A Comparison of the Second and Third UK Community Innovation Survey.[1]

Marion Frenz

South Bank University
103 Borough Road
London SE1 0AA
Tel. 020 7815 7786
Fax. 020 7815 7076
Email: frenzma@sbu.ac.uk

[1] This work was supported financially by the DTI. The author of the report is grateful for this support and for useful comments received on earlier drafts by: Prof. Grazia Ietto-Gillies, Dr. Ray Lambert, Dr. Martha Prevezer, Mr. Brian Stockdale, Mr. Marc Thomas.

Executive Summary

The CIS's are so far the most comprehensive surveys into firms' innovation activities in the UK, providing data on various forms of direct innovation outputs and factors influencing innovation activities. Hitherto most research into innovation has utilised patent data or data on R&D expenditures as a proxy for innovation output, and focused on high technology intensive manufacturing industries. CIS 2 and CIS 3 provide direct measures of innovation output across most industry sectors. This report focuses on a comparison between various forms of innovation output in CIS 2 and CIS 3.

Working with CIS 2 and CIS 3, a simple direct comparison between the two surveys is not possible. This is because of variations in the underlying questionnaires and differences in the industry sectors surveyed. Issues related to differences in the questionnaires are dealt within section three of the report and implications of variations in sectors are assessed in section five. Although in CIS 2 high-tech sectors and large enterprises were more heavily surveyed, imposing weights to correct for this discrepancy.

A comparison becomes possible through some adjustments in CIS 2 and CIS 3 (see section three and four). This report examines variables related to innovation outputs and selected factors influencing innovation output, namely innovation inputs and innovation constraints. The dynamics between the two survey periods, 1994 to 1996 and 1998 to 2000, are assessed. As innovation output is difficult to quantify, related questions in the two surveys focus mainly on whether or not an enterprise engaged in a certain type of innovation activity, such as product (goods or services) and process innovation. Hence, this report compares the number of self-declared innovators in CIS 2 with CIS 3, rather than levels of innovation output. (See sections five to ten).

The main results, based on the amended data set, are the following. The number of firms reporting innovation output in CIS 3 is substantially below the proportion of enterprises declaring to have had some innovation output in CIS 2. There was a decrease of 19 percent in the proportion of product (goods and services) innovators. Within this, all high-tech enterprises and all construction and production firms reported the strongest decline in innovators. This is despite the greater increase in the number of high technology and knowledge intensive enterprises in the population than low-tech firms, comparing the two reference periods of the surveys.

Examining firms' innovation inputs, e.g. intramural and extramural R&D, personnel in R&D, the emerging picture is diverse. The number of enterprises engaging in some forms of R&D related expenditures, such as the acquisition of machinery in connection with innovation, is increasing, whilst firms' engagement in other areas of R&D, such as the acquisition of external knowledge, is decreasing. Particularly significant is the drop in high-tech enterprises engaging in internal R&D. The high-tech sector also saw a large fall in its innovation outputs.

Some factors contributing to a decline in the proportion of enterprises with innovation output have been identified.

The drop in innovators between CIS 2 and CIS 3 is accompanied by an increase in the number of enterprises reporting unsuccessful innovation projects of approximately ten percent (see table 5.2). This indicates that obstacles to successful innovation output have increased between CIS 2 and CIS 3. Because of differences in the questionnaires, it is not possible to assess the proportion of firms affected by specific innovation constraints. However, there has been a shift in the distribution of firms affected by widespread innovation constraints towards financial constraints to innovate, such as direct innovation costs and costs of finance.

There is also some indication of a process of concentration of innovation activities taking place between CIS 2 and CIS 3. A larger proportion of enterprises in CIS 3 generated a higher proportion of turnover from new or improved products than in CIS 2. One possible explanation for this is that fewer enterprises generated higher levels of innovation output in CIS 3 than in CIS 2.

Finally, because the sample of firms is different between CIS 2 and CIS 3, some results might be due to these differences in samples. We go on to compare all those enterprises common to both surveys. There are 786 enterprises, which answered both CIS 2 and CIS 3. Analysing the same observational units (enterprises) in CIS 2 and CIS 3 provides some panel data, which gives scope for more sophisticated statistical work. Future work will focus on the overlap sample between CIS 2 and CIS 3.

Contents

List of tables

1. Introduction

The aim of this report is to give a comparison of the results in the second and third Community Innovation Survey (CIS 2 and CIS 3). The CIS is a EU-wide survey collected in the UK by the Office for National Statistics and funded by the Department of Trade and Industry (DTI). The reference periods are 1994 to 1996 and 1998 to 2000 respectively for CIS 2 and CIS 3. The surveys under consideration are the most extensive surveys into innovation activities in the UK and give a unique opportunity to shed light on innovation activities. The questions asked relate to input and output measures of innovation, aims and effects of innovation, factors hindering innovation, co-operations and governmental support. Information on structural characteristics is also provided, in particular enterprise size, in terms of turnover and employment, and nationality of ownership.

Given the large number of questions in the survey any report can centre on a variety of variables and permutations. Three principles guided the drafting of this report: (1) comparability of data between the two CIS's; (2) use of as many observations as possible; (3) analysis of categories according to the main sector (production and construction versus distribution and services[2]); (4) analysis according to level of knowledge and technology (low and high-tech sectors); and (5) making comparisons in the most relevant categories in the survey, that is outputs, inputs of innovation and constraints.

As regards to principle (5), the report deals with the following. Firstly, *output measures of innovation* are assessed and the results of CIS 2 and CIS 3 are compared. In particular we look at: the proportion of innovators; product and process innovation; novel innovation, unsuccessful projects, and number of patents applied for.

In comparing innovation activities, the two surveys are subdivided into high and low-tech enterprises and into production and construction, versus distribution and services. This is done in order to see whether these groups differ from each other in terms of their innovation patterns or in other words to find evidence that technology and knowledge intensity and main industry sector matter in terms of innovation.

Secondly, we are looking at *input factors of innovation*. The specific variables considered are: proportion of firms engaging in intramural and extramural R&D, the number of personnel working in R&D and the proportion of enterprises continuously conducting R&D. Again the analysis starts with a comparison of all enterprises answering CIS 2 and CIS 3, followed by grouping the CIS's into firstly all low and all high-technology and knowledge intensive industries and secondly into production and construction, and distribution and service enterprises.

In a final section of the results we are looking at various *factors hindering innovation*. These factors are grouped into *economic factors, internal factors and other factors.* Economic factors are: the economic risks of innovation perceived by the responding enterprises, the direct costs of innovation, the costs of finance and the availability of finance. Internal factors imposing a constraint on an enterprise's ability to innovate

[2] The term production industries, refers to: mining and quarrying; manufacturing; electricity, gas and water supply.

are: organisational rigidity, lack of qualified personnel, lack of information on technology and markets. Other obstacles are: the impact of regulations or standards and the lack of customer responsiveness to new goods or services. Innovation constraints are considered in general for CIS 2 and CIS 3.

2. Structure of the report

Sections three, four and five consider issues related to the first four principles as mentioned in section one, specifically: comparability of data; maximum number of observations; analysis according to the level of technology and knowledge, analysis according to main industrial sectors.

