LONGITUDINAL ASPECTS OF INNOVATION SURVEYS: THE CBR EXPERIENCE

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Abstract

This study was commissioned by Eurostat as part of an ongoing evaluation programme entitled Studies on Innovation and R&D Statistics. It describes the salient features of the design and conduct of the Centre for Business Research surveys and the construction of the panel database. We first provide an overview of the objectives and coverage of the programme of three successive surveys which resulted in the current panel database. We then go on to describe the sampling and survey methods. We then evaluate in some detail the evolution of the sample since 1991, testing for the effects of attrition and non-response bias within the panel database with respect to employment size, turnover size, business activity, age, profit margin, export levels and innovation. The paper then summarises the problems associated with the creation and maintenance of a longitudinal company panel, with particular emphasis on innovation surveys. It draws heavily upon the work of the survey team which produced *The Changing State of British Enterprise.* A version of this report was presented at a Workshop on "Longitudinal Aspects of Innovation Surveys" at the Zentrum für Europäische Wirtschaftsforschung (ZEW) in Mannheim on 6 June 1997.

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Further information about the ESRC Centre for Business Research can be found on the World Wide Web at the following address: http://www.cbr.cam.ac.uk

Longitudinal Aspects of Innovation Surveys: The CBR Experience

Introduction

This paper describes the salient features of the design and conduct of the Centre for Business Research surveys and the construction of the panel database. We first provide an overview of the objectives and coverage of the programme of three successive surveys which resulted in the current panel database. We then go on to describe the sampling and survey methods. We then evaluate in some detail the evolution of the sample since 1991, testing for the effects of attrition and non-response bias within the panel database with respect to employment size, turnover size, business activity, age, profit margin, export levels and innovation. The paper then summarises the problems associated with the creation and maintenance of a longitudinal company panel, with particular emphasis on innovation surveys. It draws heavily upon the work of the survey team which produced *The Changing State of British Enterprise.*

Objectives and coverage of the CBR SME Surveys

The first CBR survey of SMEs was conducted in 1991. This survey provided the first comprehensive view of the UK SME sector, covering manufacturing and business services, since the report by Bolton (1971) [see *The State of British Enterprise* Report (SBRC 1992)]. The salient features of the design and conduct of this survey are shown in Appendix A along with information about response rates. The sample, split equally between manufacturing and business services, was drawn from a sample of over 8,000 companies on the Dun and Bradstreet database, stratified by size within the 1-500 employment range. After removal of those firms which, on further investigation, exceeded this size band, had ceased trading, or were owned by others, the questionnaire was sent to a little over 6,000 firms. The 2028 respondents to the original survey were then re-

surveyed in 1993. This produced 1341 responses. The objective of the second survey was to update the information on firm performance for the original 1991 sample and to examine in greater detail than in 1991 the financing constraints facing UK SMEs and evaluate the extent to which these affected performance.

The purpose of the most recent survey, conducted in 1995 was to extend our knowledge of the innovation process in SMEs as well as providing up to date information on the UK SME sector. The questionnaire for the 1995 survey, while based upon the European Commission Harmonised Innovation Survey (CIS), was designed to be compatible with previous CBR surveys, drawing from the same sample and maintaining longitudinal comparability wherever possible. A pilot survey was conducted using a local business database to test the 1995 questionnaire. The draft 1995 survey benefited in question design by using questions previously found successful in the 1991 survey and the lessons learned from the CIS survey. It was also circulated to academics involved in that survey for comment as well as to other experts in the innovation field. As a result only a small number of changes in phrasing and questionnaire design were found to be necessary as a result of the pilot.

Table 1 shows a summary of the topics covered by the 1991, 1993 and 1995 surveys. The 1991 survey was very extensive with 61 questions covering eight topics and resulting in 316 variables. The 1995 survey was designed to be more limited in scope with 29 questions covering six topics and resulting in 198 variables. However, the 1995 survey had a particular emphasis on innovation and innovation-related expenditures with the full-length postal questionnaire including 14 questions and 107 variables focusing on these topics as opposed to only 6 questions and 43 variables in the 1991 survey. The 1993 survey focused largely on finance characteristics. The fax questionnaire in 1995, sent to those firms unable to complete the full questionnaire, also included questions regarding finance and a limited number on innovation activity.

