frequency of physical mobility (for instance if they temporarily took up a position within a firm in the previous five years) or 2) determining if Technology Transfer

Offices can answer such a question. Alternatively, such a question could be asked in the Innobarometer series.

Figure 8



For country identifier codes, see Annex Table A4.

3.8 Commercialisation of publicly funded research

A major thrust of European policy is to improve the commercialization of research conducted in the public research sector (universities and government research institutes). The belief is that Europe produces excellent research, but is less successful than the United States in turning this research into competitive products and processes. Although there is some debate over whether or not this ‘European paradox’ is true (Dosi et al, 2005), the public research sector is heavily dependent on government funding and consequently provides good conditions for implementing pro-innovation policies.

The CIS provides a basic indicator for commercialization, which is the share of all firms reporting public research as a high value information source. However, this indicator still does not measure if the knowledge produced by the public research sector actually finds its way into innovations. A better question would be to ask:

“Was knowledge gained from universities/government research institutes directly incorporated into your firm’s product and process innovations?”

An alternative is to survey Technology Transfer Offices to identify the output of universities and research institutions in terms of potential, commercially viable innovations. As shown in Table 2, the AUTM survey for the United States and the ASTP survey for Europe provide five relevant indicators per unit of research expenditures, while the ASTP survey also provides results per 1000 research staff¹⁴.

¹⁴ The ASTP survey for Europe was not large enough to provide breakdowns by country.

Both surveys provide estimates of gross licensing income, permitting the calculation of the share of research expenditures ‘recovered’ through license income. For 2004, this is 3.02% for all European ASTP members compared to 3.36% for all American AUTM respondents. The ASTP survey also permits a breakdown of license income for patented and non-patented inventions.

Table 2. Indicators for the commercialisation of public research, 2004

Per million PPP\$ research expenditures	Universities & research institutes combined			Universities only		
	US	Europe	Ratio ¹	US	Europe	Ratio ¹
1. Invention disclosures per million	0.305	0.407	0.75	0.333	0.404	0.82
2. Patent applications per million	0.121	0.255	0.47	0.095	0.255	0.37
3. Patent grants per million	0.057	0.089	0.64	0.038	0.088	0.43
4. Licenses executed per million	0.134	0.115	1.17	0.083	0.110	0.75
5. Start-ups established per million	0.016	0.011	1.45	0.028	0.011	2.55

Source: Arundel and Bordoy, 2006, Table 5.1.

1: US/Europe. When > 1 the performance of European public research institutes exceeds that of the United States.

The disadvantage of these indicators is that they do not cover all universities and research institutes, although the AUTM survey covers 96 of the 100 top research universities in the United States. As noted above in section 3.2.2, it would be relatively inexpensive to collect complete data from all European universities and public research institutes, permitting a breakdown of these indicators for each EU member state.

A second disadvantage of the ASTP/AUTM approach is that both fail to capture the effect of the public research sector through non-formal information flows, such as when firms read the scientific literature or develop informal contacts with university staff. Consequently, it is essential to also draw on the CIS for measures of the importance of knowledge produced by the public research sector and for the importance of scientific journals. Unfortunately, the CIS question on scientific journals, where the majority of articles is produced by the public research sector, is combined with the usefulness of ‘trade/technical publications’, where academics rarely publish. To be useful for this purpose, the CIS question would need to be limited to ‘scientific journals’¹⁵.

3.9 Public sector innovation

There are almost no comparable indicators for innovation in the public sector. The exceptions concern the e-economy, such as the provision of public services on-line. These can be measured by the percentage of firms and individuals who report using

¹⁵ Any revision could also include other “open” outputs of the public research infrastructure, following the recommendations of Chapter 6 of the Third Oslo Manual on linkages. The current question on institutional sources could then be revised to point to personal contacts with staff.

the internet to interact with government authorities (New Cronos indicators polindd2 and polindd3).

As almost all public sector organizations are large, there are enormous opportunities for productivity gains through organisational innovation and technology adoption. Canada has experimented with gathering data on both types of innovation (Earl, 2004), but we are not aware of any equivalent research in Europe.

Given the economic importance of the public sector, the development of indicators for public sector innovation should be a very high priority in Europe. This work is beyond the capacity of Trend Chart. In the near future, the Framework Programme funded project, PUBLIN, should provide suggestions on how to measure innovation in the public sector.

