Virtual Micro Data Laboratory Data Brief: Spring 2007[1]

Community Innovation Survey

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The Community Innovation Survey (CIS) is a survey conducted every 4 years by EU member states to measure progress in the area of innovation. The CIS complements other indicators of innovativeness by providing a regular snapshot of innovation inputs and outputs and the constraints faced by businesses in their innovation efforts. This data brief provides an overview of the UK CIS and describes how the CIS data has been used for research in conjunction with other ONS business data sets held within the Virtual Microdata Laboratory. The brief concludes with an analysis of how various firm characteristics influence innovative activity.

1. Overview of the CIS

The CIS is based on a core questionnaire developed by the European Commission (EuroStat) and member States, to which the DTI adds questions for the purpose of the UK CIS. The survey structure has changed over time. In general the survey covers product, process and wider innovation including expenditure on different kinds of innovative activity, effects of innovation, sources of information and co-operation, barriers to innovation, protection methods for innovation, and public support for innovation.

Within the CIS**,** innovation is defined as ***major changes aimed at enhancing a firm's competitive position, performance, know-how, or capabilities for future enhancements***. These can be new or significantly improved goods, services or processes for making or providing them. Expenditure on innovative activities includes machinery and equipment, R&D, training goods and service design or marketing. The CIS is carried out at the level of the enterprise. As such, an enterprise may carry out one or more activities at one or more locations.

There have been four CIS surveys conducted to date, each covering a three-year period.

- CIS 1 covers the period 1991-1993. Due to the poor response rate (10%), this survey is regarded as being of poor quality and is not available within the VML.
- CIS 2 covers the period 1994-1996. In total 5,416 enterprises were surveyed, of which 2,339 responded to the survey achieving a response rate of 43%.
- CIS 3 covers the period 1998-2000 and was conducted in two waves. The first wave sampled 13,340 enterprises. Of the 19,625 enterprises to which the survey was sent, 8,172 responded achieving a response rate of 42%.

[1] For information on the CIS or other business data sets held within the VML, please email: vml@ons.gov.uk.

- CIS 4 covers the period 2002-2004. It is the largest of the innovations surveys conducted so far, sent to some 28,000 UK enterprises. Of those, 16,445 enterprises provided valid responses, representing a response rate of 58%.

The sample of enterprises is drawn from the ONS Inter-Departmental Business Register (IDBR) and is based upon those firms with more than 10 employees. The sample is designed to be statistically representative of the 12 regions of the UK, most industrial sectors and all sizes of firms. The responses to the survey are weighed back to the population using the inverse sampling proportion in each stratum. On average, each respondent in CIS4 represents 11 enterprises in the population.

The CIS is a voluntary postal survey. To boost response, enterprises are sent the survey, posted a reminder, posted a second reminder (with the survey again) and finally telephoned. There are a number of concerns about the data, primarily as the result of inconsistent responses provided by survey respondents. A number of marker variables were created in the cleaning process to identify problematic cases.

2. Linking CIS to ONS Business Data

The IDBR is the key sampling frame for business surveys within ONS. Enterprises appearing within ONS surveys are assigned a unique IDBR reference number which can facilitate linking of information on the same enterprise over time and between surveys. The reporting unit identifier in the CIS is given by ru_ref in CIS2 and ruref in CIS3 and CIS4. There are 789 reporting units which appear in CIS2 and CIS3, and 959 reporting units which appear in CIS3 and CIS4. One hundred and one reporting units appear in all three CIS surveys.

Linking of information on the same enterprise between surveys provides the opportunity to explore research questions that otherwise would not have been possible. The largest and most comprehensive ONS business survey is the Annual Business Inquiry. This survey includes information on turnover, costs, employment and investment. Due to the size and content of this survey, the ABI generally forms the spine against which most linking activity takes place. Responses to the CIS can therefore be linked to information collected on these organisations collected from the ABI.

Within the VML, information from the ABI is held in the Annual Respondents Database (ARD). To reduce compliance costs, the ABI is not a census of all businesses, with smaller reporting units being sampled. Within the ARD there are therefore two types of enterprise. Information collected directly from the survey returns of the ABI are held on the ‘selected files’ of the ARD. Information on those organisations included within the ABI survey universe but which are not included within the actual survey during a given year are held on the `non-selected’ files. By including information from the ‘non-selected’ ARD files, the coverage of the ARD is broadened considerably. However, the range of data items held on the non-selected files is more limited.