The 1991 CBR Survey

The sampling framework used in the construction of the original 1991 survey was the Dun & Bradstreet (D&B) database. This database has its origin in the credit-rating business and is probably biased as a result towards the inclusion of a relatively higher proportion of expanding firms seeking finance than is true of the enterprise population as a whole. It is also known to under-represent sole proprietors, partnerships and single person self-employed enterprises compared to the overall enterprise sector. In view of the objective of weighting the sample respondents to the larger end of the SME population the latter problem is less serious than it might otherwise be. Moreover use of the (D&B) database has a number of advantages. First it provides indicative information about enterprises such as legal form, employment, activity, and names and functions of executives in addition to the essential address and telephone data. Second the database has been used in a series of influential studies of the role of SMEs in the job generation process in the UK so that its properties have been carefully explored (see for instance Daly, Campbell, Robson and Gallagher (1991)). The database also offered the possibility of supplementing the essentially quantitative analysis of existing job generation studies with qualitative and quantitative data other than numbers of employees alone. Finally the D&B database has had the additional advantage, owing to its credit control bias, of being particularly effective in tracking more accurately the fate of firms that have survived a period of extended recession.

The 1991 survey was designed to achieve a sample of over 2000 independent enterprises located in England, Scotland and Wales. The sample was to be equally split between the manufacturing sector and the business services sector. A stratified sample was sought within each of manufacturing and business services, weighted towards the larger small and medium sized enterprises (SMEs) in the 1- 500 employment size range. It has been estimated that at the end of 1989, 98.8% of enterprises employed less than 50 people, and 87.7%

employed less than 5. Thus, a sample design which is 'representative' in terms of employment distribution of all UK enterprises would yield insignificant numbers of respondents employing over 50 or even over 5 people (see Daly and McCann (1992)).

In the original study, 8050 firms were approached of which 1880 were discarded as being too large, subsidiaries of other businesses, ceasing to trade or otherwise outside the scope of the survey. This left 6170 firms which were surveyed. Of this total, 4142 either declined to take part or failed to return the completed questionnaire, leaving 2028 useable questionnaires (a 32.9% response rate).

A detailed description of the 1991 survey characteristics, including a comparison with aggregate SME data is contained in *The State of British Enterprise* report (SBRC (1992)). The appendix to that report, included here as Appendix A, confirms the under-representation of smallest firms compared to national size distributions which was a deliberate result of the sample design. It also confirms the under-representation of the very youngest firms, and of sole proprietorships and partnerships; a combined reflection of the Dun and Bradstreet database and the size stratified sample design. The regional distribution of the 1991 sample is shown to be broadly representative of the regional distribution of all VAT registered businesses in the UK.

The Re-surveys and the Development of the CBR SME Panel Database

As an integral part of the re-survey process, the Centre continued to monitor the status of the original 2028 firms after 1991 using up-dated Dun and Bradstreet information on-line data from InterCompany Comparisons (ICC), and microfiche data from Companies House. This process revealed which firms had been dissolved or had had receivers appointed since the original survey, making it possible to identify which of the original 2028 could potentially respond to the

subsequent surveys in 1993 and 1995. So before the 1995 survey, for example, searches of these secondary databases indicated that 337 out of the original 2028 firms had either failed or were failing. Of these, 24 firms were subsequently found to be alive but by that time it was too late to include them in the survey.

Given the natural attrition due to firm failure and the risk of a dwindling response amongst the firms still trading, particular efforts were made to obtain responses from those firms of the original 2028 which were thought to be still trading in 1993 and again in 1995. For example, in 1995 the firms were sent a questionnaire, together with a letter addressed to the managing director, reminding them that they had participated in the previous survey in 1991. A brief summary of the results of the earlier surveys of 1991 and 1995 were also sent to encourage them to participate.

