

National Differences in Innovation Behaviour: Facts and Explanations

Results Using Basic Statistics from CIS 3 for France, Germany, Spain and United Kingdom¹

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Abstract

Various indicators based on the results of the Third Community Innovation Surveys reveal significant differences in the innovation activities and performances at the national level across the four large European countries France, Germany, Spain and United Kingdom. This paper addresses the question whether country-specific differences or differences in the industrial composition of economic activity across countries are the driving forces for this innovation pattern. As a summary of facts, we find the shares of innovators do not seem to be strikingly different sector by sector, with the exception of Germany where they are consistently higher across sectors. There is some additional heterogeneity, however, in innovation input measures.

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1 Introduction

The results of the Third Community Innovation Surveys (CIS 3) demonstrate significant differences among European countries in most innovation indicators at the aggregate level, both with respect to firm participation in innovation (share of innovators), to innovation efforts (expenditure for innovation over total turnover), and innovation success (share of turnover with new products), see Eurostat (2004). This is even true when comparing the four large European countries France, Germany, Spain and the United Kingdom (UK).

This pattern raises the question which effects mainly drive the aggregate differences: On the one hand there might be differences in the incentives for firms to innovate on a country level, i.e. country-specific features common to all or certain industrial sectors, e.g. through differences in the macroeconomic environment, competition, structures of factor markets, regulation, technology policy including public support. On the other hand, the differences in innovation behaviour could also be due to varying sector compositions of economic activity given that innovation behaviour is sector-specific. This would be suggested by the ongoing process of European economic integration and globalisation facilitated by the EU that both increase active (through growing export orientation) and passive (through growing import competition) international competition of domestic firms. Increased international competition means that market structures of national markets become more homogenous, firms get better access to foreign factor markets (which will lead to an assimilation of factor prices) and national peculiarities are likely to diminish. As a result, innovation incentives for firms from different countries in the same product market will assimilate which should harmonise innovation behaviour of firms within a certain sector across countries. At the extreme, if there is strong harmonisation of institutions, we should observe that innovation indicators are similar across countries when comparing only one sector. Thus, national differences in the innovation behaviour would be primarily due to varying sector structures across countries.

In 2001, CIS 3 were conducted under the co-ordination of Eurostat in the (at that time) 15 European Union (EU) member states as well as Norway, collecting data on innovation activities in the enterprise sector in the reference period 1998 to 2000. So far, Eurostat has published only results on a highly aggregated sector level (manufacturing, wholesale trade, producer services) for each country (Eurostat, 2004, European Commission, 2004). Eurostat's online data base, New Cronos, as well provides data on that sector level only.

The purpose of this paper is to present some empirical facts on the question whether country-specific differences or differences in the industrial composition of economic activity across countries are the driving forces for the observed innovation pattern. To analyse the question we also decompose the aggregate differences for several innovation indicators into a “structure” as well as a “sector” effect. This is done by analysing indicators of innovation activities for eleven manufacturing sectors (see Table 1) in the four large EU countries: France, Germany, Spain, and the UK. For these countries, firm level data from CIS 3 are available² that allow computing innovation indicators for sectors within each country. By applying weighting factors, these innovation indicators are representative for the total firm population in each sector and thus enable sector comparisons between countries. The description and explanation of main innovation features across the four countries have been carried out at the same time that econometric coordinated analysis using the micro data was undertaken (see Griffith et al., 2004, Harrison et al., 2004 or Abramovsky et al., 2004).³

Numerous innovation quantities are provided by CIS data from which we selected the following core indicators for the cross country comparison: The share of firms that have successfully introduced product and/or process innovations gives an indication of the spread of innovation activities and is strongly influenced by the behaviour of small and medium-sized enterprises (SMEs) as they determine the total number of firms. Developing innovations requires various inputs, from which R&D is the most important one in manufacturing. The share of firms that perform R&D and the R&D intensity (R&D expenditure over turnover) both give a hint on the extent of new knowledge production in the course of innovation activities. The ratio of innovation expenditure to total turnover usually referred to as the innovation intensity is an indicator for the input effort in all. The share of sales with new products is used as a quantitative indicator for the success of product innovation activities. In addition to these input and output indicators, we look on a behavioural and a technology policy variable as well. The share of innovative firms with co-operations in innovation

² The data have been made available through the research project "Innovation and Employment in European Firms: Microeconomic Evidence (IEEF)", sponsored by the European Commission under the Fifth Framework Programme. The authors thank the respective statistical offices for access to the data.

³ An alternative method would have been to use a pooled data set of these four countries and test econometrically for industry and country specific effects. However, confidentiality regulation prohibits the merge of firm data set of these four countries.

projects represents one measure of inter-firm knowledge spillovers and the share of innovative firms with public financial support is used as a proxy to cover the role of innovation policy activities for innovation in firms.

The rest of the paper is organised as follows. Section 2 gives a brief overview on the data sets used, including information on sector and size structures of the total firm population in manufacturing, and their comparability across the four countries. The sections 3 to 7 discuss country as well as sector differences and similarities and present results of the decomposition of the various innovation indicators mentioned before, i.e. the share of innovators, innovation input, innovation output, co-operation and public financial support respectively. Section 5 summarises the main findings of the paper.

2 Data Sets and Comparability

The Community Innovation Surveys take place every 4 years in European countries to investigate firm's innovation activities. In 2001, the third wave has been conducted. The CIS 3 follow the recommendations of the OSLO Manual on performing innovation surveys (see OECD and Eurostat, 1997). The surveys were carried out by national authorities and were co-ordinated by Eurostat. The questionnaire - including definitions - which was sent by post to the firms is harmonised across countries and includes some core as well as some optional questions. In the following we concentrate on questions common for all countries. Beyond the questionnaires, statistical survey methods, too, as well as data mining and analytical methods are co-ordinated by Eurostat. Table 2 summarises the main features of the surveys in each of the four countries considered.⁴

The CIS 3 covers all enterprises with 10 or more employees. An enterprise is defined as the smallest combination of legal units that is an organizational unit producing goods or services. In France, however, the target population for manufacturing covers firms with 20 or more employees, only. This fact makes difficult cross countries comparisons of Germany, Spain and Spain with France. In CIS 2 launched in 1997 the target population had also been

⁴ Note, figures in Table 2 like the response rate are related to the overall sample, not solely to manufacturing.

enterprises with at least 20 employees.⁵ One aim pursued with the new CIS 3 was to better understand the innovation activities among small firms which are a main part of the economy. Thus, despite the different coverage, in what follows we compare figures which are expanded to the respective target population of each country and only report additional figures for firms with at least 20 employees in all countries when there are major differences (more comparisons with 20 employees as cut-off point can be found in IEEF, 2004).

CIS 3 is based on stratified samples of the total firm population in each country, typically applying disproportional drawing probabilities by size class and sector. While for most countries carrying out the CIS 3, participation in the survey is voluntary for firms (such as in Germany and the UK), some countries have set CIS3 as compulsory (such as France and Spain).