In section three we are looking at the comparability of the questionnaires used in CIS 2 and CIS 3. Differences in questionnaires impose limitations onto the direct comparability of certain areas/questions in the surveys. Additionally, dissimilarities in the questionnaires have an impact on selecting specific subsets of CIS 2 and CIS 3, e.g. all innovation active firms.

Section four deals with the actual observations and sectors surveyed. It deals with comparability issues, e.g. ensuring that both samples reflect the same sectors of the UK population. In section four we also explain how the surveys are subdivided into high versus low-tech, and production and construction versus distribution and services.

In section five we compare the distribution of sample and population of both surveys in terms of technology and knowledge intensity and in terms of production and construction industries versus distribution and service industries. This section shows that both the distribution and service sector, and high-tech sector experienced an increased growth in number of enterprises than in their production and construction, and low-tech counterparts.

The actual comparisons on outputs, inputs of innovation and constraints, are analysed in sections six to eleven.

Section six starts with general results on innovation output, comparing the whole sample and population as derived from CIS 2 and CIS 3. This is followed by more detailed analyses of innovation output of high versus low technology and knowledge intensive enterprises and production and construction versus distribution and services.

Section seven, eight and nine look at issues affecting different proportions of innovators between CIS 2 and CIS 3, such as looking at a different set of enterprises within the surveyed sectors, an increase in the number of firms with unsuccessful innovation output and an increase in turnover derived from new or improved products.

Proportion of enterprises with innovation input, such as intra- and extramural R&D is dealt with in section ten, starting with a general comparison of both surveys, followed by an examination of high versus low-tech and production and construction versus distribution and services.

A general comparison in the shift of innovation constraints between CIS 2 and CIS 3 is given in section eleven.

Section twelve summarises the main findings.

3. Differences in the questionnaires between CIS 2 and CIS 3

CIS 3, although based on CIS 2, was developed further to enrich results and research opportunities. This causes some complications when comparing the two because we are not always comparing like with like, our results have to be treated with some caution. The following points give an overview of major changes in CIS 3 compared to CIS 2, which are of importance to this report.

3.1 CIS 2 different questionnaire for distribution and service sector

In CIS 2, service and distribution firms received different questionnaires from the one sent out to production and construction enterprises. Production and construction firms were asked whether they introduced new products and secondly whether they introduced new processes.

In CIS 3 this question is applied to both distribution/services firms and production/construction enterprises, referring to product innovation in terms of new goods and in terms of new services. In CIS 3 all enterprises received the same questionnaire.

In CIS 2, service and distribution enterprises were asked 'whether they introduced new services or methods to produce or deliver services'. This question combines product and process innovation. Answering 'yes' means that an enterprise is either a product innovator (new service) or a process innovator (new method to produce or deliver services) or a firm engaging in both. If an enterprise answered 'yes', it was asked to specify its areas of innovation activity: product or process innovator or both.

52 enterprises, who formerly declared to have introduced either a new service or a new delivery/production method, did not specify the type of their innovation activity. We classified these 52 enterprises as product innovators only. This assumption may not reflect reality and may result in a bias towards product (goods and services) innovation in CIS 2.

3.2 Definition of product innovation

Product and process innovation in CIS 2 are any 'technologically new or improved products or processes which have been introduced to the market between 1994 and 1996'. In an introduction to this question as well as in an appendix to the questionnaire, *improved* products and process are further defined as 'an existing product (process) whose performance has been *significantly* enhanced or upgraded'.

The same question was rephrased in CIS 3 to: 'during the three year period 1998-2000, did your enterprise introduce any technologically new or *significantly* improved products (processes) *which were new to your firm?*'

It is likely that some recipients of the CIS 2 questionnaire did not thoroughly read the introduction in small prints or appendices. Therefore, CIS 2 asks for any improved

products and processes and CIS 3 for significantly improved products and processes. Consequently, the number of self-declared innovators in CIS 3 is expected to be lower.

3.3 Filter questions in CIS 2

CIS 2 contains a number of filter questions. For example, only firms which answered 'yes' to a specific question relating to innovation activity, were asked to give details on patent numbers applied for, their R&D expenditure, their turnover generated from new or improved products, and their number of R&D personnel. In CIS 3 these types of filter questions were omitted and all enterprises were asked to answer the whole survey.

Because this report is comparing CIS 2 and CIS 3, only innovation active firms are examined when looking at a) the number of patents an enterprise applied for, b) proportion of turnover generated from new or improved products and c) various types of R&D expenditures.

3.4 Evaluating factors hampering innovation

Another discrepancy occurs when looking at the questions related to factors hindering innovation in CIS 2 versus CIS 3. Innovation constraints are, e.g. direct innovation costs and organisational rigidities. The specific innovation constraints embedded in CIS 2 are the same as those included in the CIS 3 questionnaire.

CIS 2 asked those firms that had had projects delayed, terminated or not started, for the factors that had contributed to this. Therefore it dealt with a sub sample of those firms whose projects had been disrupted in some way. CIS 3 asked directly about the factors hampering innovation, requiring firms to rank those factors in importance. It also required all firms to assess these factors.

As a result the proportion of enterprises reporting effects of innovation constraints is greater in CIS 3 than in CIS 2, where the question was linked exclusively to the existence of unsuccessful innovation projects. This limits the comparability of results between the two surveys. Firstly, only those firms, which reported unsuccessful innovation can be analysed, because all other firms did by default not answer the questions in CIS 2. Secondly, a ranking scheme had to be introduced to compare replies in CIS 2 with the ones in CIS 3.

4. Data and related issues

4.1 The datasets

The surveys cover enterprises with 10 or more employees in sections C-K of the UK Standard Industrial Classification of Economic Activities (UK SIC 92). In total 2,342 and 8,172 observations were obtained in CIS 2 and CIS 3 respectively. The observations were weighted to match the sample with the number of enterprises on the Inter-Departmental Business Register (IDBR). The observations relate to questions in CIS 2 and questions in CIS 3.

4.2 Distribution of small and large enterprises in CIS 2 and CIS 3

Large enterprises tend to be more innovation active than small ones. One would expect a change in the distribution of small, medium and large enterprises to lead to a change in innovation activity within an economy. This section examines the distribution of small, medium and large firms in the population and sample of CIS 2 and CIS 3 respectively. Table 4.1 gives an overview of the UK enterprise population as derived from weighted data in CIS 2 and CIS 3. In the case of CIS 2 we give results including and excluding retail, hotels and restaurants.

Table 4.1: Distribution of small, medium and large enterprises in the UK population.[3] CIS 2 and CIS 3 weighted.