If the questionnaire was not returned within two weeks a reminder letter was sent. A second reminder and another copy of the questionnaire were sent after another two weeks. Following this a brief one page questionnaire, with 7 questions covering the sections on type and size of business, innovative activity and finance, was prepared. Those firms that had not replied 5 weeks after the first questionnaire was sent were telephoned and asked whether they would be able to fill in the full questionnaire or whether they would be willing to answer the brief version, which, in that case was, faxed to them. Alternatively they were offered the possibility of answering the brief questionnaire over the telephone. A final telephone follow up call was undertaken 4 months after the first letter for any questionnaires outstanding. This exhaustive process provided information on additional firm failures, not contained in the secondary databases. By the completion of the survey a total of 394 firms were found to have failed or be failing.

As Table 2 shows for the 1995 survey, 681 firms returned the full postal questionnaire and 317 firms completed shorter questionnaires,

either by fax, telephone or during face-to-face interviews. When one accounts for the excluded and failed firms, this results in a total response rate of 62.7% in 1995.

Tests for Sample Attrition and Non-response 1991-1995

We carried out an analysis of the 1995 sample for any attrition and non-response bias. This involves using data from the 1991 survey to compare the characteristics of firms which by 1995 had failed, still trading but no longer responding or still responding. As shown in Table 3, we divide the firms which were still responding in 1995 into those which completed the full questionnaire and those which completed the shorter questionnaire, thus creating four separate groups for sampling and attrition bias tests. These groups are directly comparable with those in Table 2 above; the only difference is that the 42 firms which were found to be subsidiaries or had more than 500 employees in 1990 are excluded from the analysis.

The response groups shown in Table 3 are mutually exclusive and independent. To test whether the response groups are all from the same population One-Way Anova and Likelihood Ratio Chi-Square tests were performed according to the business characteristics relating to the 1991 survey listed in Table 4.

The tests used to analyse the attrition and non-response bias include the One-Way Anova test and the Likelihood Ratio Chi-Square test. The results for the business characteristics shown in Table 4 are reported in detail in Appendix B. All the tests show that the failed firms, i.e. group 4, are different from the rest. The failing firms are more likely than other firms to be: smaller with respect to both employment and turnover; in the service sector; younger; less profitable; and exporting less. This suggests that there is significant bias due to attrition in the 1995 sample. Another way of stating this is that the panel database enables us to identify particular risk categories for SME failure.

With the exception of turnover size, none of the means in the remaining groups are different at the 10 percent level of significance when the failed firms are excluded. In the case of turnover size, the Likelihood Ratio Chi-square test indicates that groups 1, 2 and 3 are not significantly different, whereas the One-Way Anova test suggests that the firms still trading but not responding in 1995 (group 3) are likely to have significantly higher turnover than firms responding to the full postal questionnaire. This implies that, with the possible exception of bias with respect to turnover, the 1995 sample does not display a significant non-response bias regardless of whether responding firms completed the full or the shorter questionnaires.

Summary

The **problems** created by longitudinal panels relate both to the sample of firms and the survey questions.

Sample

- sample attrition and bias
- sample refreshment

Questions

- variable consistency and linking
- new questions and re-focusing
- response inconsistency across the surveys

Sample attrition and bias

Firms may drop out of the sample due to failure, acquisition, or non-response and it is important to distinguish between these causes. The scale and impact of this for the Centre for Business Research sample has been discussed above. It is important to recognise attrition bias

and to correct for it either by careful interpretation of the survivor findings, or by re-weighting the survivor results to more closely reflect the opening distribution of firms. This process becomes more complex with each new survey period unless the sample is refreshed. The treatment of acquired firms must be considered - a sample of independent firms like that of the Centre for Business Research will exclude them, but other surveys may retain them (with caution about interpretation of their responses).

Sample refreshment

The sample will inevitably be based upon an incomplete vision of the relevant population and may be drawn as a random, or stratified sample from this database. The refreshment of the sample has two aspects:

- the selection of a sampling frame, and
- the selection of companies to rebalance the sample.

The usual purpose will be to add to the respondents of the last survey in order to create a sample which is again representative of the population under consideration. This leads to the problem of non-response, surviving companies, who may respond to subsequent surveys. These should be left in the sample, but it should be recognised that their response rate may be lower than others and this may have to be taken into account in adding further firms.