Net sample sizes (i.e. the number of firms returning a completed questionnaire) vary considerably among the four countries. Although Germany has the largest total population of firms, the net sample size is the lowest. This is caused by a small sampling frame due to financing restrictions of the German CIS survey and a low response rate as a result of voluntary participation combined with a general somewhat greater reluctance of German firms to participate in surveys. The largest net samples are available for France and Spain as a result of compulsory surveys. The sampling ratios range from 3.4 % (Germany), 7.9 % (UK) and 13.7 % (Spain) to 18.6% (France). In order to control for a response bias in the net sample, non-response analyses (NRA) have been carried out in Germany. A stratified random sample of firms in the gross sample that did not respond to the questionnaire was asked on a few questions relating to core innovation activities, using a computer-assisted telephone interview technique. The sample size of the NRA was about the same size as the net sample in order to compensate for the low sample ratio. According to the Eurostat methodology, the results of the NRA were used to adjust weighting factors for each responding firm in order to represent differences in the response behaviour of innovating and non-innovating firms.

CIS 3 was launched in 2001 with reference year 2000, the total firm population thus refers to the year 2000. The size of the total firm population differs only slightly among the

⁵ The different target population in CIS 2 and CIS 3 hinders direct comparisons between the two waves (without losing much information) and we will leave out of account the development in time of innovation

four countries as can be gathered from Table 3. Germany shows the largest firm population in manufacturing (approximately 49,500 firms with 10 or more employees), followed by Spain (44,200) and the UK (39,400). France, for which the total population refers to firms with 20 or more employees, only, shows a total population of 24,500. This is the smallest figure even when compared with the respective total populations of firms with 20 and more employees in the three other countries (Germany: 38,300, UK: 27,700, Spain: 25,500). The large number of firms in Spain is somewhat astonishing as the country size in terms of GDP is only about a third of that of Germany, and only half of that of France and the UK. This result points to the fact that the firm density in Spanish manufacturing is high and the average firm size is low, i.e. the share of small firms is much higher than in the other three countries. The average size of Spanish firms, measured by the number of workers, is only somewhat higher than 50% of the size of its European counterparts (see Table 4). Only in a few isolated cases size is more similar to the firms' sizes in other European countries (e.g. high technology firms in Spain and UK).

Table 4 shows that in total and for all sectors the average firm size is higher in innovative firms in each country. This is in line with the second Schumpeter hypothesis and with various empirical findings showing that the incentives to innovate are generally directly related to size.

Divergence on the average size of the firms of the three biggest countries is, interestingly enough, more acute in the high technology sectors than in the low technology ones (see Table 4). This becomes especially clear when one focuses the sizes corresponding to firms with more than 20 employees. In addition, Germany, France and UK alternate in the ranking of average sizes by sectors. Spain shows, by the contrary, the smallest sizes across all sectors. All this suggests some ideas. Firstly, that dominantly acquired positions in one or another market, possibly due to scale economies, previous sunk investments or technological advantages and spillovers, tend to persist over time despite globalisation, and must be taken into account. Secondly, that the size of the domestic market matters, and probably more the less advanced the innovative activities of the firms in a particular industry or industries (which are likely to be associated to more intense exchanges).

indicators across the countries.

The total population of firms by sector (see Table 3) reveals the well known differences in sector specialisation. Germany has a comparatively large share of firms in machinery, electrical engineering (including medical, precision and optical instruments), plastics and metals. Spain's firm population shows relatively high shares in food, textile, non-metals and NEC. The firm population in the UK is rather strongly represented in transport, chemicals, and wood/paper, while France shows comparatively high firm numbers in food, textile, and metals. In total, Germany has a larger weight of high technology sectors (32 % of total number of firms), followed by the UK and France (29 and 27 %, respectively), while Spain has only one out of five firms in the high-technology sectors (19 %). As market incentives to innovate, as well as technological opportunities for developing new products and processes, are typically larger in high technology sectors, one may expect a higher share of innovative firms in Germany and a lower one for Spain.

Although CIS3 is a EU harmonised statistic some differences remain across countries which imply that very specific comparisons must be made with care. In particular, statistical errors associated with each number can differ greatly, and the different wording and the different institutional framework for some questions may induce somewhat different responses. Importantly the various methods used to deal with the difficult problem of item-non-response can lead to further differences in the numbers, both across countries and potentially within the national statistics. In any case, the numbers presented in the next sections have been checked both at the national and international levels, to ensure that they present a useful and reliable picture taken as a whole.

3 Spread of Innovation Activities

Germany has the biggest share or percentage of innovators (60%) within the period 1998-2000, with an important advantage over all the other countries. The aggregate proportion of France (41%) comes next, somewhat higher than the proportions of Spain (35%) and UK (34%), but this can be due to the fact that French proportions are referred to firms with more than 20 employees and the propensity to innovate is generally directly related to size. In fact, the numbers of France, Spain and UK are roughly comparable when referred to firms with

more than 20 employees (see IEEF, 2004).⁶ The divergences are smaller for the share of product innovators and the share of process innovators respectively, but still the shares are substantially higher for Germany than for the rest of the countries.

At the sector level, the most innovative industries come from the high-technology sector and are chemicals for France (64%), Spain (53%) and the UK (50%) and machinery for Germany (74%). Among the low-technology sectors rubber and plastic is the industry with the highest share of innovators in all four countries. This structure can also be seen for the share of product innovators. For process innovators a different picture emerges however. Especially industries that are under pressure to reduce costs normally tend to increase their efforts to generate process innovations. Low-technology sectors usually compete with prices instead of quality which might explain why the difference between the low-tech and high-tech sectors in the share of process innovators is smaller than the share of product innovators. The country differences in the share of process innovators in certain industries might also be the result of the different pressure on the firms to reduce costs or increase flexibility.

Spain shows a country specific phenomenon in the relative importance of product and process innovations. It is the only of the four countries where the share of process innovators is higher than the share of product innovators. This is mainly driven by the low-technology sector in Spain where all but the rubber and plastics industry had a higher share of process innovators. In the other three countries even for low-tech industries the share of product innovators is larger.

A fairly large amount of firms in all countries introduced both types of innovation which can be seen from the fact that the sum of the share of product and process innovators is higher than the overall share of innovators. This is not surprising as different types of innovations tend to be developed together, e.g. the production of a new product often requires also an

⁶ However, when calculating the share of firms with positive innovation expenditure in year 2000, a different picture emerges as about one half of the UK firms report that they have positive innovation expenditure. For the other three countries the difference between both indicators is much smaller (F: 33%, GER: 64%, S: 32%, see Table 7). The large divergence between both indicators in the UK may be real phenomenon and can be explained by a lag between an input into the innovation process and its output, i.e. an innovation. But as this phenomenon occurs not only in one specific industry (e.g. chemicals) but in all industries, another likely explanation is due to the fact that there is an important difference between the Eurostat and UK questionnaire because in the UK there is no filter, thus *all* firms answer the question on R&D and innovation expenditure. In France, innovation expenditure questions were not well answered.

innovative production technology. Some specific high values of the share of product relative to that of process innovators in low-technology sectors point to the fact that these industries are trying to avoid the price competition by producing high quality products. One example is the textile and leather industry in Germany which is well-known for its so called “smart textiles”, which are very innovative products.