3.10 Globalisation

Innovation activities could be increasingly globalised, in the sense that firms both perform more of their innovation activities in different countries. Relevant indicators are:

1. R&D spending of affiliates as a percent of total BERD (OECD, MSTI 64).
2. The percentage of total business R&D funded from abroad (New Cronos indicator ir024).
3. Co-patenting by individuals in different countries. Data are available from the OECD¹⁶,
4. Co-authorship share for international scientific articles. Data are available from the NSF¹⁷ for the United States, the EU-15, Japan and China.

These indicators share a common problem: the degree of internationalization is positively correlated with the size of the domestic economy. For example, small countries have higher levels of co-patenting and co-authorship than large countries because there are fewer opportunities to find a co-author or co-inventor in the home country. This effect is not related to national innovation capabilities, so including these indicators in the EIS would distort the results. Similarly, indicator 2 above might not be directly linked to national innovative capabilities because the value of the indicator could increase if there is little domestic innovative capability. Until these problems are solved, we do not recommend including indicators for globalization in the EIS.

¹⁶ See OECD Science, Technology and Industry Scoreboard, page 82.

¹⁷ National Science Foundation, Science and Engineering Indicators 2006, Volume 2, Appendix Tables 5-47 to 5-49.

4. Other Changes to the EIS

Section 3 above provides suggestions for new indicators that could be included in future editions of the EIS. In addition, several current EIS indicators could be deleted and replaced with alternative indicators.

A prime candidate for replacement is indicator 2.5 on university R&D expenditures financed by business. The indicator is not linearly correlated with innovative capabilities because in a few new member states very high shares of university R&D are funded by business, due to a lack of either public funding for university research or a poorly developed private research sector. An option is to replace this indicator with one that characterizes *how* public and private research sectors cooperate, for example an indicator for collaboration with public research, the importance of informal knowledge flows between the public and private research sectors, or by an indicator of the commercialization of public research. Indicators for the latter are not yet available, but indicators for how public and private research sectors cooperate could be obtained from CIS-4.

A second candidate for replacement is indicator 3.6 on the share of SMEs introducing non-technical change. The problems with this indicator, linked to poor comparability across countries, were not solved in CIS-4 and are unlikely to be addressed until the 2008 version of the CIS (CIS-6). For this reason, we do not recommend replacing this indicator at this time because it captures vital characteristics of innovation, particularly rapid organizational innovation in the new member states. However, over the long term the comparability problems with the indicator need to be solved.

5. Conclusions

This document has identified possible indicators of relevance to EU policy for measuring national innovative capabilities. The indicators could come from three sources: 1) existing data sources, including the CIS, 2) by making modifications to future versions of the CIS, and 3) by conducting new surveys to gather the necessary data. Annex Tables 1 to 3 summarize these indicators, although Annex Table 1 only lists existing indicators that could be obtained from the CIS. These indicators would require access to the CIS micro-data because they require analyzing the CIS data in new ways. Other existing indicators can be drawn directly from New Cronos, the OECD, or NSF sources.

The proposed new CIS indicators (Annex Table 2) are based on CIS-4. It is important to note that all proposed new indicators would need to be thoroughly field tested to ensure that they are feasible to construct, that they measure what they are intended to measure, and that they are reliable. For these reasons, we cannot precisely define several of these indicators, such as for market demand.

The proposed new indicators that would require new surveys all cover specialized or infrequent activities. The target population in many cases is comparatively small, such as university Technology Transfer Offices or venture capital firms. Consequently, the most economically efficient method of surveying these populations is to conduct a single EU-wide survey. This suggests a role for the European Commission in funding such surveys, as it does already through Innobarometer.

6. References

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Annex Tables
Summary of proposed indicators