Sizeband: Number of employees	**CIS 2** (SIC 50, 52, 55 included)		**CIS 2** (SIC 50, 52, 55 excluded)		**CIS 3**	
	Number	Percent	Number	Percent	Number	Percent
10 to 49	129,032	83%	81,088	79%	101,877	80%
50 to 249	21,013	14%	16,758	16%	19,935	16%
250 to 499	2,616	2%	2,616	3%	2,646	2%
500 to 999	1,475	1%	1,289	1%	1,375	1%
1,000 and more	1,156	1%	875	1%	942	1%
Total	155,293	100%	102,663	100%	126,775	100%

Comparing the proportion of enterprises in the different size bands in CIS 2 and CIS 3 the patterns are very similar. This is especially the case comparing CIS 2 excluding retail, hotels and restaurants with CIS 3. The inclusion of retail, hotels and restaurants results in a larger proportion of small, less innovative enterprises. Therefore, comparing CIS 2, leaving out enterprises in SIC 50, 52 and 55, with CIS 3 one would not expect a change in innovation activity between CIS 2 and CIS 3 due to a change

[3] Information on enterprise size bands derives from the IDBR.

in size in UK enterprises. Table 4.2 gives the same picture for the CIS's samples instead of population.

Table 4.2: Distribution of small, medium and large enterprises in the CIS's samples. CIS 2 and CIS 3 non-weighted.

Sizeband: Number of employees	**CIS 2** (SIC 50, 52, 55 included)		**CIS 2** (SIC 50, 52, 55 excluded)		**CIS 3**	
	Number	Percent	Number	Percent	Number	Percent
10 to 49	877	37%	856	38%	4,761	58%
50 to 249	680	29%	666	29%	2,023	25%
250 to 499	269	11%	269	12%	722	9%
500 to 999	229	10%	215	9%	402	5%
1,000 and more	287	12%	269	12%	264	3%
Total	2,342	100%	2276	100%	8,172	100%

Comparing CIS 2 and CIS 3 sample we see that a higher proportion of large enterprises and a lower proportion of small enterprises replied to CIS 2. Both sample distributions differ from the enterprise distribution in the population. This is more significant in CIS 2 than in CIS 3. Comparing the non-weighted samples of CIS 2 and CIS 3, results will be biased towards innovation activities of large firms. This is more the case in CIS 2 than in CIS 3.

Table 4.3 gives the response rates as the fraction of achieved sample over the population, for CIS 2 and CIS 3 for the five size bands.

Table 4.3: Response rates. CIS 2 and CIS 3.

Sizeband: Number of employees	**CIS 2** (SIC 50, 52, 55 included)	**CIS 2** (SIC 50, 52, 55 excluded)	**CIS 3**
10 to 49	0.7%	1.1%	4.7%
50 to 249	3.2%	4.0%	10.1%
250 to 499	10.3%	10.3%	27.3%
500 to 999	15.5%	16.7%	29.2%
1,000 and more	24.8%	30.7%	28.0%
Total	1.5%	2.2%	6.4%

The higher response rate of large firms in CIS 2 and CIS 3 should not lead to a bias towards innovation active enterprises if one is examining weighted data and hence analysing the population.

4.3 Technology intensity

For this report both surveys have been subdivided into low and high-tech. The manufacturing sector is classified according to technology intensity and the service and distribution sector according to the knowledge intensity along the OECD's classification (OECD, 2001).[4] For the purpose of this report low and medium-low sectors are summarized under low-tech and high and medium-high under high-tech. Those industries not classified by the OECD, namely extractive industries (SIC 10 - 14), construction (SIC 45) and electricity, gas and water supply (40-41), have been assessed using UK data from the Business Enterprise Research and Development survey (BERD) and the Annual Business Inquiry (ABI) for the years 1995 to 2000. Ratios of R&D expenditures over turnover and over value added were calculated for the industry under consideration. This is a very similar calculation to the one applied by the OECD in manufacturing. The results of the ratios for extractive industries, construction as well as electricity, gas and water supply place these industries either among the low or medium-low technology sectors.

4.4 Sectors

In CIS 3, as opposed to CIS 2, retail sector and hotels and restaurants (SIC 50, 52 and 55) were not surveyed. These industries are particularly large in terms of number of enterprises. Their innovation activities are fairly low. As only a small proportion of enterprises in retail, hotel and restaurant sectors achieved responses in CIS 2; those particular enterprises were related to high weights, to reflect the population on the IDBR register. Therefore, surveyed retail firms, hotels and restaurants had an over proportional impact on the outcomes of innovation patterns in CIS 2. In order to avoid these difficulties, the DTI excluded retail sector and hotels and restaurants from CIS 3. Section five of this report shows the impact of retail, restaurant and hotel sectors on population and sample of CIS 2, and section six shows the effect of the former sectors on innovation output in CIS 2. All other examinations in this report compare the whole of the CIS 3 sectors with similar CIS 2 sectors, omitting retail, hotel and restaurant sector, unless specified differently.

[4] For manufacturing industries the OECD applies three indicators which reflect different degrees of technology intensity under two aspects: firstly "technology producer" and secondly "technology user". The three indices are: R&D expenditures over value added, R&D expenditure over production and R&D expenditures plus technology embodied in intermediate and investment goods divided by production. The division of industries into high, medium-high, medium-low and low technology intensity was determined after ranking the industries according to their average over 1991 to 1997 evaluated for 13 OECD countries.
The OECD captures knowledge intensive service sectors by examining their share of value added in relation to total gross value added. Currently the OECD considers the following service sectors as knowledge intensive: Post and telecommunications, finance and insurance and business activities.
(OECD, 2001; Cox, Frenz and Prevezer, 2002)

4.5 Distribution of sample and population

The following section gives an overview of the distribution of sample and population of both surveys. It shows shifts in technology intensity and main industrial sectors and the divergences between population changes and sample changes.

There are two main motives for this exercise. Firstly, a change in proportion of high and low-tech enterprises and main industry sectors between CIS 2 and CIS 3 would raise expectation for a simultaneous shift in terms of innovation output and input. Secondly, it sheds further light on the complications occurring in the weighting of retail, restaurant and hotel sectors in CIS 2 and enables us to make a better assessment on whether or not to omit retail, hotel and restaurant sector in CIS 2 for the purpose of this report, namely to compare CIS 2 with CIS 3.[5]

The observations in table 4.4 and table 4.5 show the proportions of low-tech versus high-tech enterprises; in both production and construction enterprises versus distribution and service enterprises. We are comparing with CIS 3 all observations of CIS 2 enterprises as well as the CIS 2 observations omitting retail, hotels and restaurants.

Table 4.4 gives weighted results and hence represents the UK population. Table 4.5 gives non-weighted results and shows the distribution of firms in both CIS's samples.

Table 4.4: Proportion of high versus low-tech in production and construction versus services and distribution enterprises in the UK population. CIS 2 and CIS 3, weighted percentages.