The descriptive statistics of Table 5 already show that there are significant differences at the aggregate level across countries and that e.g. for Germany the shares of innovators are consistently higher across sectors, while for Spain and UK they do not seem to be very different sector by sector. But Germany is also more focussed on the high-technology sectors, especially machinery and equipment as their European counterparts. As market incentives to innovate, as well as technological opportunities for developing new products and processes, are typically higher in these sectors this might also explain Germany’s general leading role. To analyse which effects mainly drive differences across countries, in what follows we decompose the difference at the aggregate level for two countries at a time into a structure as well as a sector effect. The comparison is based on the following decomposition.⁷ Let R and C be the aggregate values of an indicator for two countries (R for row and C for column country say) and $i=1, \dots, S$ is an index for the industry. The difference between R and C can be written as

$$R - C = \sum_{i=1}^S (w_{R,i} - w_{C,i}) I_{R,i} + \sum_{i=1}^S w_{C,i} (I_{R,i} - I_{C,i})$$

$I_{R,i}$ and $I_{C,i}$ are the sector values and $w_{R,i}$ and $w_{C,i}$ the weights derived from the industry structure. The first term gives the role of the industrial structure, the second the role of the differences which are seen “sector by sector”.

The decomposition for the share of innovators is given in Table 12. It makes clear that Germany’s difference in the percentage of innovators originates mainly in sector by sector higher proportions of innovative firms. Differences in the sector structure are of minor importance, although are not completely negligible. For example 1.5 out of 19 percentage points difference in innovative firms between Germany and France can be explained by the

⁷ For a more detailed description of the methodology and the weights used, see the Appendix.

diverging industrial structure. Even when comparing with Spain, where the share of firms in high-technology sectors is substantially lower, the structure effect is only slightly more important. Moreover, the proportions of innovators of Spain and UK are surprisingly close sector to sector. The slight difference between Spain and UK in favour of Spain would be somewhat bigger, however, if the industry structure of the UK were not compensating lower sectorial proportions of innovators.

In summary, as the Tables shows, differences in industry structure are not very important at the time of determining the aggregate numbers.

4 Innovation Inputs

Developing innovations requires various inputs. R&D activities are a special part of innovation activities and they tend to be more institutionalised than innovation activities and are usually regarded as the core of innovation activities in manufacturing. Table 6 presents the share of manufacturing firms engaged in intramural R&D.⁸ Germany has again the biggest proportion of firms which performs R&D (39%). But with regards to this input, Spain shows now clearly the lowest value (14%). The proportion of firms with intramural R&D in Germany is 1.7 times the proportion of firms in UK (22%). The proportion of French firms, in between the two with 30%, may be again influenced by the question of the target population. In any case, the Spanish proportion clearly lags behind, setting the lower bound. This suggests that for Spain firms innovation activities which do not reach the level of R&D are important.

A common phenomenon in all countries is that high-technology industries have a higher share of firms engaged in intramural R&D than low-technology firms, which is not surprising. However, while nearly 60% and 50% of German and French high-tech firms perform intramural R&D, it is only about one third in Spain and UK. The industry with the largest share in all countries is the chemical industry which is known for its heavy reliance on basic research and institutionalised R&D efforts. Among the low-technology sector the plastic/rubber industry is the one with the largest share of firms with intramural R&D in all

⁸ To be more precise it is the share of firms with positive intramural R&D expenditure in 2000. The figures must be interpreted with care, because more detailed investigations have shown that there is some underestimation of French innovation expenditure and there are some interpretation problems with R&D expenditure and R&D employment in the UK.

countries but Germany. This industry is a major supplier for other industries like the automobile industry which require an ongoing increasing performance and quality of plastic and rubber materials. In order to be able to develop these products R&D is necessary.

As the Table 13 shows, differences in the industry structure across the four countries are again not very big important at the time of determining the aggregate numbers. The only partial exception is Spain: as R&D performer proportions are lower in the low technology sectors, the weight of these sectors in the Spanish economy induce a further lowering of the aggregate proportion. But also for Spain the sector effects are more important. One explanation for this may be the size structure of the Spanish industries with a substantial smaller average firm size. As larger firms are more likely to engage in R&D this can explain part of the lagging.

The R&D intensity (ratio of intramural R&D expenditure over total turnover) is much more similar across Germany (2.6%), France (2.1%) and UK (2.2%) than the share of R&D performers itself. However, Table 6 reveals that the effort of Spanish firms performing R&D is just one third of the effort its European counterparts and that the difference is firmly rooted in the effort differences in the high-technology sectors.⁹ The difference between high-tech and low-tech is substantial in all countries. In Spain the R&D intensity in high-tech is about three times that of low-tech, in France it is about five times higher, in Germany eight times and in the UK 14-times. As far as industries are concerned once again the country-specific set-up, strategy and environment of an industry play an important role. The UK chemical industry e.g. has an extremely high value for R&D intensity of 7.1% for all firms and 9% for innovators respectively. A large proportion of UK R&D is concentrated in this sector.

Developing innovations requires various inputs like human resources, physical capital and know-how. The ratio of innovation expenditure to total turnover usually referred to as the innovation intensity is an indicator for input efforts.¹⁰ At the aggregate level the indicator demonstrate similar differences as the R&D intensity: Germany has the highest innovation intensity with 5%, followed by the UK (3.5%) and France (3.2%). The relative behaviour of

⁹ Differences are however not so high in R&D employment what suggests that part of the differences can be related to the cost of R&D personnel (by composition reasons or wage levels).

Spanish firms slightly improves (1.9%), again pointing to the importance in Spanish firms of innovation activities which do not reach the category of R&D. Again, we do observe major differences across countries if looking at a particular sector, e.g. the electrical industry is the one with the highest innovation effort in Germany (8.9%), France (8.5%) and Spain (6.5%). In the UK however the electrical industry is in second place behind the chemical industry (mainly explained by the concentration of R&D in the pharmaceutical sector in the UK).

The firms in the high-tech sector are not only more frequently spending some amount on innovation activities than low-tech firms they are also spending a larger proportion of their sales. This is the case in all countries and independently whether we look at the innovation intensity for all firms or just for innovative firms, with the remarkable exception of Spain. Spanish innovators in the low-technology sector spend a larger share of their turnover on innovation activities than the high-tech sector. The wood and paper industry, despite its comparatively low share of innovators, now has the highest innovation intensity in Spain.

Compared to the share of innovative firms we find that diverging industrial structures play a more important role in explaining national differences in innovation intensities¹¹ (see Table 3). In this case the structure effect tends to be important for Spain. Notice that innovation expenditures tend to be roughly comparable in the low-technology sectors for all countries, even for Spain, but this is not the case in the high technology sectors. However, sector effects still dominates the structure effects for Germany or France.

5 Innovation Output

The share of sales with new or significantly improved products is used as a quantitative indicator for the success of product innovation activities. Since no harmonised output indicator for process innovations is available we will only focus on product innovation success. The share is highest in Germany with 45%, followed by Spain (32%) and UK (30%). The large share for the high-tech sector in all countries is in part a result of the high quality and eventually the high prices of the products these industries produce. In addition to that the

¹⁰ Innovation expenditure includes: R&D expenditure, expenditure for the acquisition of machinery and knowledge related to innovation and expenditure for training and marketing related to innovations.

¹¹ Similar results have been found for the R&D intensity.

products of most of these industries (with the exception of chemicals) have a shorter life-cycle than in the low-tech industries and thus the pressure to develop and market new and improved products is in general higher in these sectors. On the other hand some low-tech industries earn a substantial amount with product innovations like the NEC and recycling industry in France, Spain, Germany and the UK. What is even more surprising is that the German wood and paper industry has a share of turnover due to product innovations of almost 50%. As Table 8 shows the shares in certain sectors differ substantially between countries pointing again to the fact that there are still national peculiarities working.