Table 1 shows the number of links that can be made between the CIS and the ARD, differentiating between links with selected and non-selected files. It is noted that whilst the ABI is an annual survey, the CIS covers a three year period. However, a number of questions in the survey refer only to the last of the three years covered by the survey. This suggests that the most appropriate link is likely to be to the ABI in that year. Table 1 therefore shows the number of links that can be expected when linking CIS2 to the 1996 ARD, CIS3 to the 2000 ARD and CIS4 to the 2004 ARD. It can be seen that for the CIS4, over 90% of enterprises can be linked to the ARD, with approximately 38% being able to be linked to the detailed information contained within the ‘selected’ files.

Table 1: CIS Survey Sample and links to the Annual respondents Database

	CIS Sample	**Links to the Annual Respondents Database**		
		Selected Files	Non-selected Files	Total Links
CIS2	2,342*	248	109	357
CIS3	8,172	3,472	4,010	7,482
CIS4	16,445	6,179	8,710	14,889

*Three replicated reference numbers have been removed from the original CIS sample

3. Previous Research Using the CIS

As the sponsor of the UK Community Innovation Survey, the DTI is one of the most active users of the survey for research purposes. A summary of some of the DTI-sponsored research projects using the CIS is shown below.

Innovative Business and the Science and Technology Base (Swann, 2002)
This analysis uses CIS3 to assess the role of the university (and other research institutions) as a source of information and cooperation for innovative businesses and the effect of such cooperation on business performance. It finds that companies are more likely to cooperate with universities when they are process innovators, but less likely when they are product innovators. The results suggest that universities play a relatively more important role through cooperation than as a source of information. Cooperation with the university is especially effective in achieving better process performance - i.e. greater production flexibility, reduced unit labour costs, and increased capacity.

Design and company performance: Evidence from the Community Innovation Survey (Cereda et. al, 2005)
This research undertakes an analysis of the relation between design inputs and other innovation and economic performance indicators. The authors find that around 9% of firms reported some spending on design and that design spending represented around 10% of all reported spending on innovative activities. They also find that design has a positive and statistically significant association with product innovation but not process innovation. They estimate a marginal return to design expenditure of about 17% which they state is likely to be an overestimate of the causal effect. Receiving government support raises design expenditure by about 3% of mean expenditure (for those firms undertaking expenditure).

Information Technology, Organisational Change and Productivity (Crespi, Criscuolo and Haskel, 2006)
This research uses the CIS3 and ARD to examine the relationships between productivity growth, IT investment and organisational change. Consistent with the small number of other micro studies the researchers find that (a) IT appears to have high returns in a growth accounting sense when organisational change is omitted; when organisation change is included the IT returns are greatly reduced, (b) IT and organisational change interact in their effect on productivity growth, (c) non-IT investment and organisational change do not interact in their effect on productivity growth.

Productivity, Exporting and the Learning-by-Exporting Hypothesis (Crespi, Criscuolo and Haskel, 2006)
This research uses a matched CIS2-CIS3 panel to examine the proposition that exporting firms learn from their clients and this learning raises their productivity. The research finds that (a) firms who exported in the past are more likely to report that they learnt from buyers (relative to learning from other sources) and that (b) firms who had learned from buyers (more than they learnt from other sources) exhibited higher productivity growth, supporting the learning-by-exporting hypothesis.