The sampling frame may go out of existence or be significantly altered. Therefore, whenever possible, the sampling frame should be capable of covering the whole economy in order to minimise inconsistency. The changing size distribution, or industrial balance of an economy can also give problems. Such changes force the choice between maintaining the balance of the original sample, or moving with the changing structure of the whole economy. These issues are of

central importance if it is intended to use the survey results to aggregate to the whole sector, or economy.

Variable consistency and linking

The first problem here concerns the discontinuous nature of the surveys. Certain variables are measured only every few years. To some extent this can be addressed by seeking historical information, but this is limited both by what is reasonable to ask and by everyone's innate desire to re-write history (particularly in relation to qualitative questions). There can also be a problem in linking variables where either the definition has changed (possibly due to new accounting or legal standards), or where the period of measurement differs.

There are some key questions which must be included in each survey in order to check whether there have been changes. The most important of these are: legal form of organisation; size; industry; and whether they remain independent.

New questions and re-focusing

Experience of previous surveys leads to improvements in many of the questions. This in turn gives difficulties in interpretation of the comparison with the results of earlier surveys. This problem can be compounded by the introduction of a new focus to the survey. If this leads to the introduction of wholly new questions at the expense of others then many of the benefits of a longitudinal panel will be lost.

Response inconsistency across the surveys

This can be a problem for longitudinal surveys when a response to one survey changes the categorisation given to the firm in an earlier survey. It usually occurs when a key question is answered in a different manner. In certain cases (e.g. the firm's industry) the change could be genuine, but in others (e.g. the date of achieving company

status) only one can be correct. In both cases the discrepancies should be checked using other sources, or the firm should be contacted about the potential discrepancy.

TABLES

Table 1 Coverage of the 1991, 1993 and 1995 surveys

Topics	*No. questions (No. variables)* 1991 survey Postal		1993 survey Postal		1995 survey Postal		Fax	
General business characteristics	6	(17)	5	(9)	5	(11)	2	(2)
Workforce and training	5	(55)	1	(2)	1	(15)	1	(1)
Innovative activity	4	(38)	0	(0)	11	(89)	1	(2)
R&D and other innovation expenditure	2	(5)	0	(0)	3	(18)	1	(2)
Commercial activity and competitive situation	20	(117)	0	(0)	7	(45)	0	(0)
Finance	6	(19)	4	(18)	2	(20)	2	(20)
Executive structure	12	(43)	0	(0)	0	(0)	0	(0)
Acquisition activity	6	(22)	1	(1)	0	(0)	0	(0)
Total	61	(316)	11	(30)	29	(198)	7	(27)

Table 2 Evolution of 1991 sample to 1995: respondents, non-respondents, failures and exclusions

Respondents to original 1991 survey		2028		
(less excluded firms)	Firms with more than 500 employees in 1990	(16)		
	Subsidiaries in 1990	(26)		
	Total of excluded firms	**(42)**		
Potential sample frame for 1995 survey		1986	1986	
(less failed firms)	Dissolved	(213)		
	Receiver appointed	(73)		
	Winding up	(5)		
	Ceased trading	(77)		
	Address and telephone unknown[a]	(26)		
	Total of firms failed or failing between 1991 and 1995	**(394)**		
Final sample frame for 1995 survey		1592	1592	100%
(less non-respondents)	Firm too busy		(79)	5.0
	Firm considered survey not relevant		(30)	1.9
	Company policy not to take part in surveys		(27)	1.7
	Refused to take part (no reason offered)		(74)	4.7
	Willing to take part but did not return questionnaire		(268)	16.8
	Unuseable questionnaires		(5)	0.3
	No response[b]		(87)	5.5
	Firms mistakenly not sent questionnaires as previously thought to have failed		(24)	1.5
	Total number of non-respondents for 1995 survey		**(594)**	**37.3**
Total responses for 1995 survey		998	998	62.7
of which	Postal respondents (full questionnaire)		681	42.8
	Other respondents (shorter questionnaire)		317	19.9

a Following Storey et al. (1987) who used the absence of a telephone directory entry as an indicator of whether a business has ceased to trade

b A maximum of 6 attempts were made to contact each firm by phone.