6 Innovation Co-operation

Co-operation is a major topic for policy makers nowadays as more and more public funding for R&D and innovation is directed at fostering co-operation among companies and among companies and public institutions like universities or research labs. The rationale behind this policy is to generate or improve knowledge spillovers between public institutions and private firms or between private firms, as these spillovers are assumed to essentially lead to more growth and a better performance of the national system of innovation.

The share of innovative firms which are involved in co-operation projects shows, somewhat surprisingly, one of the largest and more different variations (see Table 10). France (35%) and the UK (26%), with proportions which could be not so far if measured for firms with the same size, present the highest degrees of cooperation. Germany presents the intermediate level (19%) and Spain the lowest (10%). This ranking of the countries is not only valid for manufacturing as a whole, but can also be found for most of the sectors within manufacturing, except for textile/leather where the UK has a slightly higher rate than France and machinery where the UK is substantially ahead. For all countries and partners the high-tech sectors exhibit a higher percentage of innovators involved in innovation co-operation than the low-tech sector. This is not surprising as high-tech sectors in general have a greater need for outside knowledge and are involved in riskier and more costly projects. They thus have a higher incentive to co-operate as knowledge spillovers and cost- and risk-sharing have been identified as motives for co-operation (see Abramovsky et al., 2004). A noteworthy result is that the glass/ceramics industry has the highest cooperation intensity in Germany although it belongs to the low-tech sector and is the industry with one of the lowest rates of innovators. This industry also has an exceptionally high rate of co-operating firms in France. The high variance of this indicator in an industry across countries suggests that it is not only

the sector composition of a country that leads to a high or low level of co-operation but the specific conditions and set up of certain industries within a country. Table 16 makes this clear. Differences in the sector composition of the economy are of minor importance for explaining the aggregate differences, with the partial exception of Spain. The weight of the low-technology industries, with a lower propensity of firms to cooperate, is again contributing to a low aggregate value.

A decomposition of the co-operation figures by type of partner shows that co-operative agreements with competitors from a firm's own industry are relatively rare in general. The highest share of firms with co-operative agreements with competitors can be found for the German chemical industry (19%). This sector is for all countries one of the industries with the largest rate of co-operation. The tough competition in the industry, a long development time for products and intellectual property rights might play a role in the emergence of this structure. Sometimes firms have to co-operate in order to be able to use certain patented technologies or processes. The largest difference between countries can be found in the food industry. In France and the UK this industry has one of the largest percentages of co-operation with competitors, but only few enterprises in that industry co-operated with competitors in Germany and Spain.

Co-operative agreements with the research base (scientific co-operations) are especially common among the high-technology industries, especially chemicals. This is not surprising as the high-technology industries are often more important in the first stages of the innovation process and thus normally rely more on basic knowledge. Usually research institutes and universities are those who produce this kind of knowledge. In Germany, it is again the glass/ceramics exhibiting the largest percentage of co-operating firms (31%). This share is also relatively high for France (23%). This is an indication that those innovators which co-operate in that industry are developing fairly sophisticated products and processes, even though they are considered as a low-technology firm. They probably profit significantly from research into new materials. The high importance of sophisticated textiles for the competitiveness of the European textile and leather industry is confirmed by the high percentage of innovators co-operating with the research base in three of the four countries.

Horizontal co-operations (with suppliers or customers) are relatively rare in Spain compared to other countries. Only 5.3% of Spanish innovators co-operated with customers or suppliers. In other countries like France and the UK the percentages are about four times higher. A comparison between the figures for co-operation with the research base and vertical

co-operations points out for manufacturing in France and Germany scientific institutes are more frequent co-operation partners while for Spain and the UK vertical co-operations are more important.

Increasing globalisation and competition in the home market have led to an increase in the importance of knowledge and partners from sources outside the home country. As Table 10 shows French innovative manufacturing firms have more co-operative agreements with foreigners than their European counterparts. Especially surprising is the low number of German firms which are involved in common innovation projects with foreigners. However, this small share is mainly driven by the low-technology sector. The global markets and relatively high number of multinational firms in the chemical industry is certainly one reason for the high percentages of foreign co-operations in all four European countries.

7 Public Financial Support for Innovation

Innovation is seen as one of the major drivers of growth, competitiveness and wealth of a nation. But conventional wisdom also stresses that “market failures” (induced by problems as sunk costs, moral hazard and free riding, imperfect appropriability, spill-overs etc.) may hinder R&D and innovation investments. In order to stimulate these investments, policy makers support innovations in various ways. The measures adopted include intellectual property rights, tax credits for certain investments or direct public subsidies for R&D and innovation activities and they can vary substantially between the countries in detail. In Table 9 we present the share of innovators which received public financial support for innovation in the period 1998-2000. The proportion of firms with public financial support turns out to be the virtually the same in France, Germany and Spain (about 30%) and clearly lower in the UK (about 20%).¹² This difference might be one explanation for the fact that the UK in general is lagging behind France and Germany in the spread of innovation activities. Differences among the three first countries are small and sometimes partly related to the differences in structure.

A closer look reveals that the proportion for the UK is closer in the high-technology sector. Proportions tend to be similar between the two types of sectors in France and Spain,

but are different in Germany and the UK. That relatively fewer low-technology firms receive public funding is not surprising as most countries try to support technologies that are complex and sophisticated or less standardised.

The structure of funding of certain industries differs a lot between the countries, e.g. in Germany about 48% of all innovators in transport received public support, in France the largest share can be found for the electrical industry (38%), in Spain for food, tobacco and beverages (39%) and in the UK for machinery (29%).

All the results have to be interpreted with care since they reflect the different public policies with regard to funding in general and funding of specific industries or technologies. Note that Table 9 only reflects on the share of innovators in an industry that received public funding and not on the amount of public money a certain industry received. Proportions of supported firms may be hiding, however, important differences in the amount of funds received by firms and the process by which these funds are assigned.

8 Conclusion

The aim of this paper has been to present evidence characterising the degree by which innovation activity presents differences across countries, and the extent by which these differences are country-specific, are related to the inter-country structure of the markets, or are due to differences in the composition of economic activity across countries. This has been done by analysing the extent of innovative activity, input and output indicators of innovation activities and some related behavioural and policy variables for eleven manufacturing sectors, with CIS3 data, in four large EU countries: France, Germany, Spain, and the UK.

Although CIS3 is a EU harmonised statistic some differences remain across countries which imply that very specific comparisons must be made with care. In particular, statistical errors, the different wording and the different institutional framework for some questions and the various methods used to deal with non-response can lead to statistical differences in the

¹² As other shares of firms this percentage is mainly determined by SMEs due to their large number. UK policy had been changed just a few years ago by introducing R&D tax credits for SMEs, thus it might be that their use spreaded later on and it's not reflected in the data.

numbers. But the data used have been checked both at the national and international levels, to ensure that they present a useful and reliable picture taken as a whole.

The data show significant differences among countries in most innovation indicators at the aggregate level: with respect to firm active participation in innovation, the innovation efforts, the innovation output and in both behavioural and technological policy variables (cooperation and public financial support respectively). This fact raises the question of which effects drive the differences across countries and the work of, at least, three important forces: the trend towards incentive equalisation, the development of integrated European markets and industry composition.