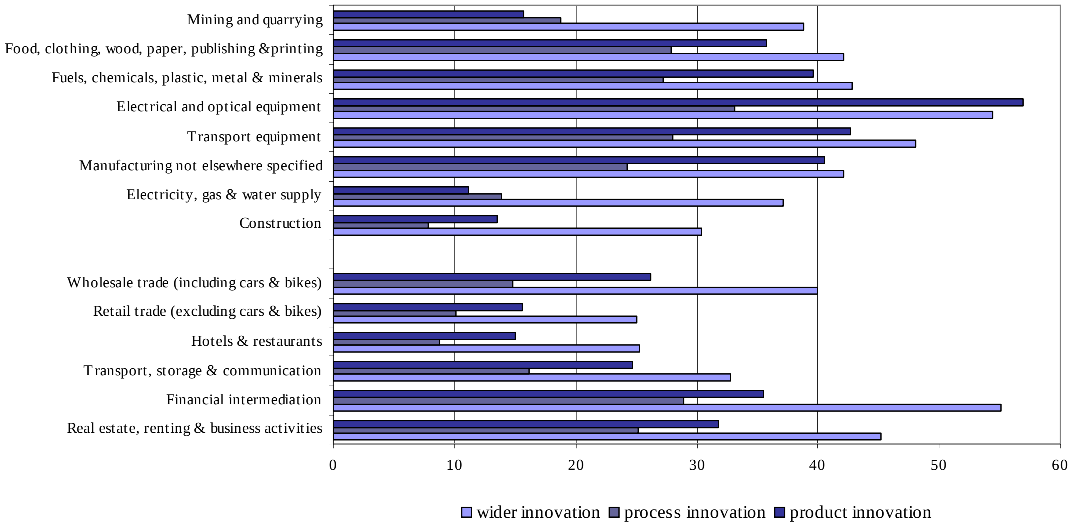
Productivity Growth, Knowledge Flows and Spillovers (Crespi, Criscuolo, Haskel and Slaughter, 2007)

The linked CIS2-CIS3-ARD panel is used to explore the role of knowledge flows and TFP growth. Results suggest that the main sources of knowledge are competitors, suppliers, plants that belong to the same group and universities. They find a statistically significant association between TFP growth and above-firm-average information flows from other firms in the enterprise group, competitors and suppliers. The effects are economically significant as well, with such information flows "explaining" (in a growth accounting sense) about 50% of TFP growth. They conclude that the main "free" information flow spillover is from competitors and that multi-national presence may be a proximate source of this spillover.

4. Which firms innovate? Analysis of CIS4

The section describes the incidence of innovative[2] firms in the CIS4 according to a number of firm and market characteristics. Innovative activities are divided into three types, product process and wider innovation. Overall, 29% of firms in CIS 4 report product innovation, 20% report process innovation and 39% report wider innovation. Figure 1 shows that innovation activity is most prevalent in manufacturing. In construction, mining and quarrying, and electricity, gas and water supply innovative activity has a very different composition to that in other production sectors, dominated by wider innovation and process innovation outweighing product innovation in the latter two. Wider innovation also seems to be more prevalent, relative to product and process innovation in the distribution and service sectors.

Figure 1
Innovation activity by industry (%)



[2] Innovation is divided into product, process and wider innovation and the markers for these are available in the CIS4 data. Product innovation occurs when a firm introduces a new or significantly improved good or service. Process innovation occurs when a firm introduces new or significantly improved processes for producing or supplying goods or services and these processes are new to the enterprise. Wider innovation occurs when an enterprise makes major changes in business structure and practices, including corporate strategy, advanced management techniques, organisational structure and marketing.

Figure 2 shows that standalone enterprises are less likely to innovate than enterprises which are part of an enterprise group. This may partly reflect the fact that standalone enterprises are on average smaller (mean employment of 129 compared with 546 for enterprises that are part of a group), but it may also capture innovation spillovers between enterprises within an enterprise group. For all types of innovation, larger firms are more likely to innovate than smaller ones. Finally, innovation activity is found to be more prevalent among firms where at least one employee has a science or engineering degree, compared to other degrees and compared to enterprises where no employee has a degree[3].