Table 3 Groups for attrition and non-response bias tests

	Frequency	Percent
Group 1: Postal Response	681	34.3
Group 2: Other Responses	317	16.0
Group 3: No Response and Alive	594	29.9
Group 4: Failed Firms	394	19.8
Total	1986	100.0

Table 4 Business characteristics for attrition and non-response bias tests

Characteristic	Categories with respect to 1991 survey
Employment size	Micro, Small, Medium, Larger
Turnover size (£th.)	$T<100$; $100\leq T<1000$; $1000\leq T<10000$; $10000<T$
Business Activity	Manufacturing, Services
Age	Older, Younger
Profit margin (%)	lower 50th percentile; upper 50th percentile
Export Levels (£th.)	$X=0$; $0<X<100$; $100\leq X<1000$; $1000\leq X$
Innovation	Innovating; Non-Innovating

APPENDICES

Appendix A: The CBR SME Survey of 1991

The Survey in 1991

This appendix describes the salient features of the design and conduct of the survey on which this report is based and the characteristics of the sample respondents in terms of employment size, age and location compared with various estimates for the SME sector as a whole.

Survey Sampling Objectives

The objective of the survey design was to achieve a sample of 2,000 independent enterprises located in England, Scotland and Wales. The sample was to be split equally in terms of numbers of respondents between the manufacturing sector and the rapidly expanding business services sector of the economy, and within each was to be weighted towards larger small and medium sized enterprises (SMEs) in the 1-500 employment size range. Since it has been estimated that at the end of 1989, 98.8% of enterprises employed less than 50 people, and 87.7% employed less than 5, a sample design which was 'representative' in terms of employment distribution of all GB enterprises would have yielded insignificant numbers of respondents employing over 5 or even over 50 people (Daly, M. and McCann, A. 'How Many Small Firms?' *Employment Gazette*, February 1992, pp 47-51).

The Sampling Framework

The sampling framework used in the construction of the Survey was the Dun and Bradstreet database. This database has its origin in the credit rating business and is probably biased as a result towards the inclusion of a relatively higher proportion of expanding firms seeking finance than is true of the enterprise population as a whole. It is also known to under-represent sole proprietorships, partnerships and single person self-employed enterprises compared to the overall enterprise sector. In view of the objective of weighting the sample of

respondents to the larger end of the SME population the latter problem is less serious than it might otherwise be. Moreover use of the Dun and Bradstreet database has a number of advantages. First it provides indicative information about enterprises such as legal form, employment, activity, and names and functions of executives in addition to the essential address and telephone data. Second the database has been used in a series of influential studies of the role of SMEs in the job generation process in the UK so that its properties have been carefully explored (see for instance Daly, M., Campbell, M., Robson, G. and Gallagher, C. 'Job Creation 1987-89: The contributions of small and large firms' *Employment Gazette,* November 1991, pp 589-596). Finally a survey based on this database offered the possibility in future work of supplementing the essentially quantitative analysis of existing job generation studies with qualitative and quantitative data other than numbers of employees alone.

Pilot Surveys

Two pilot surveys were carried out. The first consisted of a detailed assessment of the questionnaire design by means of interviews with a small number of enterprises with whom members of the Small Business Research Centre and personal contacts and whose directors agreed to fill in the questionnaire. This led to a number of changes in the phrasing of questions, the layout of the questionnaire and the kinds of responses required to different questions. This was followed by a full scale pilot which was designed to evaluate alternative methods of contacting potential respondents, and possible biases in response rates, as well as to further refine the questions and check the coding, computerisation and analysis of responses.

Two methods of contact were tested on a sample of 423 firms drawn randomly from the Dun and Bradstreet population of Manufacturing and Business Service firms employing less than 500 people.

a) **Telephone approach** - each firm in the sample was telephoned with the intention of contacting a senior manager and soliciting their cooperation. If the contact agreed to participate, a questionnaire and a personalised covering letter was addressed to them. A prompt was sent after two weeks and a second accompanied by a copy of the questionnaire, followed two weeks later.

b) **Blind approach** - a questionnaire was sent to each firm without prior contact and a single prompt was sent after three weeks.