	CIS 2 (SIC 50, 52 and 55 included)			**CIS 2 (SIC 50, 52 and 55 excluded)**			**CIS 3**		
	Production and construction	Distribution and Services	Total	Production and construction	Distribution and Services	Total	Production and construction	Distribution and Services	Total
low-tech	32	51	83	48	26	74	42	26	67
high-tech	8	9	17	12	14	26	9	24	33
total	39	61	100	60	40	100	50	50	100

The population size of CIS 2 is 155,293 enterprises. Omitting retail this count falls to 102,663 firms. CIS 3 population accounts for 126,775 enterprises. Comparing the UK enterprise population in CIS 3 with the enterprise population in CIS 2 omitting retail, hotels and restaurants, there are ten percent more service firms in CIS 3 and around seven percent more high-tech firms. This indicates that high technology and

[5] In CIS 2 the highest possible weight is allocated to one retail enterprise and equals 2,749 times. The average weight for the whole of CIS 2 equals 66 times, with retail in general averaging 816 times. These problems do not occur in CIS 3, because the retail sector has been omitted and also because the sample size is larger. The average weight in CIS 3 is 16 times with a maximum weight for a specific enterprise being 61.

knowledge intensive industries as well as service industries have experienced a faster growth in the UK between CIS 2 and CIS 3, in comparison to low-tech, and production and construction industries. Because high-tech firms are more innovation active, one would expect the number of firms engaging in innovation to increase between CIS 2 and CIS 3.

Comparing CIS 2 including all service sectors that are not embedded in CIS 3, one would be looking at a decline in service enterprises of around ten percent and an increase in high-tech firms of around 16 percent. Analysing CIS 2 including retail, hotels and restaurants will distort the results of CIS 2 towards the activities of low-tech and service enterprises.

Table 4.5: Proportion of high versus low-tech in production and construction versus services and distribution enterprises in CIS's samples. CIS 2 and CIS 3 non-weighted percentages.

	CIS 2 (SIC 50, 52 and 55 included)			**CIS 2 (SIC 50, 52 and 55 excluded)**			**CIS 3**		
	Production and construction	Distribution and Services	Total	Production and construction	Distribution and Services	Total	Production and construction	Distribution and Services	Total
low-tech	45	14	59	47	12	58	42	23	66
high-tech	23	18	41	23	18	42	13	21	34
total	68	32	100	70	30	100	56	44	100

Comparing CIS 2 and CIS 3 samples, leaving out retail firms, hotels and restaurants, 14 percent more distribution and service and eight percent more low-tech enterprises were surveyed in CIS 3. As there is a decrease in low-tech enterprises in the UK population, not weighting data from the CIS's would bias the comparison towards the innovation patterns of low-tech enterprises and towards distribution and service firms.

Altogether 124 enterprises were surveyed in retail, hotel and restaurant industries; 73 in SIC 50, 25 in SIC 52 and 26 in SIC 55. This is a proportion of 5.3 percent of all observations in CIS 2. Therefore, table 4.5 shows marginal difference in patterns between CIS 2 including and excluding retail. In terms of the population however, these 124 observations reflect 52,629 enterprises which is a proportion of 34 percent of the UK population and as table 4.4 shows, there is a great difference between the patterns of firms in CIS 2 including retail and excluding retail. As a result the weighting applied to the 124 retail enterprises is very large, since only a small proportion of all UK retail enterprises was surveyed. Because of these problems it had been decided not to survey the retail and hotel and restaurant sector in CIS 3. Contributing to this decision is the fact that little innovation is carried out by the retail industry.

For the purpose of a comparison of innovation activity between CIS 2 and CIS 3, this report considers weighted data, hence the UK population for both surveys. As regarding CIS 2 the report omits retail, hotel and restaurant sector, unless specified differently.

5. Results relating to innovation output

First this report looks at *output measures of innovation*. Novel product innovation, product (goods and services) innovation, process innovation and unsuccessful projects are considered as well as the number of patents an enterprise applied for in the reference period of both surveys.

The term *novel innovation* is defined as all product innovations that are both new to the firm and new to the market. *Product and process innovation* are new or (significantly) improved products and processes, new to the firm but not necessarily new to the market.

Unsuccessful innovation projects are all those innovation projects that were abandoned, delayed or projects which had not even started in the reference periods of CIS 2 and CIS 3 respectively.

In terms of novel, product, process and unsuccessful innovation all CIS's enterprises were examined. In analysing the *number of patents applied for* this report looks at all those enterprises that were innovation active in CIS 2 and CIS 3. Non-innovation active firms have been excluded from the patent analysis.[6]

Innovation active as defined in this report, are all those firms engaging in one or more of the following activities:

- Introduction of new or improved goods, services or processes,
- Innovation related expenditures,
- Formal co-operation with another enterprise or institution on innovation,
- Not yet completed innovation projects whether delayed or not,
- Abandoned innovation projects.

5.1 Results relating to innovation output: general comparison

The following part of this section gives an overview of the proportion of enterprises engaging in: novel product innovation; product (goods and services) innovation; process innovation; the average number of firms with unsuccessful innovation output and the average number of patents applied for. To compare CIS 2 and CIS 3, we look at CIS 2 excluding as well as including retail, hotel and restaurant sectors. We examine weighted as well as non-weighted data, hence comparing sample and population results.

Table 5.1 compares innovation output of the population between CIS 2 and CIS 3 including retail, hotels and restaurants. Table 5.2 omits retail, hotels and restaurants.

[6] In CIS 2 a filter question is imposed for enterprises stating the number of patents they applied for between 1994 and 1996. A condition for considering the patent question was that enterprises expected to introduce new or improved products in the next five years following the survey period. However, this project is analysing the patent number applied for in regards to all innovation active firms for two reasons. Firstly, the filter question was not effective. Although only 102 firms answered the filter question positively, 2,336 firms answered the patent question. Secondly, no equivalent question is embedded in CIS 3.

Table 5.1: Output measures of innovation in CIS 2, CIS 3 and changes. CIS 2 includes retail, hotel and restaurant sectors. Both surveys weighted.

Innovation output	**CIS 2** incl. SIC 50, 52, 55	**CIS 3**	***Changes***
Novel product innovation	9%	8%	*-1%*
Product innovation (goods and services)	45%	18%	*-27%*
Process innovation	15%	15%	*0%*
Unsuccessful innovation	19%	37%	*18%*
Number of patents applied for	0.39	0.69	*0.30*

In terms of innovation output table 5.1 shows an overall decline between CIS 2 and CIS 3. In CIS 3 fewer enterprises reported to be novel innovators and product innovators. The proportion of process innovators remained unchanged between CIS 2 and CIS 3. The 27% drop in self-declared product innovators is particularly extreme. The sharp drop in firms with innovation output comes with a simultaneous increase in the proportion of enterprises reporting unsuccessful innovation projects. The number of patents applied for increased by 0.3 in CIS 3.[7]

In the above table CIS 2 includes the UK retail, hotel and restaurant sector. These sectors were not surveyed in CIS 3. The following table 5.2 gives weighted results for CIS 2 excluding retail, hotels and restaurants in order to achieve a higher comparability. As these three sectors are a very large proportion of all UK enterprises which are not particularly innovation active, one would expect the above reported decrease in innovation activity to accelerate. Table 5.2 gives an overview.

[7] In both CIS 2 and CIS 3 there is one outlier. One enterprise has applied for 3,000 or more patents in each of CIS 2 and CIS 3. These two observations are included. This however could mean that the real average patent number enterprises applied for in the UK are below that reported in table 6.1 and 6.2. Patent number applied for: since there are 16.8% missing values in CIS 3 and only 0.3 % in CIS 2 (6 enterprises with system missing) the missing values are replaced with 0. Note we are looking at innovation active firms only.