Figure 2
Innovation activity by enterprise characteristics (%)

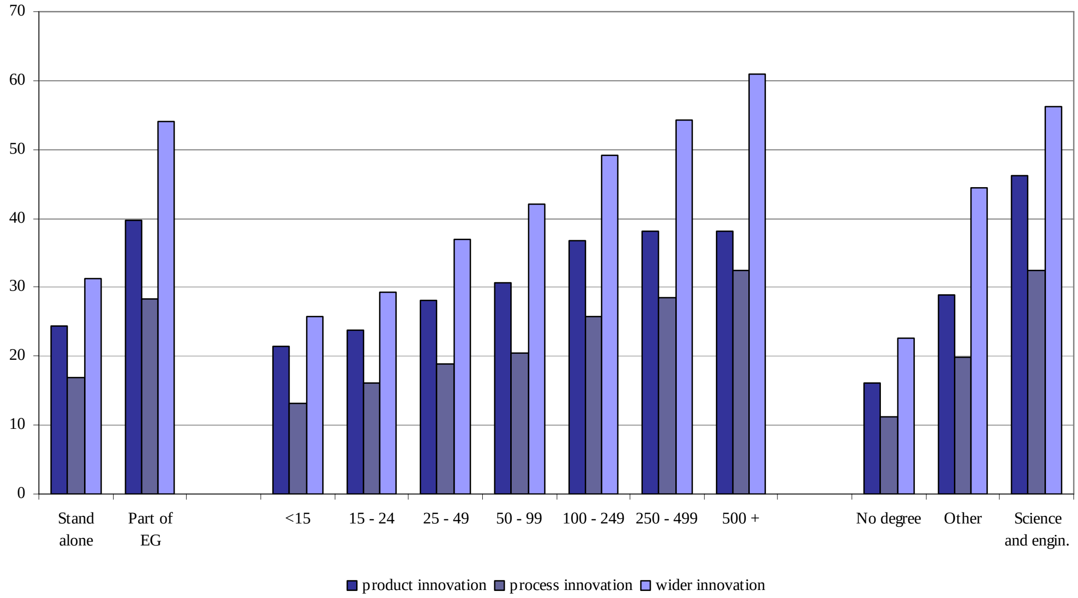


Figure 3 shows that firms engaging in export activities are far more likely to innovate in all areas, with a higher proportion of innovators among those firms who export beyond Europe. Innovation activity is most prevalent among firms whose main customers are other businesses, followed by those doing business with the public sector and finally consumers.

Comparing innovative activity between the three CIS surveys[4], Figure 4 suggests that innovative activity has increased in manufacturing between CIS3 and CIS4, whereas it has declined in construction, utilities and the distribution and service sectors. Electricity, gas and water supply is notable for the large fall in reported innovation over time. Figure 5 suggests that whilst innovative activity was relatively

[3] This variable is limited to a dummy designating whether or not the firm employs at least one employee with a degree. Respondents were asked to report the proportion of employees who have a degree but many appear to have reported the number of employees instead. The reported figures could therefore not be used to construct a more detailed measure of the education attainment of employees.

[4] Innovation-active firms in CIS3 and CIS4 are defined as those engaging in product, process or wider innovation, or innovation projects which have been abandoned or ongoing, or one or more innovative activities in the "Innovative activities and expenditures" part of the survey. The structure of the CIS2 questionnaire is quite different to the latter CIS surveys. In CIS2 innovation-active firms are defined as those that have undertaken service innovation, or innovation projects which have been unsuccessful, terminated, delayed or not yet completed (questions 3 and 13), or one or more organisational changes or new management techniques in question 4, or one or more innovative activities in question 7.

stable over the last 15 years amongst the smaller firms whereas it seems to have declined among the larger firms.

Figure 3
Innovation activity by market characteristics (%)