As a summary of facts, we can say the shares of innovators do not seem to be strikingly different sector by sector, with the exception of Germany where they are consistently higher across sectors. Specific high values are detected, however, for particular countries and sectors, which can be linked either to some European leadership of the firms in the sector (product innovation), or particular efforts to reduce costs and become more competitive (process innovation).

There is some additional heterogeneity, however, in innovation input measures. Germany shows often – but not always – the highest industry values while, in the other extreme, Spain shows consistently the lowest values (at the aggregate level partly due to relative industry concentration in the low technology sectors). Heterogeneity in input measures across countries in one sector can be considered mostly reflecting relative European-wide market positions of the involved firms. They also seem to remark that besides the production of innovations may be involved very different contents.

More heterogeneity may be involved in behaviour, where cooperation shows, somewhat surprisingly, one the largest and more different variations. France and the UK, with proportions which can be close, present the highest degrees of cooperation, while Germany only intermediate and Spain the lowest one.

Average proportions of financially supported firms tend to be similar with the exception of the UK (whose proportion of supported firms in high technology sectors is however not so dissimilar). Proportions of supported firms may be hiding, however, important differences in the amount of funds received by firms and the process by which these funds are assigned.

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Appendix: Computation of Structure and Sector Effects

The difference in various innovation indicators at the aggregate level for two countries at a time can be decomposed into a “structure” as well as a “sectors” effect by the following calculation. Let R and C be the aggregate values of an indicator for two countries (R for row and C for column country say) and $i=1, \dots, S$ is an index for the industry. The indicators can be written respectively as

$$R = \sum_{i=1}^S w_{R,i} I_{R,i} \quad \text{and} \quad C = \sum_{i=1}^S w_{C,i} I_{C,i}$$

which represent the weighted sums of the sector values of the country indicators $I_{R,i}$ and $I_{C,i}$ respectively, with weights derived from the industry structure. Sector values may be referred at any aggregation level and we use the split of manufacturing in eleven industries.¹³

It easy to see that the difference between indicators can be written as¹⁴

$$R - C = \sum_{i=1}^S (w_{R,i} - w_{C,i}) I_{R,i} + \sum_{i=1}^S w_{C,i} (I_{R,i} - I_{C,i}).$$

The first term is the “structure effect” which is calculated as the difference between the row country minus a virtual row country with the industry structure of the column country. The second term captures the “sector effect” computed as difference between a virtual country with sector values of the row country and structure of the column country minus the column country. Thus, the first term gives the role of the industrial structure, the second the role of the differences which are seen “sector by sector”.

Suitable weights differ according to the indicator. For the shares of firms measured as a percentage of all firms (e.g. share of innovators) the weight of sector i in country $j=C,R$ is simply based on the ratio of the number of firms in sector i to total population. In case of

¹³ The simple split in two sectors –high-technology sectors and low technology sectors- would also be possible. Of course, the specific amounts of both effects will depend on the sector aggregation level.

¹⁴ $R - C = \sum_{i=1}^S w_{R,i} (I_{R,i} - I_{C,i}) + \sum_{i=1}^S (w_{R,i} - w_{C,i}) I_{C,i}$ is an alternative decomposition.

indicators like the share of co-operating among innovating firms, the weight is given by the ratio of the number of firms in sector i to total population times the share of innovators in sector i and divided by the overall share of innovators. Concerning innovation intensity measured as innovation expenditure over total turnover the correct weight to be applied would be the ratio of sales of sector i to total sales. However, as this information is not available for the countries, we approximate sales by employees (computed from the number of firms and average firm size). The divergence of the explained differences compared to the actual differences in the Tables are due to the imperfection of the weights approximation.

The decomposition for various innovation indicators is given in Tables 12-16. For each couple of countries, the first entry is the difference between the indicators at the aggregate level while the second and third rows report the structure and sectors effect respectively. Each couple of countries admits two similar comparisons, which usually give similar results.

Tables

Table 1: Industry definitions

NACE Code	Industry Name	
34-35	Transport equipment	High- technology sectors
23-24	Chemicals	
29	Machinery and equipment	
30-33	Electrical	
15-16	Food, beverages and tobacco	Low- technology sectors
17-19	Textile and leather	
20-22	Wood and paper	
25	Rubber and plastic products	
26	Non-metallic mineral products	
27-28	Metallic products	
36-37	NEC and recycling	

Table 2: Characteristics of CIS 3 in France, Germany, Spain and UK

	France	Germany	Spain	UK
Responsible national authority	INSEE for trade and services, SESSI for the manufacturing industry, Ministry of Research for R&D firms, Banks and Insurance companies, SCEES for the food industry ^(e)	ZEW (Centre for European Economic Research, on behalf of German ministry for technology and education)	INE (Instituto Nacional de Estadstici)	DTI (Department of Trade and Industry)
Participation	compulsory	voluntary	compulsory	voluntary
Target population (number of employees)	20 for the manufacturing industry, 10 elsewhere	5	10	10
Frame population ^(a)	Business Register	Credit reform database	official INE register of firms (DIRCE)	Interdepartmental Business Register (IDBR)
Covered sectors ^(b)	C, D, E, G, I, J, K	C, D, E, F, G, I, J, K, O (only 90)	C, D, E, F, G, H, I, J, K, N, O	C, D, E, F, G (except 50,52), I, J, K
Stratification	Size, sectors	Size, sectors, region	Size, sectors	Size, sectors, region
Gross sample ^(d)	9,620	20,717	-	19,602
Net sample	7,836	4,611	11,778	8,172
Response rate	82%	22 %	-	42 %
Non-response analysis ^(c)	no	yes	no	yes

Notes:

(a) A business register didn't exist in Germany, Credit reform is the largest German credit rating agency. The database included more than xxx German firms.

(b) According to NACE classification: C (mining and quarrying), D (manufacturing), E (electricity, gas and water supply), F (construction), G (wholesale, retail trade, repair of motor vehicles), H (hotels), I (transport, storage and communication), J (financial intermediation), K (real estate, renting and business activities), N (health and social work), O (other community, social and personal service activities).

(c) Sample size of non-response in Germany: 4000.

(d) In France, the sampling rate varies by industry.

(e) INSEE (Institut National de la Statistique et des Etudes Economiques), SESSI (Industrial Statistics Bureau of the Ministry of Industry), SCEES (Ministry of Agriculture).

Table 3: Population and sample size in France, Spain, UK and Germany in 2000

	Population, firms with 10 or more employees ^(a)				Population, firms with 20 or more employee ^(b)				Sample size ^(a)			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	–	1334	1427	1685	880	1192	900	1348	222	77	358	325
Chemicals	–	1745	1574	1718	1264	1439	1057	1429	433	124	403	128
Machinery	–	7214	3492	3995	2291	5410	1983	2897	462	254	377	236
Electrical	–	5712	2128	4157	2301	4714	1274	3026	518	240	495	481
<i>High-technology sectors</i>	–	<i>16005</i>	<i>8620</i>	<i>11555</i>	<i>6736</i>	<i>12755</i>	<i>5213</i>	<i>8701</i>	<i>1,635</i>	<i>695</i>	<i>1633</i>	<i>1170</i>
Food/beverages/tobacco	–	5466	6288	2574	3104	4350	3576	2099	898	150	672	227
Textile and leather	–	2656	6962	2942	2878	2010	4439	2099	599	102	903	185
Wood and paper	–	7267	5896	7191	3010	5006	3338	4764	451	147	802	465
Rubber/plastic	–	3615	1962	2662	1490	2857	1187	2046	301	151	245	158
Glass/Ceramics	–	2505	3294	1412	880	1831	1929	885	180	88	427	83
Metallic products	–	9445	7309	8182	5073	7606	3812	5188	673	270	807	416
NEC and recycling	–	2559	3895	2840	1350	1839	2022	1955	242	71	554	404
<i>Low-technology sectors</i>	–	<i>33513</i>	<i>35606</i>	<i>27803</i>	<i>17785</i>	<i>25499</i>	<i>20303</i>	<i>19036</i>	<i>3,344</i>	<i>979</i>	<i>4410</i>	<i>1938</i>
Manufacturing	–	49519	44226	39358	24521	38253	25516	27737	4,979	1674	6043	3108

Notes: (a) Population are firms with 10 or more employees except for France where the threshold is 20 employees. The symbol “–” means non-available data.