Table 5.2 Output measures of innovation in CIS 2, CIS 3 and changes. CIS 2 excludes retail, hotel and restaurant sectors. Both surveys weighted.

Innovation output	**CIS 2** excl. SIC 50, 52, 55	**CIS 3**	***Changes***
Novel product innovation	13%	8%	*-5%*
Product innovation (goods and services)	37%	18%	*-19%*
Process innovation	22%	15%	*-7%*
Unsuccessful innovation	27%	37%	*10%*
Number of patents applied for	0.63	0.69	*0.06*

Indeed the decline in novel innovators increases by four percent. Moreover, there is now a seven percent decline in process innovators to register. The increase in average patent numbers that innovation active enterprises applied for has dropped close to zero.

Surprisingly the fall in product innovators is smaller, once retail, hotels and restaurants are omitted from the analysis, as is the increase in number of enterprises reporting unsuccessful innovation projects.

The same industry sectors are compared in table 5.2 and are therefore more meaningful than the results from table 5.1. Table 5.2 shows a sharp drop in the number of innovators accompanied by an increase in firms reporting unsuccessful innovation.

In table 5.3 we compare innovation output of the CIS 2 sample (non-weighted data) with the CIS 3 sample. We look at the CIS 2 sample including retail, hotels and restaurants and excluding these sectors. The proportion of retail, hotel and restaurant enterprises is 5.3 percent in terms of the whole CIS 2sample, and 34 percent in terms of the UK population reflected by the weighted data of CIS 2. In addition, the CIS 2 sample contains an excessive proportion of high-tech enterprises, with 16 percent more high-tech enterprises in the sample than in the UK population. This is not the case in CIS 3, where the difference in proportion of high-tech firms between sample and population is only one percent. Consequently, we expect the drop in innovators to be larger in table 5.3.

Table 5.3: Output measures of innovation in CIS 2, CIS 3 and changes. Non-weighted results.

Innovation output	**CIS 2** incl. SIC 50, 52, 55	**CIS 2** excl. SIC 50, 52, 55	**CIS 3**	***Changes***
	(a)	**(b)**	**(c)**	***(c)-(b)***
Novel product innovation	24%	24%	9%	*-15%*
Product innovation (goods and services)	50%	51%	21%	*-29%*
Process innovation	37%	38%	18%	*-19%*
Unsuccessful innovation	34%	34%	36%	*1%*
Number of patents applied for	4.24	4.33	2.11	*-2.22*

As expected the decrease in the proportion of innovators in the CIS 3 sample is greater than in the CIS 3 population. Table 5.3 reports 15 percent fewer novel innovators, 29 percent fewer product innovators and 19 percent fewer process innovators. On average innovation active firms in the CIS 3 sample applied for two patents less. The increase in firms reporting unsuccessful innovation projects declined to two percent.

The results for the CIS 2 sample including retail, hotel and restaurant sector do not differ a great deal from the results of the CIS 2 sample omitting these sectors. This also is an expected outcome, because only 124 enterprises out of a total of 2,342 enterprises fall under the category retail, hotel or restaurants.

In all following analyses we are examining weighted data and therefore the UK population, rather than the CIS 2 and CIS 3 samples, where the differences in the distribution of enterprises differ too much to produce reliable results.

5.2 Results relating to innovation output: low and high-tech enterprises

In this section we assess the extent to which firms' innovation output differs as a result of their technology and knowledge intensity. Table 5.4 gives an overview.

Table 5.4: Output measures of innovation CIS 2, CIS 3 and changes: low and high-tech enterprises. CIS 2 excludes retail, hotels and restaurants. Both surveys weighted.

	Low-tech			High-tech		
Innovation output	**CIS 2**	**CIS 3**	***Changes***	**CIS 2**	**CIS 3**	***Changes***
Novel product innovation	10%	6%	*-4%*	22%	11%	*-11%*
Product innovation (goods and services)	34%	15%	*-19%*	46%	25%	*-21%*
Process innovation	20%	13%	*-7%*	29%	19%	*-10%*
Unsuccessful or incomplete innovation	24%	37%	*13%*	35%	37%	*2%*
Number of patents applied for	0.34	0.34	*0.00*	1.22	1.24	*0.01*

Overall high-tech enterprises are more likely to be innovators. This is particularly the case in terms of novel and product innovation as well as in the number of patents an enterprise applies for. However, this is true to a far lesser extent in the case of process innovation.

The high-tech sector underwent a slightly larger decrease in product and process innovators than the low-tech sector and a considerably greater decline in the number of novel innovators.

At the same time low-tech enterprises experienced a far greater increase in unsuccessful innovation projects.

5.3 Results relating to innovation output: production and construction; and distribution and services.

High innovation activity is traditionally linked to specific manufacturing sectors. However, in the UK in particular there has been a faster growth in services driven by knowledge, such as the finance, insurance, business services and in telecommunications.[8] The following table gives an overview of patterns of innovators amongst distribution and services, and production and construction firms.

[8] See OECD (2001).

Table 5.5: Output measures of innovation CIS 2, CIS 3 and changes: distribution and services; production and construction. CIS 2 excludes retail, hotels and restaurants. Both surveys weighted.

	Distribution and services			**Production and construction**		
Innovation output	**CIS 2**	**CIS 3**	***Changes***	**CIS 2**	**CIS 3**	***Changes***
Novel product innovation	15%	7%	*-8%*	11%	8%	*-3%*
Product innovation (goods and services)	29%	18%	*-11%*	43%	18%	*-25%*
Process innovation	20%	14%	*-6%*	24%	16%	*-8%*
Unsuccessful or incomplete innovation	26%	36%	*10%*	27%	39%	*12%*
Number of patents applied for	0.24	0.61	*0.38*	0.90	0.76	*-0.14*

Between CIS 2 and CIS 3 innovation activities in the production and construction sectors as well as in the service sector declined as a whole. However, the construction and production industries experienced a larger drop in product and process innovators of 25 percent and 8 percent respectively. Patent protection has played a bigger role in services in recent years and there was an average increase of 0.38 applications per enterprise.

Both sectors had considerably fewer product innovators, with the construction and production enterprises being worse affected; services and distribution however, had a greater fall in the number of novel product innovators. Both sectors showed a similar increase in the number of firms reporting unsuccessful innovation output.

Whereas the innovation patterns amongst distribution and services versus production and construction varied greatly in CIS 2, they did so to a lesser extent in CIS 3.

5.4 Summary of results relating to innovation output

In CIS 3 fewer enterprises reported having engaged in novel, product and process innovation. At the same time the proportion of firms reporting unsuccessful innovation output increased. Between the two surveys there was some increase in the average number of patents enterprises applied for.

In terms of the sector break down, the decline in the proportion of innovators is more dominant in the high-tech sector, whereas the increase in unsuccessful innovators is greater in the low-tech sector. Production and construction industries experienced a sharper fall in the proportion of innovators than service and distribution sectors. The

former also showed a greater increase in the number of firms with unsuccessful innovation projects.