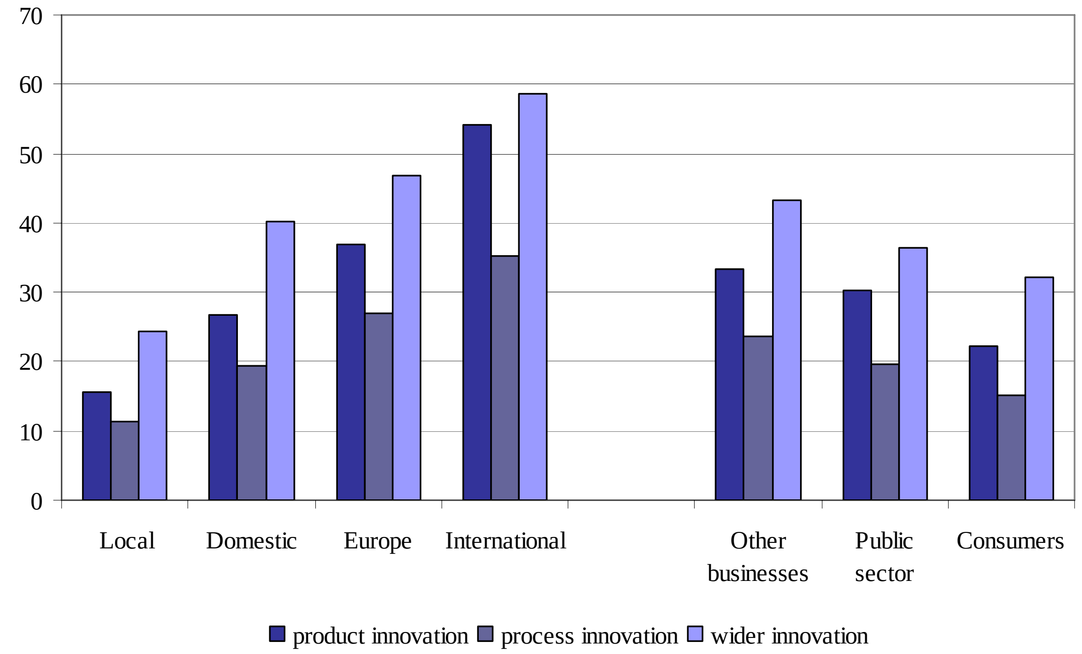


Figure 4
Changes in Innovation Activity: by industry (%)

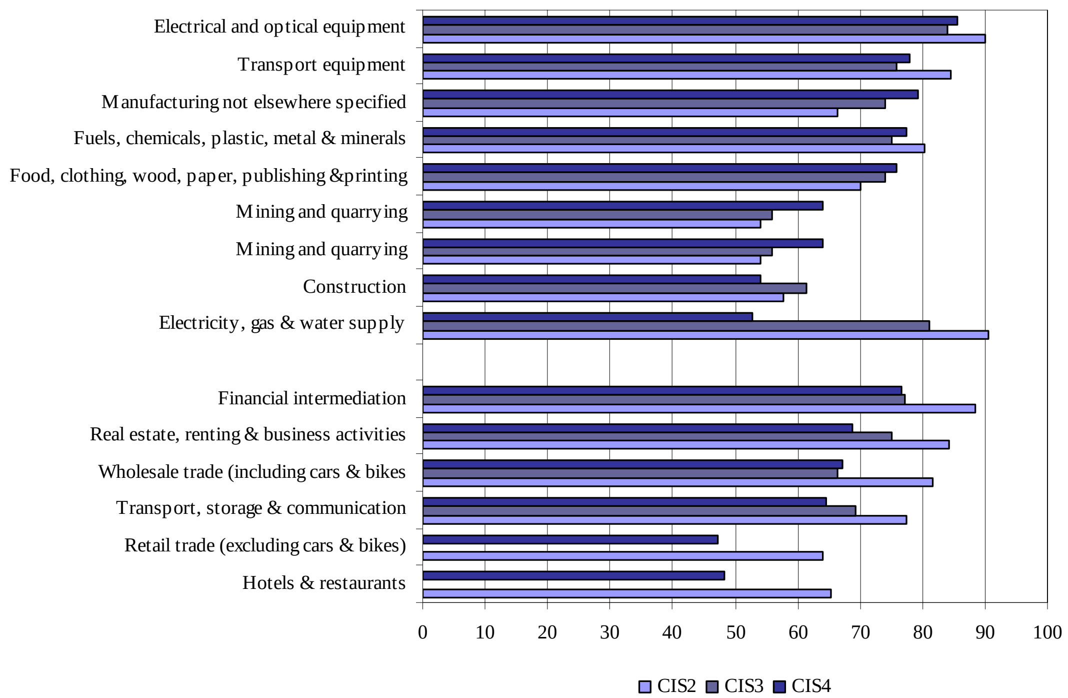
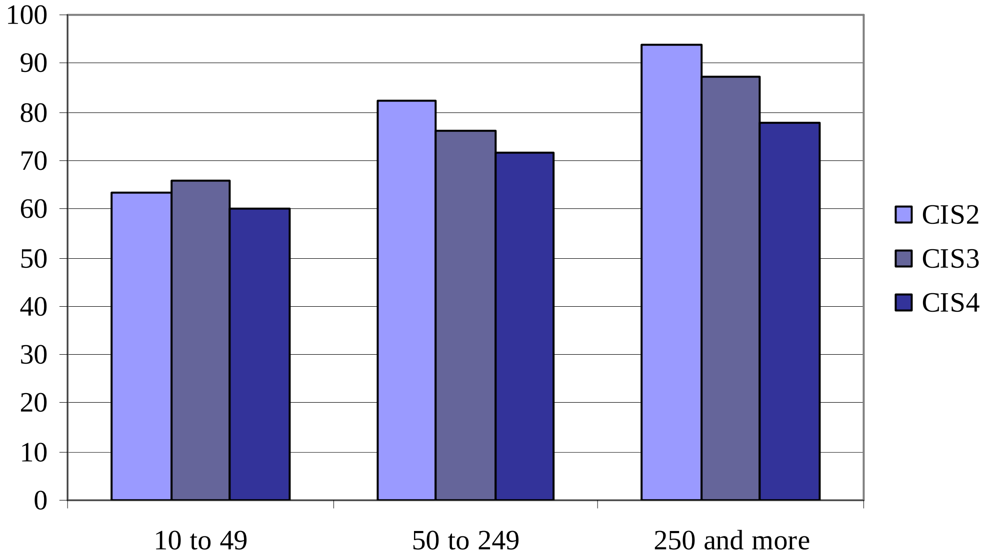