Table 4: Average firm size in France, Spain, UK and Germany in 2000

	Average firm size ^(a) , total population				Average firm size ^(b) , total population				Average firm size ^(c) , innovators			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	–	642.7	147.7	184.1	509	716.5	225.7	226.7	937	973	283.5	263.9
Chemicals	–	330.7	113.4	161	250	398.9	161.9	190.6	319	470.3	169.4	215.3
Machinery	–	126.4	45.2	72.4	130	164.3	68.6	94.5	195	157.3	60.3	107.4
Electrical	–	162.2	72.9	112.3	215	194.2	112.1	148.9	313	225.1	99.2	152.8
<i>High-technology sectors</i>	–	204.5	81.5	116.2	231	253.4	125.3	149.7	345	274.8	124.6	163.3
Food/beverages/tobacco	–	79.5	48.0	147.5	135	96.9	73.6	177.9	218	92.2	73.5	193.7
Textile and leather	–	84.3	36.7	65.7	79	106.9	49.5	86.4	112	123.3	46.1	104.7
Wood and paper	–	76.2	38.8	78.5	96	104.5	57.7	111.2	142	96.8	45.0	106
Rubber/plastic	–	80.9	50.0	78.3	159	98.9	73.7	97.7	219	100.7	61.8	125
Glass/Ceramics	–	99.9	46.2	109.5	148	130.4	69.2	166.3	192	155.2	64.6	193
Metallic products	–	93.3	39.3	43.7	96	112.9	62.2	60.6	168	134.9	61.2	64
NEC and recycling	–	67.5	32.3	60.5	102	88.0	48.6	81.5	143	84	43.5	86.9
<i>Low-technology sectors</i>	–	83.8	40.7	73	108	106.0	60.7	100.1	173	111.9	56.5	106.9
Manufacturing	–	122.8	48.6	85.7	142	155.1	73.9	115.6	238	173.4	74.0	132.9

Notes: (a) Population are firms with 10 or more employees. (b) Population are firms with 20 or more employee. (c) Population are firms with 10 or more employees except for France where the threshold is 20 employees. The symbol “–” means non-available data.

Table 5: Share of Innovators in France, Spain, UK and Germany in 2000

	Share of innovators (product and/or processes), total population				Share of product innovators, total population				Share of process innovators, total population			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	46.7	62.8	39.0	37.8	40.2	52.3	30.4	28.4	26.1	44.1	27.6	26
Chemicals	64.3	67.4	52.7	50	59.8	59.7	43.4	46.6	35.9	40.2	33.1	23.5
Machinery	51.7	73.6	43.9	39.3	48.0	66.0	36.1	31.5	22.3	42.7	27.1	21.1
Electrical	59.6	67.2	50.2	48.6	54.0	62.2	40.8	40.8	32.8	31.2	32.6	24.4
<i>High-technology sectors</i>	<i>56.1</i>	<i>69.7</i>	<i>46.3</i>	<i>44</i>	<i>51.3</i>	<i>62.8</i>	<i>37.7</i>	<i>36.6</i>	<i>28.9</i>	<i>38.5</i>	<i>29.6</i>	<i>23.4</i>
Food/beverages/tobacco	40.2	50.8	34.4	31.2	34.0	39.2	22.8	18.9	24.2	30.8	25.9	27.7
Textile and leather	27.0	49.5	25.3	24.3	23.4	39.5	13.8	16.4	13.4	20.4	18.9	15.1
Wood and paper	30.3	57.9	35.6	34.1	20.3	36.8	19.6	19.3	20.3	42.7	27.5	23.9
Rubber/plastic	51.9	63.0	43.0	37.1	44.8	52.9	30.1	30	35.3	36.8	26.8	26
Glass/Ceramics	45.7	49.1	32.8	22.6	42.1	44.6	21.1	17.9	18.8	28.2	25.2	14.5
Metallic products	30.5	53.8	30.3	27.5	21.0	35.5	17.7	17.6	21.3	39.3	20.3	19.2
NEC and recycling	38.8	59.3	35.4	25.6	31.2	42.2	25.4	17.9	21.2	37.1	24.1	17.4
<i>Low-technology sectors</i>	<i>34.8</i>	<i>54.9</i>	<i>32.4</i>	<i>29.7</i>	<i>27.4</i>	<i>39.8</i>	<i>20.0</i>	<i>19.3</i>	<i>21.4</i>	<i>35.9</i>	<i>23.4</i>	<i>21</i>
Manufacturing	40.6	59.7	35.1	33.9	33.9	47.2	23.4	24.4	23.5	36.7	24.6	21.7

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 6: R&D activities in France, Spain, UK and Germany in 2000

	Share of firms with intramural R&D, total population				R&D intensity (intramural R&D expenditure to total turnover), total population				R&D intensity (intramural R&D expenditure to total turnover), innovators			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	38.9	49.1	19.0	22.5	4.8	3.9	0.7	0.6	4.8	4	0.8	0.4
Chemicals	58.0	57.8	37.2	42.2	1.4	3	0.7	7.1	1.7	3.2	0.8	9.0
Machinery	44.3	58.1	28.0	37.9	1.9	3.3	1.0	0.9	2.2	3.5	1.4	1.1
Electrical	48.8	57.2	31.0	34.1	5.6	5.6	1.9	4.3	6.1	6.1	2.4	2.1
<i>High-technology sectors</i>	<i>47.7</i>	<i>57</i>	<i>29.0</i>	<i>35</i>	<i>3.2</i>	<i>4.0</i>	<i>0.9</i>	<i>4.1</i>	<i>3.8</i>	<i>4.2</i>	<i>1.1</i>	<i>4.1</i>
Food/beverages/tobacco	25.7	19.1	13.3	22.7	0.5	0.2	0.2	0.2	0.7	0.3	0.3	0.2
Textile and leather	18.0	43.6	6.6	16.5	0.6	0.3	0.4	0.2	1.2	0.5	0.9	0.2
Wood and paper	20.1	21.6	8.6	11	0.4	0.5	0.2	0.1	0.8	0.6	0.4	0.1
Rubber/plastic	42.5	36.9	21.7	29.7	1.2	0.8	0.6	0.7	1.6	1	1.0	0.9
Glass/Ceramics	31.4	42.6	11.0	13.9	0.7	1.3	0.3	0.3	1.0	1.7	0.7	0.6
Metallic products	20.8	35.9	10.7	12.3	0.6	0.6	0.3	0.2	1.0	0.7	0.5	0.2
NEC and recycling	26.6	23.4	11.8	20.9	1.1	0.4	0.4	1.1	1.8	0.5	0.7	2.0
<i>Low-technology sectors</i>	<i>23.9</i>	<i>30.3</i>	<i>10.8</i>	<i>16.2</i>	<i>0.6</i>	<i>0.5</i>	<i>0.3</i>	<i>0.3</i>	<i>1.0</i>	<i>0.7</i>	<i>0.5</i>	<i>0.4</i>
Manufacturing	30.4	38.9	14.3	22.3	2.1	2.6	0.6	2.2	2.8	3	0.8	2.4