Table A1: New indicators that can be constructed from existing CIS data		
Indicator	Relevant CIS-4 questions	Relevance
Knowledge diffusion	2.2 & 3.2: Product/process innovation developed together with other firms/institutes 6.2 Any innovation cooperation	Measures the prevalence among firms of all types of knowledge diffusion (with any partner) in innovation processes.
Technology diffusion	2.2 & 3.2: item 3 (mainly other enterprises developed the innovation)	Firms that <i>only</i> innovate through technology adoption.
Effective technology diffusion	2.2 & 3.2: item 3 (mainly other enterprises developed the innovation) 7.1: 'high' score for either items 2 and 3 for product innovations, 'high score' for either items 1 – 4 for process innovations	Measures the ability of technology adopters to effectively implement technology acquired from other firms/institutes.
Fast growing gazelles	11.1 or 11.2 on sales or employment (in top quintile for growth) Measure of innovative status: Either 5.1/5.2, item 1 on R&D expenditures, or 2.3 on innovation sales share (new to market), 2.2/3.2 item 3 on technology adoption, or 10.1 on organizational innovation.	General measure of success of EU policies in promoting innovation. Best to develop indicators for several different types of innovative gazelles, as these could be more appropriate for EU differences in national innovation systems. For instance, fast growing technology adopters could be more prevalent in the new member states.
Organisational innovation	Section 10: all questions. There are many options here for better indicators; can also be combined with 3.1 on process innovation, particularly item 3.2 on logistics.	Organisational innovation could be a key component in productivity improvements.
Innovation demand	1.2 on markets, 8.2 item 9 on uncertain demand as a hampering factor, 8.2 item 11 on no demand for innovations. Identify most pro-innovation market and determine percent of firms active in the market.	Demand is a central driver of innovation investments.
Technology demand (also diffusion indicator)	Q 5.1/5.2 item 3. Note that the use of this indicator depends on a substantial improvement in data quality compared to previous CIS surveys.	Extent of demand for new production equipment, plus a measure of the diffusion of these technologies.

Table A2: New indicators that could be constructed from modified or new CIS questions		
Indicator	Required change or addition to CIS	Relevance
Knowledge diffusion	CHANGE 2.2 & 3.2: Product/process innovation developed together with other firms/institutes; change option to <i>any</i> innovations introduced ‘together with other enterprises or institutions’	Current format of question, which forces respondents to choose their main approach to innovation, will miss many firms that also partly depend on the diffusion of ideas and/or technology from other firms or organisations.
Technology diffusion	ADDITION: Develop a firm-specific question that asks about the importance to the firm of obtaining new product and process technology from external sources. We do not suggest disaggregating the question by region (home country, Europe, US, etc) as used in CIS-1, as this would dramatically increase the question length.	Direct measure of inward technology diffusion and would be particularly valuable information at the sector and national levels. CIS-1 also asked about outward diffusion, but there is no need to obtain outward diffusion data.
Technology diffusion / demand	CHANGE: 5.1 and 5.2 on acquisition of machinery: Change question to “produce new or significantly improved products <i>or for use in</i> new or significantly improved processes”.	Both adoption of new technology and a measure of investment in its purchase, which is a demand indicator.
Organisational innovation	ADDITION: Percent employees affected by organizational innovation. ADDITION: No need for an organizational innovation ADDITION: Direction of change in workforce responsibilities Improve international comparability by listing organizational practices and their date of implementation.	Measure of ‘size’ or impact of organisational innovation. Improve international comparability. Increase in employee responsibility should improve innovative capabilities.
Government procurement	ADDITION: First, if the firm sells to the government, if yes, relative influence of cost versus innovative characteristics on procurement decision	Role of government procurement in demand for innovation.
Human resources	ADDITION: Would require a complete module on questions such as mobility, quality, shortages, training, etc.	Relevant to both innovation and policy on HRST, but this would notably increase the length of the CIS. It would be better to first explore alternative methods of gathering HRST data.

Table A3: New indicators that would require new survey work		
Indicator	Target population	Relevance
<p>Family of indicators for the outputs of the public research sector, measured in units per 1000 researchers or million Euros R&D expenditures:</p> <ol style="list-style-type: none"> 1. Spin-offs 2. Patents (applications & grants) 3. Licensing agreements 4. Licensing income 	<p>Universities and publicly funded research organizations. The questionnaire could be sent to Technology Transfer Offices, who should be able to provide this information.</p>	<p>Directly relevant for measuring the commercialization of publicly-funded research, but must be combined with measures of the importance to firms of 'open science' through scientific publications.</p>
<p>Venture capital availability</p>	<p>Venture capital firms, other organizations that provide early-stage capital</p>	<p>Availability of capital for risky projects is a better indicator of the ability of entrepreneurs to obtain capital than a measure of the supply. Can also be limited to project ideas based on a new invention.</p>
<p>Supply of entrepreneurial managers</p>	<p>Venture capital firms Technology Transfer Offices</p>	<p>A lack of skilled management could be a serious constraint to the success of new start-up firms.</p>
<p>Percent of S&E students that take classes on entrepreneurship; could also ask about the content of the classes, such as on management, IPR, etc</p>	<p>Students – to reduce costs could be limited to a survey of MSc and PhD level students. Could be a suitable topic for a Eurobarometer survey.</p>	<p>Development of entrepreneurial capabilities and knowledge among S&Es.</p>
<p>Mobility of research staff between the public research sector and the business sector</p>	<p>Scientists and engineers in the public research sector, or firms using Innobarometer.</p>	<p>Of interest to mobility policy, but little information on the relevance of this method of knowledge diffusion versus other methods such as open science.</p>