Figure 5
Changes in Innovation Activity: by size-band (%)



The above descriptive analysis of the CIS shows that innovation activity varies considerably across industry, size and other characteristics of the firm and market. However, such analysis does not identify the individual contribution of each of these characteristics on innovation, holding all other characteristics constant. For example, does being part of an enterprise group increase the likelihood of an enterprise engaging in innovative activity, or do these enterprises differ in other characteristics that may also make them more likely to innovate?

To do this, we employ logistic regression analysis to estimate the additional and independent effect of a range of firm and market characteristics on the probability that the firm will engage in innovative activity. We restrict the analysis to the most recent Community Innovation Survey. In addition to the information contained within the CIS, additional variables drawn from the 2004 Business Structure Database are merged onto the CIS data. The Business Structure Database is a version of the Inter Departmental Business Register held within the VML. Specifically, we use the BSD to explore how enterprise structure and company age effect innovative activity.

Explanatory variables are included to control for organisational structure, legal status, size, age, export market, main customers, industry and region. Selected results from the logistic regression are presented in Figures 6 and 7. It is noted that these results are derived from the same models presented in the Annex and are presented in separate charts purely for expositional convenience. For each of the variable sets, the results are expressed in terms of the percentage difference in the probability of engaging in innovative activities relative to a reference category. Innovation activities are once again divided into product, process and wider innovation. The coloured bars are used to indicate where a variable is estimated to be significantly different from the reference category at the 5% level.

Figure 6 confirms the earlier finding that larger firms are more likely to innovate, particularly in process and wider innovation. Amongst those organisations with less than 15 employees, the analysis distinguishes between those organisations where at least employee has a degree and those who do not. As noted above, we restrict this distinction to the smallest enterprises where it is more likely that the person filling out the survey will know if any of the employees has a degree. Among those enterprises with less than 15 employees, those enterprises with staff who have a science degree are approximately 200% more likely (or 3 times as likely) to engage in innovative activity. The presence of staff with other degree subjects also increases the likelihood of innovative activity within small enterprises.

Figure 6
Probability of undertaking innovation activities: influence of firm size and education