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 7: Innovation input in France, Spain, UK and Germany in 2000

	Share of firms with innovation expenditure, total population				Innovation intensity (innovation expenditure over total turnover, %), total population				Innovation intensity (innovation expenditure over total turnover, %), innovators			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	41.6	72.2	33.8	50.4	5.2	7.6	2.6	1.9	5.5	7.8	3.0	3.2
Chemicals	61.9	67.2	49.7	70.2	2.8	4.7	1.3	8.2	3.5	5	1.4	12.7
Machinery	45.5	79.4	45.2	57.4	2.5	5.8	2.1	3.1	3.0	6.1	3.0	4.6
Electrical	51.9	74.6	47.9	64.5	8.5	8.9	3.0	6.5	9.3	9.8	3.8	5.6
<i>High-technology sectors</i>	<i>50.3</i>	<i>75.7</i>	<i>44.7</i>	<i>60.7</i>	<i>4.8</i>	<i>6.8</i>	<i>2.2</i>	<i>5.4</i>	<i>5.5</i>	<i>7.2</i>	<i>2.5</i>	<i>7.6</i>
Food/beverages/tobacco	32.5	57.9	32.3	47.2	1.3	0.9	1.1	1.4	1.9	1.2	1.8	2.5
Textile and leather	19.6	55.8	21.1	36.8	0.7	1.4	1.5	1.4	1.5	1.9	3.1	3.1
Wood and paper	21.9	60.8	32.5	49	0.8	4.5	2.4	1.6	1.8	5.7	4.8	3.2
Rubber/plastic	45.8	65.1	41.2	55.2	1.7	3.4	1.9	2.1	2.2	4.2	3.3	2.8
Glass/Ceramics	38.1	63.5	28.7	49.1	1.1	3.1	1.8	1.8	1.5	3.8	3.5	3.9
Metallic products	23.2	55.2	29.1	46.6	1.1	1.9	1.7	1.9	1.7	2.3	2.8	3.1
NEC and recycling	30.2	58.7	32.7	48.3	1.5	1.4	2.1	1.8	2.4	1.9	3.3	3.5
<i>Low-technology sectors</i>	<i>27.2</i>	<i>58.9</i>	<i>29.7</i>	<i>47.4</i>	<i>1.2</i>	<i>2.2</i>	<i>1.6</i>	<i>1.6</i>	<i>1.8</i>	<i>2.9</i>	<i>2.9</i>	<i>3.0</i>
Manufacturing	33.5	64.3	32.6	51.3	3.2	5.0	1.9	3.5	4.2	5.8	2.7	5.5

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 8: Innovation output in France, Spain, UK and Germany in 2000

	Innovative sales (turnover due to new or significantly improved products over total turnover, %), product innovators			
	France*	GER	Spain	UK
Transport equipment	30.3	76.7	59.8	44.6
Chemicals	10.6	23.1	13.2	26.3
Machinery	19.3	32.4	29.8	26.0
Electrical	31.3	59.3	40.2	50.5
<i>High-technology sectors</i>	<i>22.7</i>	<i>51.7</i>	<i>37.8</i>	<i>38.0</i>
Food/beverages/tobacco	8.3	18.2	18.9	11.3
Textile and leather	14.8	23.9	31.0	31.8
Wood and paper	10.2	49.6	22.2	23.8
Rubber/plastic	13.8	34.3	25.9	26.7
Glass/Ceramics	9.8	36.2	26.9	16.7
Metallic products	9.8	27.4	24.1	23.0
NEC and recycling	21.3	33.8	41.7	36.8
<i>Low-technology sectors</i>	<i>10.7</i>	<i>30.4</i>	<i>24.0</i>	<i>20.8</i>
Manufacturing	18.7	45	32.4	30.4

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 9: Public financial support for innovation in France, Spain, UK and Germany in 2000

Share of firms with public financial support for innovation, innovators				
	France*	GER	Spain	UK
Transport equipment	33.2	47.7	37.0	18.9
Chemicals	25.0	29	34.1	19.9
Machinery	26.1	27	19.3	28.5
Electrical	38.2	35.1	36.0	23.8
<i>High-technology sectors</i>	<i>31.0</i>	<i>31.5</i>	<i>29.4</i>	<i>24.0</i>
Food/beverages/tobacco	21.5	21.7	38.8	28.3
Textile and leather	25.1	32.6	31.5	19.7
Wood and paper	34.4	29.9	31.4	10.2
Rubber/plastic	37.3	13.7	25.0	12.0
Glass/Ceramics	13.9	27.9	32.4	23.0
Metallic products	34.3	31.9	27.0	22.8
NEC and recycling	28.6	25.4	30.0	22.3
<i>Low-technology sectors</i>	<i>29.1</i>	<i>26.9</i>	<i>31.4</i>	<i>18.0</i>
Manufacturing	29.8	28.6	30.9	20.3

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 10: Innovation cooperation agreements in France, Spain, UK and Germany in 2000

	Share of firms with innovation co-operations, innovators				Share of firms with international innovation co-operations, innovators			
	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	37.8	27.3	17.3	36.5	27.7	19.8	7.4	22.9
Chemicals	55.0	33.8	28.7	39.8	39.4	23.2	20.6	27.5
Machinery	29.5	26.0	9.4	34.4	19.4	13.2	2.6	13.3
Electrical	45.1	32.0	18.1	33.5	31.4	12.6	8.4	24.0
<i>High-technology sectors</i>	<i>41.5</i>	<i>28.9</i>	<i>16.9</i>	<i>35.2</i>	<i>29.0</i>	<i>14.5</i>	<i>8.6</i>	<i>21.2</i>
Food/beverages/tobacco	35.2	6.0	8.4	26.1	15.3	4.1	1.3	14.6
Textile and leather	23.4	22.8	7.0	24.2	9.3	6.7	0.5	15.0
Wood and paper	28.5	6.8	9.6	15.5	14.3	1.2	1.4	5.7
Rubber/plastic	36.2	19.6	6.4	24.7	17.5	5.5	2.8	16.5
Glass/Ceramics	43.3	35.1	9.2	17.7	26.4	4.3	4.4	13.6
Metallic products	31.0	13.6	7.1	23.6	17.5	3.9	2.7	5.4
NEC and recycling	20.4	2.6	5.3	14.2	14.8	0.7	1.4	5.9
<i>Low-technology sectors</i>	<i>31.5</i>	<i>12.8</i>	<i>7.7</i>	<i>20.6</i>	<i>15.8</i>	<i>3.5</i>	<i>1.9</i>	<i>8.9</i>
Manufacturing	35.5	18.9	10.1	26.2	21.0	7.7	3.6	13.6