Of the 423 firms in the sample, 212 were telephoned and 211 were surveyed blind. The response rates were 39.2% and 20.9% for the telephone and blind approaches respectively.

In addition a number of further benefits of the telephone approach were identified:

(i) The address details could be checked.

(ii) The current status of the firm could be ascertained, in terms of trading status, employment size and independence. The latter was particularly important as it proved difficult to exclude subsidiaries, especially of foreign companies, from the Dun and Bradstreet sampling framework.

(iii) The most suitable recipient of the questionnaire could be identified - an executive both able and willing to provide the information required.

The telephone approach was therefore adopted.

The analysis of response rates, and experiences with coding and analysing responses in the main pilot, led to some changes in question formats and in the proportions of enterprises by employment size

which it was estimated would need to be approached to obtain the final achieved sample.

Response Rate

In the light of the pilot results a sample of 8050 enterprises stratified by size band within the 1-500 employment range was drawn from the manufacturing and business services sector of the Dun and Bradstreet database. As Table A1 shows, of these, 1,880 were discarded after initial telephone screening as being too large, subsidiaries of other businesses, ceasing to trade or otherwise outside the scope of the survey. This left 6,170 enterprises which were surveyed between April and September 1991. Of this total, 4,142 either declined to take part at the telephone stage, or failed to return a questionnaire having agreed to consider filling it in at the telephone stage. The final response rate of 32.9% represents 2,028 completed usable questionnaires returned. This is a lower response rate than achieved in the pilot but still a very respectable result for a national survey focusing on smaller firms.

Table A1 Main survey responses

(i)	Total no. firms in sample	8050
(ii)	Large firms, non-independents, ceased trading	1880
(iii)	Usable firms in sample (i) - (ii)	6170
(iv)	Completed questionnaires	2028
	Response rate (5)	32.9

Source: SBRC Survey

The Comparative Employment Size, Age, and Locational Characteristics of the Sample

Table A2 shows the employment size distribution of the Dun and Bradstreet manufacturing and business services sampling framework and the corresponding distribution of the achieved sample, which as already explained was deliberately weighted towards the larger size categories to achieve worthwhile numbers of businesses in the larger SME size categories. The weighting of our sample towards the larger end of the SME size spectrum also affects the distribution of enterprises by legal form.

Table A2 Employment size distribution

Size Class	Dun and Bradstreet* manufacturing and business services sectors (%)	Respondents (%)	Respondents (%)
1 < 50	82.6	65.0	1299
50 < 199	14.8	26.3	525
≥ 200	2.8	8.8	176
Total	100.0	100.0	2000
Missing **			28

Source: SBRC Survey, Dun and Bradstreet

* A proportion of companies in the Dun and Bradstreet database are unclassified by employment size. The distribution shown here assumes they have the same distribution as those reporting employment.

** Of the 2028 respondents 28 failed to provide employment data for 1990.

Table A3 shows the breakdown of the sample between enterprises with different forms of legal organisation by comparison with the Dun and Bradstreet database, and with VAT registered businesses in

manufacturing and business services combined, the progressive reduction in the representation of sole proprietorships and to a lesser extent of partnerships is a reflection in turn of the under-representation of smaller businesses in the Dun and Bradstreet database, and the weighting of larger SMEs in the Survey design.

Table A3 The distribution of enterprises by legal form of organisation

	VAT registered legal units in manufacturing & business services	Dun and Bradstreet manufacturing & business services	Sample respondents
	(%)	(%)	(%)
Sole Proprietorships	30.5	12.9	4.0
Partnerships	16.4	10.0	8.5
Companies	53.1	76.9	87.5

Source: SBRC Survey, *Business Monitor PA 1003* 1990, Table 3D Dun and Bradstreet

Table A4 allows a rough comparison to be made between the formation dates of the companies in our survey sample and the distribution of incorporation dates of the company sector as a whole. The sample respondents are more evenly spaced across the last two decades than the company population as a whole but there is considerable similarity in the earlier decades. As might be expected the increasing importance of business services in recent decades compared to manufacturing means that sample companies in that sector have formation dates more concentrated in the last twenty years. Even so the formation dates of the sample as a whole are less concentrated into the 1980s than the incorporation dates of companies as a whole. This may reflect a gap between business formation and subsequent incorporation.