Table A4: Country identifier codes

Austria	AT	Lithuania	LT
Belgium	BE	Luxembourg	LU
Bulgaria	BG	Malta	MT
Cyprus	CY	Netherlands	NL
Czech Republic	CZ	Norway	NO
Denmark	DK	Poland	PL
Estonia	EE	Portugal	PT
Finland	FI	Romania	RO
France	FR	Slovak Republic	SK
Germany	DE	Slovenia	SI
Greece	EL	Spain	ES
Hungary	HU	Sweden	SE
Iceland	IS	Switzerland	CH
Ireland	IE	Turkey	TR
Italy	IT	United Kingdom	UK
Japan	JP	United States	US
Latvia	LV		

Table A5: PORCH Recommendations for the measurement of organisational innovations in large scale surveys

<p><i>Complexity of organisational innovation:</i> It is not sufficient to only ask for "organisational innovation" in general. Questions like "changes in the organisation of work" or "changes in your relation with other firms", as it has been asked in the CIS, are too general. It is necessary to enquire for specific innovative organisational concepts separately. For instance, for the general question on "changes to the organisation of work" one might specify the concrete organisational concept that implies a change of the work organisation, such as "team work", "decentralisation of functions into customer or product-related departments" or "creating customer or product-related lines/cells in the factory instead of shop floors". Specifications for the question "changes in your relation with other firms...such as through alliances, partnerships, outsourcing or subcontracting" are "cooperation in R&D", "cooperation in production", "cooperation in administrative activities", "outsourcing of production", "outsourcing of R&D" or "outsourcing of administrative activities". The specification on individual organisational concepts is important because different organisational innovations have different effects on performance indicators and are of different importance for different sectors. An organisational innovation indicator based on a very general question on organisational innovations only has limited explanatory power.</p>
<p><i>Life-cycle of organisational innovation:</i> It is not sufficient to simply ask whether organisational concepts have been changed over the past years. In contrast it is important to determine the proportion of firms that has generally implemented an organisational innovation at all. This is crucial because organisational innovations do not age as fast as product innovations do. Thus, applying questions like "During the years 2002 and 2004 did your company introduce a major change to the organisation of work within your company" incorrectly only classifies latecomers as innovative. Those companies that have introduced changes in the work organisation before 2002 are ignored and therefore considered as not innovative. This is misleading as companies having implemented changes more than three years ago are not necessarily less innovative than companies reorganised their work organisation two years ago. Therefore, it is recommended that questions on organisational innovation should also include the year in which the organisational concept was used for the first in time in the company.</p>
<p><i>Extent of use of organisational innovations:</i> It is not sufficient to only ask for "use" or "non-use" of organisational innovations. It is, however, necessary to identify the extent to which organisational innovations have been implemented into business processes. Questions on "changes of work organisation" with the limited options of "yes" and "no" are misleading. Companies answering "yes" to this question might have implemented changes in work organisation (e.g. the implementation of team work in manufacturing and assembly) only in one small part of production as a pilot, for the assembly of one product or for all manufacturing processes in the company. In order to generate viable estimations on the performance effects of organisational concepts, the extent of use of organisational innovations has to be taken into consideration. Organisational innovations being only implemented in single parts of the companies probably do not have any effect on performance indicators, however, these companies are considered as innovators.</p>
<p><i>Quality of organisational innovation:</i> It is not sufficient to only ask for labels of organisational innovations like "team work" or "task integration" as in every company organisational concepts are defined and shaped differently and answers of the respondents vary according to their own definition. It is crucial to know how terms like "team work" are used in the respective company. Merely using labels or catchwords when inquiring about organisational innovations biases the diffusion of organisational innovations across companies. It is recommended to include definitions about the specific organisational innovations that are surveyed in order to be sure that every respondent understand the innovative organisational concept in the same way.</p>

Source: Armbruster, Kirner, Lay (2006): *Final report of Patterns of Organisational Change in European Industry (PORCH)*, Karlsruhe, Fraunhofer ISI.