Notes: Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 11: Innovation co-operation partners in France, Spain, UK and Germany in 2000

	Share of firms with scientific co-operations (with the research base) ^(a) , Innovators				Share of firms with vertical co-operations (with suppliers or customers), Innovators				Share of firms with horizontal co-operations (with competitors), Innovators			
	France	GER	Spain	UK	France	GER	Spain	UK	France	GER	Spain	UK
Transport equipment	21.5	13.8	12.0	15.5	23.2	24.1	9.2	30.6	10.2	9.6	5.2	3.7
Chemicals	36.3	28.4	25.9	21.4	32.5	20.6	18.6	25.7	11.6	18.7	14.2	7.1
Machinery	14.8	20.7	7.8	25.9	20.9	18.5	4.8	27.1	6.3	5.4	1.4	4.2
Electrical	27.2	20.3	14.4	16.3	32.1	22.3	10.5	26.8	10.3	12.9	5.1	5.1
<i>High-technology sectors</i>	<i>24.7</i>	<i>20.9</i>	<i>13.9</i>	<i>20.4</i>	<i>27.7</i>	<i>20.5</i>	<i>9.8</i>	<i>27.2</i>	<i>9.3</i>	<i>9.7</i>	<i>5.6</i>	<i>5.0</i>
Food/beverages/tobacco	18.3	5.3	7.1	12.2	23.9	3.3	4.5	15.6	10.4	1.9	1.3	7.8
Textile and leather	15.7	17.7	2.8	16.8	16.0	19.2	1.4	18.2	5.2	5.2	3.4	5.7
Wood and paper	9.7	2.5	6.8	5.0	19.3	2.4	3.2	12.0	4.3	2.1	1.8	1.9
Rubber/plastic	14.7	10.3	4.9	15.9	22.6	13.1	3.9	18.3	5.7	5.9	2.2	2.4
Glass/Ceramics	22.5	31.0	7.7	15.5	31.1	12.8	4.5	16.8	8.6	8.9	4.3	3.1
Metallic products	15.9	8.6	5.2	12.8	18.5	11.5	5.0	20.7	5.7	5.0	2.9	3.9
NEC and recycling	9.5	1.0	3.6	3.5	12.7	2.6	3.4	10.9	1.8	1.0	1.7	5.5
<i>Low-technology sectors</i>	<i>15.6</i>	<i>8.4</i>	<i>5.5</i>	<i>10.6</i>	<i>20.4</i>	<i>8.3</i>	<i>3.7</i>	<i>16.1</i>	<i>6.4</i>	<i>3.9</i>	<i>2.4</i>	<i>3.8</i>
Manufacturing	19.2	13.1	7.7	14.3	23.3	12.9	5.3	20.3	7.5	6.1	3.2	4.3

Notes: (a) Scientific co-operation partners are universities or higher education institutions, government or private non-profit research institutes and commercial laboratories or R&D enterprises. Population are firms with 10 or more employees, except for France, where population concerns firms with 20 or more employees.

Table 12: Share of innovators:
A decomposition of differences into structure effect and sector effect

	France	Germany	Spain	UK
France		-19.0	5.6	6.8
		-1.6	1.7	-0.2
		-17.5	3.8	6.9
Germany	19.0		24.6	25.8
	1.5		2.9	0.4
	17.6		21.7	25.4
Spain	-5.6	-24.6		1.2
	-1.5	-2.8		-2.2
	-4.0	-21.8		3.4
UK	-6.8	-25.8	-1.2	
	0.6	-0.4	2.5	
	-7.3	-25.4	-3.7	

Notes: Structure effect: row country minus a virtual row country with the industry structure of the column country. Sectors effect: a virtual country with sector values of the row country and structure of the column country, minus the column country.

Table 13: Share of firms with intramural R&D
A decomposition of differences: structure effect and sector effect

	France	Germany	Spain	UK
France		-8.5	16.1	8.1
		-1.5	2.1	-0.4
		-7.0	14.0	9.2
Germany	8.5		24.6	16.6
	0.7		2.7	0.7
	7.8		21.9	16.6
Spain	-16.1	-24.6		-8.0
	-1.9	-3.0		-2.1
	-14.2	-21.6		-5.1
UK	-8.1	-16.6	8.0	
	-0.3	-1.3	1.2	
	-8.5	-16.1	6.1	

Notes: See Table 12. The divergence of the explained differences compared to the actual differences in the tables for UK are due to the imperfection of the weights approximation and slightly different method of treating missing values compared to Eurostat methodology.

Table 14: Innovation intensity
A decomposition of differences: structure effect and sector effect

	France	Germany	Spain	UK
France		<i>-1.8</i>	<i>1.3</i>	<i>-0.3</i>
		<i>-0.2</i>	<i>0.7</i>	<i>0.2</i>
		<i>-1.7</i>	<i>0.4</i>	<i>-0.3</i>
Germany	<i>1.8</i>		<i>3.1</i>	<i>1.5</i>
	<i>0.5</i>		<i>1.2</i>	<i>0.5</i>
	<i>1.5</i>		<i>1.8</i>	<i>1.3</i>
Spain	<i>-1.3</i>	<i>-3.1</i>		<i>-1.6</i>
	<i>-0.1</i>	<i>-0.2</i>		<i>-0.2</i>
	<i>-0.9</i>	<i>-2.8</i>		<i>-1.0</i>
UK	<i>0.3</i>	<i>-1.5</i>	<i>1.6</i>	
	<i>-0.1</i>	<i>-0.3</i>	<i>0.3</i>	
	<i>0.2</i>	<i>-1.6</i>	<i>0.8</i>	

Notes: See Table 12.

Table 15: Cooperation
A decomposition of differences: structure effect and sector effect

	France	Germany	Spain	UK
France		<i>16.6</i>	<i>25.4</i>	<i>9.3</i>
		<i>1.2</i>	<i>2.1</i>	<i>0.7</i>
		<i>14.9</i>	<i>22.9</i>	<i>8.2</i>
Germany	<i>-16.6</i>		<i>8.8</i>	<i>-7.3</i>
	<i>-0.8</i>		<i>1.4</i>	<i>0.0</i>
	<i>-15.3</i>		<i>7.5</i>	<i>-7.2</i>
Spain	<i>-25.4</i>	<i>-8.8</i>		<i>-16.1</i>
	<i>-1.3</i>	<i>-0.4</i>		<i>-1.3</i>
	<i>-23.6</i>	<i>-8.4</i>		<i>-14.8</i>
UK	<i>-9.3</i>	<i>7.3</i>	<i>16.1</i>	
	<i>-0.9</i>	<i>-0.2</i>	<i>1.3</i>	
	<i>-8.0</i>	<i>7.4</i>	<i>14.8</i>	

Notes: See Table 12.

Table 16: Public funding
A decomposition of differences: structure effect and sector effect

	France	Germany	Spain	UK
France		1.2	-1.1	9.5
		-0.4	1.5	-1.1
		1.6	-2.6	10.7
Germany	-1.2		-2.3	8.3
	-0.5		-0.2	-0.8
	-0.7		-2.2	9.2
Spain	1.1	2.3		10.6
	0.3	1.0		0.9
	0.8	1.3		9.8
UK	-9.5	-8.3	-10.6	
	-1.0	-1.1	-0.9	
	-8.6	-7.3	-9.8	

Notes: See Table 12.