Table A4 Date of formation

	Sample companies			Company register as a whole
Date of Formation/ Registration	Manufacturing %	Services %	All %	%
< 1900	7.6	0.8	4.6	5.6
1900 < 1930	6.3	1.9	4.3	4.7
1930 < 1950	9.4	1.3	5.7	6.9
1950 < 1970	16.8	8.4	13.1	7.3
1970 < 1980	23.6	22.5	23.1	7.8
≥ 1980	36.4	65.1	49.2	67.7

Source: SBRC Survey, DTI *Companies Annual General Report* 1990-91

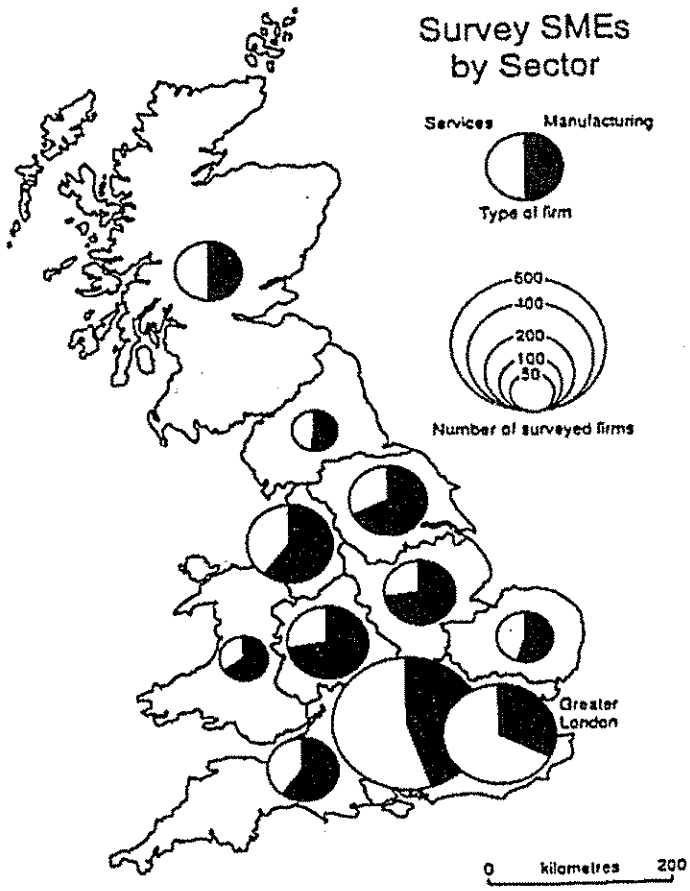
Finally as a check on the locational characteristics of our sample we can look at Table A5 and the accompanying series of maps. The table shows that the regional distribution of the survey sample replicates closely that of the total population of firms to which it relates, the latter being measured, as in Table A3 as all VAT-registered businesses (legal units) recorded by the Business Statistics Office in 1990 in the manufacturing, finance, property and professional service, and business service, sectors. This finding indicates that the SBRC survey is geographically representative of the national population of enterprises in these industries, the overwhelming majority of which are small and medium-sized enterprises.