A full analysis of the reasons behind the decline is not within the scope of this report. However, we suggest here that the following factors may explain the results presented in table 5.1 to 5.3.

1. The actual enterprises replying to CIS 2 and CIS 3 differ, although the same industries and size bands were sampled in CIS 2 and CIS 3. 786 enterprises are common to both CIS's.
2. A potential relationship between a declining number of successful innovators and an increasing number of unsuccessful innovators.
3. A concentration in innovation with the same or growing levels of overall innovation output being accounted for by fewer enterprises.
4. Finally, the fall in the proportion of UK innovators is enhanced by modifications in the questionnaire. Defining product innovation as 'new or significantly improved products, which were also new to the firm' or 'new or improved products', made a difference in reporting. However, to what extent that is true is outside the scope of this work.

The following sections six to eight focus on issues one to three above.

6. Comparison of innovation output for all enterprises common to CIS 2 and CIS 3

Although enterprises in the same industries and size bands were sampled in CIS 2 and CIS 3, receiving responses from different entities might have caused differences in outcomes.

To gain some insight into the latter possibility table 6.1 shows the development in innovation output for all those firms that participated in CIS 2 and CIS 3. There is a total overlap of 786 firms in the industry sectors considered.

Table 6.1: Output measures of innovation in CIS 2, CIS 3 and changes: 786 firms participating in both surveys. Both surveys non-weighted.

Innovation output	**CIS 2**	**CIS 3**	***Changes***
Novel product innovation	22%	14%	*-9%*
Product innovation (goods and services)	49%	29%	*-20%*
Process innovation	36%	26%	*-10%*

Using the sub-sample of overlapping firms, the drop in novel innovators, product innovators and process innovators is slightly larger than in table 5.2. Examining all those enterprises that are common to both CIS's, the drop in novel product innovators increases by four percent, the decline in product innovation by one percent and the drop in process innovators increases by three percent. Compared to the non-weighted results for CIS's samples in table 5.3 the changes in the number of innovators are lower than those for the whole surveys.

There is no indication that using the responses of different entities within the same sampling frame had a negative impact on the proportion of self-declared innovators in CIS 3.

7. Analysis of unsuccessful innovation projects

In this section we are taking a closer look into specific types of unsuccessful innovation projects. Because the number of firms reporting innovation output declined sharply between CIS 2 and CIS 3, while at the same time the proportion of firms reporting unsuccessful innovation projects increased, a closer look into unsuccessful innovation output is useful.

The next table breaks down unsuccessful innovation into: abandoned innovation projects; seriously delayed projects; and projects that had not even started during the reference periods of CIS 2 and CIS 3. The data is weighted, therefore reflects the UK population and leaves out all retail, hotel and restaurant firms.

Table 7.1: Unsuccessful innovation projects in CIS 2, CIS 3 and changes.[9] CIS 2 excludes retail, hotels and restaurants. Both surveys weighted.

Unsuccessful innovation projects	**CIS 2**	**CIS 3**	***Changes***
Abandoned innovation projects	7%	6%	*-1%*
Delayed innovation projects	13%	6%	*-8%*
Not even started innovation projects	14%	29%	*14%*

From table 7.1 we can see that the overall increase in enterprises reporting unsuccessful innovation projects (ten percent, as derived from table 6.2) can be explained solely by innovation projects that had not even started (14 percent in table 7.1).

Indeed the number of firms with delayed or abandoned innovation projects decreased by eight and one percent respectively. This could be the consequence of a greater awareness of the risks involved with innovation projects amongst firms in CIS 3, and therefore the result of a more careful assessment of innovation projects before the initial stage of launching.

It should be noted that the questions related to unsuccessful innovations appear in different parts of their respective questionnaires. This may have influenced the response levels.

[9] In CIS 3 there are 4,710 = 57.6 percent missing values in the variables related to unsuccessful innovation. These are (i) 'aband' = enterprise had abandoned innovation projects, 'yetlate' = enterprise had delayed innovation projects and 'noteven'= enterprise had innovation projects that had not even started in the reference period. The missing values have been replaced with zero. In CIS 2 there was only one missing observation, which also has been recoded as zero.

8. Testing for innovation concentration

All the above reported results on innovation output relate only to the proportion of innovators in CIS 2 and CIS 3. Each enterprise counts as one, independently of the level of innovation it is involved in. Therefore the results of section six cannot tell us the full story. This does not tell us anything about the overall level of innovation output in the UK economy, which could indeed be increasing.

One possibility is that there is no drop (or not a significant one) in the overall innovation output in the UK between CIS 2 and CIS 3, but that we see a concentration in innovation, with fewer firms concentrating a larger amount of their activities on innovation output in CIS 3 as in CIS 2.

There is only one question in the CIS's related to the level of innovation activity of a firm. This question asks enterprises to assess the proportion of their turnover that derives from a) new products and b) from (significantly) improved products.

If an enterprise receives a large proportion of its revenue from new products, then we assume that this enterprise is more innovative than a firm receiving a smaller proportion of its revenue from new products. This is measured only in relative and not in absolute terms. Consequently, we cannot conclude anything about the level of overall innovation output for the whole of the UK in either CIS 2 or CIS 3.

What we can do is see whether there are more firms that take a large share of their turnover from new or (significantly) improved products amongst the innovators in CIS 3. If that is the case it gives some support for the idea that innovation is becoming increasingly concentrated amongst fewer firms that focus more on innovation output. Table 9.1 gives an overview of the proportion of firms that take zero to 20, 21 to 40, 41 to 60, 61 to 80 or 81 to 100 percent of their turnover from new products.[10]

[10] CIS 2 and 3 weighted. CIS 2 retail omitted, only product innovators taken into account, because of filter question in CIS 3, where only product innovators split up their turnover into new, improved and unchanged products.

Table 8.1: Turnover derived from new products, sub-sample of all product innovators. CIS 2 excludes retail, hotels and restaurants. CIS 2 and CIS 3 weighted.

	Percent of enterprises		
Percent of turnover from new products	**CIS 2**	**CIS 3**	***Changes***
0 - 20	88.3	74.8	*-13.5*
21 - 40	6.7	11.1	*4.5*
41- 60	2.3	5.2	*2.9*
61-80	0.8	1.5	*0.6*
81 - 100	1.9	7.4	*5.5*

In CIS 3 there are fewer product innovators than in CIS 2. Nonetheless, the product innovators in CIS 3 derive on average a higher proportion of their turnover from new products than in CIS 2. Around six percent more enterprises derived 81 to 100 percent of their turnover from new products in CIS 3 compared to CIS 2 and around 14 percent fewer firms derived zero to 20 percent of turnover from new products.

This gives some support to the hypothesis that there has been a concentration in innovation activities in the UK.

Table 8.2 illustrates the same proportions for (significantly) improved products.

Table 8.2: Turnover derived from improved products, sub-sample of all product innovators. CIS 2 excludes retail, hotels and restaurants. CIS 2 and CIS 3 weighted.