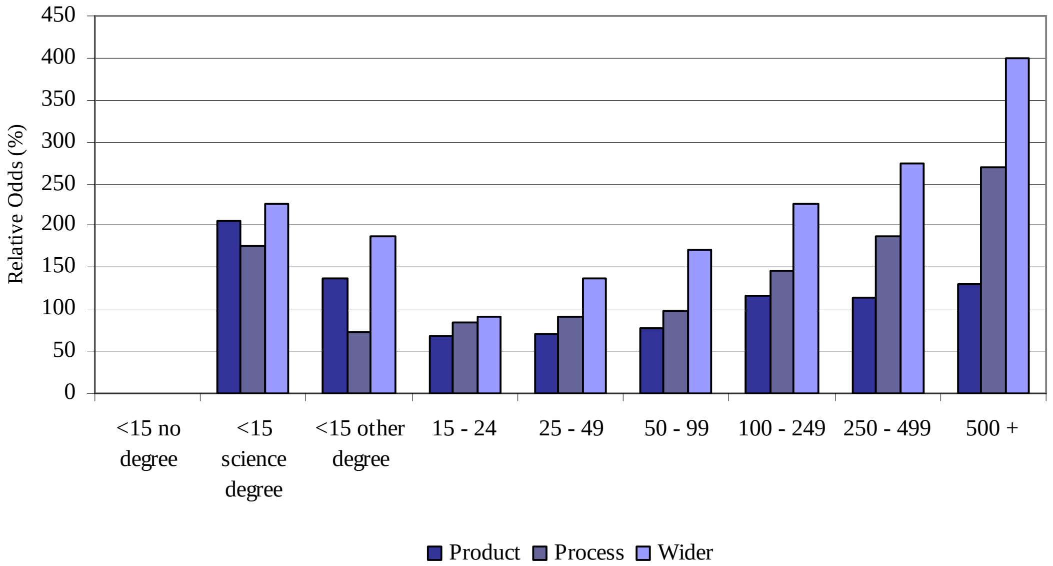


Figure 7
Probability of undertaking innovation activities: influence of organisational structure and age

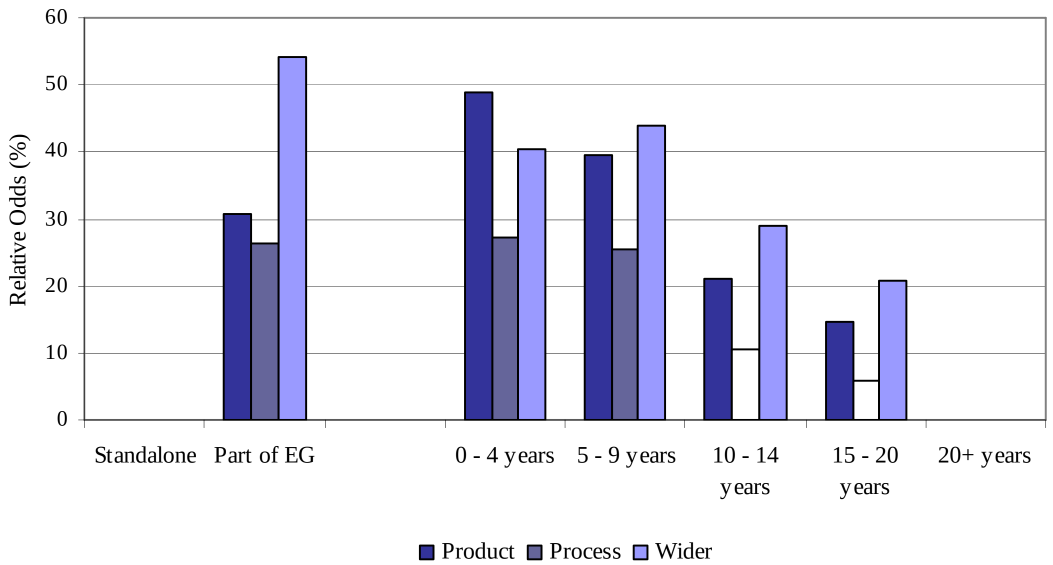


Figure 7 shows that being part of an enterprise group significantly increases the probability that a firm states that it engages in innovation, particularly wider innovation. Those enterprises who are part of an enterprise group are approximately 30% more likely to engage in product and process innovation, and 55% more likely to engage in wider innovation. Note that this effect is separate and additional to other characteristics of these enterprises. Finally, it is estimated that the youngest enterprises are most likely to state that they engage in innovative activity. Relative to those enterprises that have been established for 20 years or longer, those enterprises who have been established for 0-4 years are estimated to be 50% more likely to engage in product innovation, 27% more likely to engage in process innovation and 40% more likely to engage in wider innovation

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