	Percent of enterprises		
Percent of turnover from improved products	**CIS 2**	**CIS 3**	***Changes***
0 - 20	72.3	78.5	6.2
21 - 40	9.9	11.6	1.7
41- 60	11.1	5.8	-5.3
61-80	2.4	2.4	0.0
81 - 100	4.3	1.7	-2.6

The results in 8.2 appear to contradict those in table 8.1. In fact a slightly lower proportion of enterprises derive 81 to 100 percent of their revenue from improved

products and a larger proportion of firms derives zero to 20 percent of turnover from improved products. The following explanation can be offered for these results.

The amendments in the questionnaire between CIS 2 and CIS 3 may affect the results. In the CIS 3 questionnaire improved products are defined, as *significantly* improved products whereas in the case of the questionnaire used in CIS 2 the word significant did not occur in the actual question. This may have resulted in fewer products being viewed as improved products in CIS 3 than those that were regarded as an improved good or service in CIS 2.

On the other hand, combining the results in table 8.1 and 8.2, there remain a larger proportion of product innovators in CIS 3 that derives a higher proportion of turnover from either new or improved products as opposed to CIS 2. Table 8.3 gives an overview of the proportion of enterprises deriving turnover from either new or improved products.

Table 8.3: Turnover derived from either new or improved products, sub-sample of all product innovators. CIS 2 excludes retail, hotels and restaurants. CIS 2 and CIS 3 weighted.

Percent of turnover from either new or improved products	**Percent of enterprises**		
	CIS 2	**CIS 3**	***Changes***
0 - 20	59.4	50.0	*-9.4*
21 - 40	13.8	19.7	*5.9*
41- 60	13.6	11.0	*-2.6*
61-80	4.6	6.4	*1.8*
81 - 100	8.7	13.0	*4.3*

Amongst the product innovators in CIS 3 a higher proportion of enterprises concentrate on innovation activities than in CIS 2.

9. Results relating to innovation input

9.1 Results relating to innovation input: general comparison

The following section compares the proportion of firms engaging in intramural and extramural R&D as they emerge from CIS 2 and CIS 3. We are also looking at the average number of personnel working in R&D and the proportion of enterprises which carry out R&D on a continuously basis. With a decline in innovation output one might expect to see also a decrease in innovation input. Table 9.1 gives the average number of enterprises that carried out R&D amongst all innovation active firms.[11]

Table 9.1: Input measures of innovation CIS 2, CIS 3 and changes, innovation active firms selected. CIS 2 and CIS 3 weighted. Retail, hotels and restaurants omitted in CIS 2.

Innovation input	**CIS 2**	**CIS 3**	***Changes***
Intramural R&D expenditure	36%	16%	*-20%*
Acquisition of external R&D	6%	6%	*0%*
Acquisition of machinery and equipment	45%	61%	*16%*
Acquisition of other external knowledge	31%	17%	*-14%*
All design functions	22%	14%	*-8%*
Training	30%	31%	*1%*
Marketing	16%	24%	*7%*
Number of R&D personnel	3.80	3.54	*-0.27*
R&D continuously	21%	19%	*-3%*

Overall the emerging picture is diverse, with some innovation input measures, decreasing others increasing.

Overall 20 percent fewer enterprises conducted intramural R&D between 1998 and 2000 than between 1994 and 1996 and 14 percent fewer firms acquired external

[11] Innovation active firms were chosen because of the filter question in CIS 2.

knowledge such as the use of intellectual property (e.g. patents and know-how). Three percent fewer firms engaged in R&D continuously and there is a slight decline in the number of R&D personnel.

The proportion of enterprises acquiring technological equipment in connection with product or process innovation increased by 16 percent between CIS 2 and CIS 3. Also seven percent more firms engaged in marketing.

9.2 Results relating to innovation input: low and high-tech enterprises

Innovation in knowledge and technology intensive industries requires more scientific and technological input than in low-tech industries. Table 9.2 shows the proportion of high and low-tech firms engaging in R&D in CIS 2 and CIS 3.

Table 9.2: Input measures of innovation CIS 2, CIS 3 and changes: low and high-tech enterprises, innovation active firms selected. CIS 2 and CIS 3 weighted. Retail, hotels and restaurants omitted in CIS 2.

	Low-tech			**High-tech**		
Innovation input	CIS 2	CIS 3	*Changes*	CIS2	CIS 3	*Changes*
Intramural R&D expenditure	30%	13%	*-17%*	47%	21%	*-26%*
Acquisition of external R&D	5%	5%	*0%*	9%	8%	*-1%*
Acquisition of machinery and equipment	43%	63%	*20%*	47%	57%	*9%*
Acquisition of other external knowledge	27%	15%	*-12%*	40%	22%	*-18%*
All design functions	18%	13%	*-6%*	29%	15%	*-14%*
Training	26%	28%	*2%*	38%	36%	*-1%*
Marketing	14%	21%	*8%*	22%	27%	*6%*
Number of R&D personnel	1.45	1.28	*-0.17*	8.57	7.15	*-1.42*
R&D continuously	16%	13%	*-3%*	31%	28%	*-4%*

The proportion of high-tech firms engaging in R&D is higher than the proportion of low-tech enterprises both in CIS 2 and CIS 3. It is also the high-tech firms which account for most of the decline in innovation input, show a fall in R&D personnel and a drop in the proportion of firms which carry out R&D continuously. Particularly significant is the 26 percent decrease in intra-mural R&D shown by high-tech firms.

9.3 Results relating to innovation input: production and construction, and distribution and services

Intramural and extramural R&D traditionally measures scientific and technological expenditures and focus on research-intensive industries, close to the science base. These industries are predominately found in the manufacturing sector. One would expect production and construction to show a higher proportion of enterprises engaging in R&D. However, the CIS's extend the view on innovation input by embedding measurements such as money spent on related training and marketing.

Table 9.3: Input measures of innovation CIS 2, CIS 3 and changes: production and construction; and distribution and services, innovation active firms selected. CIS 2 excludes retail, hotels and restaurants. CIS 2 and CIS 3 weighted.

	Distribution and service			**Production and construction**		
Innovation input	CIS 2	CIS 3	*Changes*	CIS 2	CIS 3	*Changes*
Intramural R&D expenditure	26%	12%	*-14%*	42%	20%	*-22%*
Acquisition of external R&D	5%	5%	*1%*	8%	8%	*0%*
Acquisition of machinery and equipment	48%	57%	*9%*	42%	65%	*22%*
Acquisition of other external knowledge	61%	19%	*-42%*	11%	16%	*5%*
All design functions	37%	9%	*-29%*	12%	18%	*7%*
Training	40%	33%	*-7%*	22%	29%	*7%*
Marketing	14%	28%	*13%*	18%	20%	*2%*
Number of R&D personnel	2.77	3.20	*0.43*	4.50	3.86	*-0.64*
R&D continuously	17%	16%	*-1%*	24%	21%	*-3%*

On average more production and construction enterprises carried out R&D, in particular intramural R&D with more people employed in research and more firms carrying out R&D continuously.

With a drop of 22 percent it is also the construction and production sector that showed the greater decline in the proportion of enterprises carrying out in-house R&D. All other areas of R&D showed an increase in the proportion of firms engaged. This is especially true for the number of firms acquiring machinery and equipment for innovation, followed by design functions and internal or external training for personnel involved in innovation activity.

Distribution and service sector experienced a drop of firms in most types of R&D activities. Particularly large is the 42 percent decline in the proportion of firms engaging in the acquisition of external knowledge.

9.4 Summary of results relating to innovation input

Examining different types of R&D expenditures, a diverse picture emerges. In some areas of R&D fewer firms are active in CIS 3 than in CIS 2. In particular the 20 percent decrease in the proportion of firms engaging in intramural R&D is high and could be the cause of the decline in overall innovation output.

Other types of R&D activities, such as acquisition of technological equipment in connection with innovation, exhibit a larger proportion of enterprises in CIS 3 than in CIS 2.

As expected, within the high-tech sector more firms engaged in R&D than in the low-tech sector. It is also the high-tech sector that experienced a greater decline in the proportion of firms engaging in R&D activities.

In general fewer firms in the distribution and service sector engaged in R&D than in the production and construction sector. Production and construction industries show a larger drop in the number of enterprises that report having conducted intramural R&D, with all other areas showing an increased number of engaged firms. The services and distribution sectors show that fewer enterprises were committed to R&D between 1998 and 2000 than between 1994 and 1996.

10. Innovation constraints: general comparison

Certain factors impose constraints on firms' propensity to innovate. This is of particular interest since the comparison between CIS 2 and CIS 3 suggest that innovation activity may have been declining in the UK, when at the same time more enterprises reported unsuccessful innovations, and particularly those projects that were not started.

In the CIS's factors hindering innovation are divided into three groups: economic factors; internal factors; and other factors. Economic factors are: perceived economic risk; direct innovation cost; cost of finance; and availability of finance. Internal factors are: organisational rigidity; lack of qualified personnel; lack of information on technology; and lack of information in markets. Other factors are: impact of regulations or standards; lack of customer responsiveness to new products. Among other factors the latter one (lack of customer responsiveness) can also be considered an economic factor that affects the demand side. While of the economic factors the last three are all related to costs and therefore can be considered as supply side. As regarding the first economic factor (perceived economic risk) this can refer to both supply and demand factors. The following analysis identifies the factor of greatest concern amongst CIS 2 and CIS 3 enterprises.

In CIS 2 all those enterprises that reported unsuccessful innovation projects, which were either delayed, had not even started or were abandoned, were asked to assess perceived innovation constraints. Firms not reporting unsuccessful innovation projects were not asked to identify obstacles to innovate in the CIS 2 questionnaire and hence are not included in the examination of both CIS's. In the case of CIS 2 identifying factors hindering innovation meant that an enterprise did have one or more innovation projects that were terminated, delayed or not started due to a specific factor.

In CIS 3 all participants were asked to state whether certain innovation constraints had or had not an effect on their ability to innovate. It should be mentioned that more firms report obstacles to innovation than report unsuccessful innovation projects. However, as mentioned above and for reasons of comparability only enterprises that had unsuccessful innovation projects were examined in this report.

As the underlying question differs between the surveys it is not feasible to compare the outcomes directly in the form of number of firms reporting effects of specific factors hindering innovation. It is possible however, to compare a ranking in factors hampering innovation between CIS 2 and CIS 3. A ranking of one is given to the constraints binding on the greatest number of enterprises and a ranking of 10 is given to the factor that the smallest number of firms considers to be an obstacle.

Table 10.1: Ranking of factors hampering innovation. CIS 2 and CIS 3 selecting all enterprises with unsuccessful innovation projects. CIS 2 excludes retail, hotels and restaurants. CIS 2 and 3 weighted.

Factors hampering innovation		Rank CIS 2	Rank CIS 3
Economic factors / demand side	Excessive perceived economic risk	4	3
	Direct innovation costs	5	1
	Cost of finance	6	2
	Availability of finance	3	7
Internal factors	Organisational rigidities	9	10
	Lack of qualified personnel	1	5
	Lack of information technology	10	8
	Lack of information on markets	8	9
Other factors / supply side	Impact of regulations or standards	7	6
	Lack of customer responsiveness to new goods or services	2	4

Between 1994 and 1996 perceived constraints on innovation were wide spread amongst economic, internal factors and other factors, the biggest constraint being a lack of qualified personnel, followed by a lack of customer responsiveness to new products. Direct costs of innovation were ranked third by all CIS 2 enterprises.

Between 1996 and 1998 this even spread in the pattern disappears. Most enterprises stated that their concern when engaging in innovation was centred on economic factors. Direct costs of innovation and the costs of finance were the strongest perceived innovation constraints. This was followed by the excessive perceived economic risk of innovation. An enterprise's internal capabilities were regarded as less problematic.

11. Summary of results

Comparing the UK enterprise population in CIS 3 with the enterprise population in CIS 2, there are ten percent more service firms in CIS 3 and around seven percent more high-tech firms. This indicates that high technology and knowledge intensive industries as well as service industries have experienced a faster growth in the UK between CIS 2 and CIS 3, in comparison to low-tech, and production and construction industries.

With a stronger growth in the UK high-tech sector, a sharp decline in the proportion of enterprises reporting innovation output comes as a surprise. The 19 percent drop in enterprises declaring themselves to be product innovators is especially pronounced. The overall decline in firms with innovation output is accompanied by a simultaneous increase in firms reporting to have experienced unsuccessful innovation projects.

The high-tech sector that had the higher level of innovation activity, also reported a greater decline in firms with innovation output. The same applied to the UK production and construction sector.

Amendments in the underlying questionnaires of the CIS's might have enhanced the reported decline in the proportion of innovators. There is no evidence that because different entities answered CIS 3 than CIS 2 with the same industries and size bands surveyed that a different outcome was achieved. There is some support for a concentration in UK innovation, with fewer firms concentrating on more innovation output.

In terms of measures of innovation input, we see fewer firms engaging in some R&D activities, particularly in intramural R&D, and more firms engaging in other R&D measures. It is the high-tech sector that accounted for the large fall in firms in intramural R&D, with a drop of 20 percent. In most other areas however, it was low-tech enterprises that engaged to a lesser extent in R&D. Fewer firms in the distribution and service sector engaged in R&D in both surveys. Production and construction industries showed the larger drop in the number of enterprises having conducted intramural R&D whereas they had a higher commitment in all other sectors of R&D.

Between 1994 and 1996 the importance of perceived constraints on innovation were widespread amongst economic, internal and other factors. Between 1998 and 2000, all cost and finance related issues received the highest priority in innovation constraints above other issues such as a lack of qualified personnel and a lack of customer responsiveness to new goods and services.

References

Cox, Frenz, Prevezer (2002), 'Patterns of innovation in UK based industry: exploring the CIS data to contrast high and low technology industries' *Journal of Interdisciplinary Economics* 13 (1,2,3): 267-304.

Department of Trade and Industry (1997); Community *Innovation Survey 2*, London.

Department of Trade and Industry (2001); Community *Innovation Survey 3*, London.

Organisation of Economic Co-operation and Development (2001), *Science, Technology and Industry Scoreboard 2001: Towards a knowledge-based economy*, Paris: OECD Statistics.