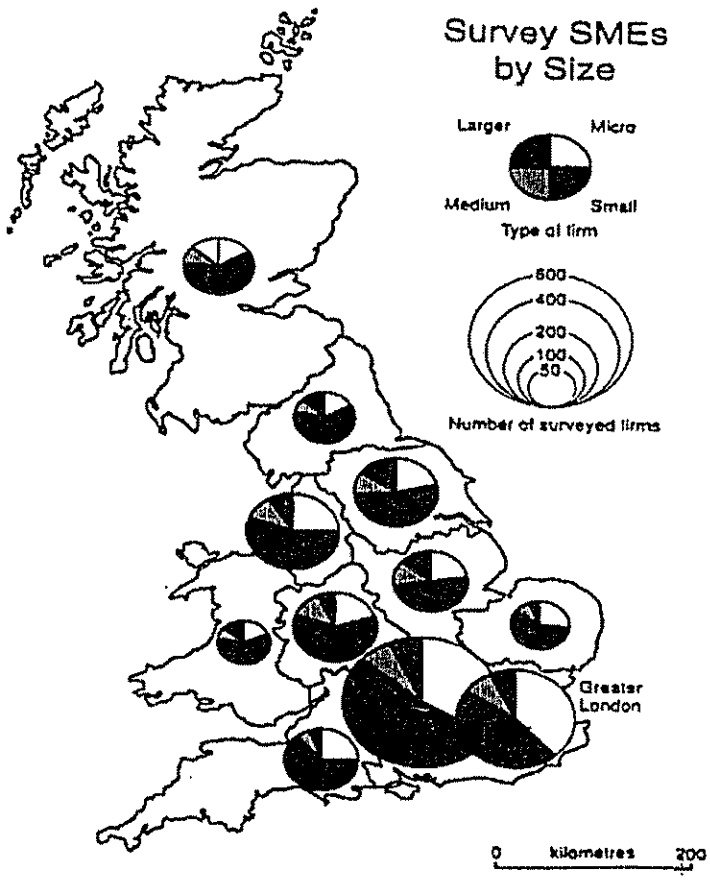
Table A5 The regional distribution of VAT registered and sample enterprises

	All VAT-registered legal units, 1990	Survey, 1991 enterprises
	%	%
South East	48.1	45.0
East Anglia	3.4	4.0
South West	7.5	6.5
West Midlands	8.9	8.2
East Midlands	6.1	6.6
Yorkshire and Humberside	6.3	7.9
North West	8.8	10.1
North	2.7	2.7
Wales	2.9	3.3
Scotland	5.3	5.8

Source: SBRC Survey, *Business Monitor PA 1003* 1990, Table 3E

The maps provide further information on geographical variations in numbers of surveyed SMEs by sector, size, age and growth. In these maps, the South East standard region is divided into Greater London and the rest of the South East (ROSE) to provide greater geographical detail.

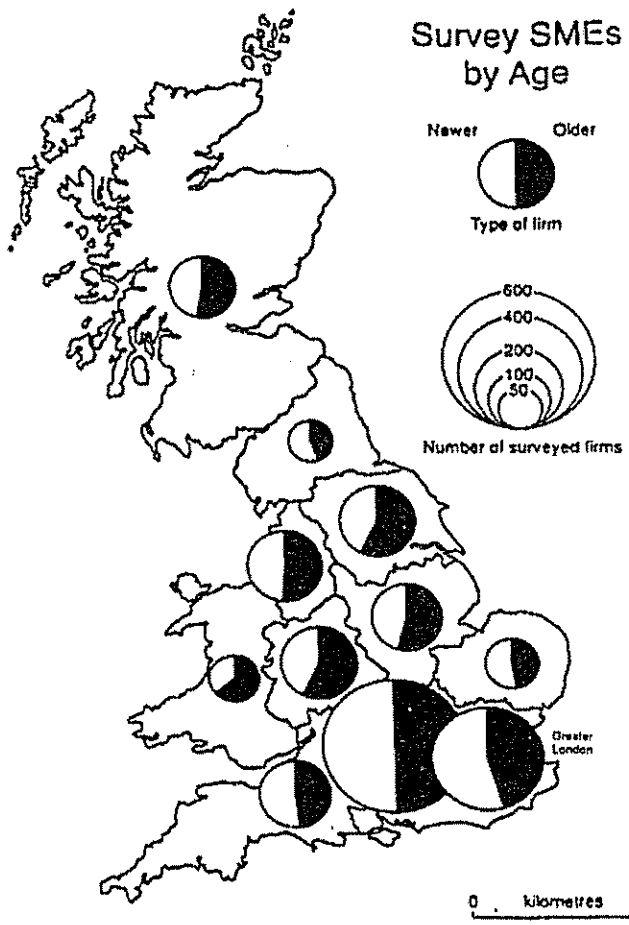

Survey SMEs
by Sector
Services
Manufacturing
Type of firm
500
400
200
100
50
Number of surveyed firms
Greater
London
0
kilometres
200

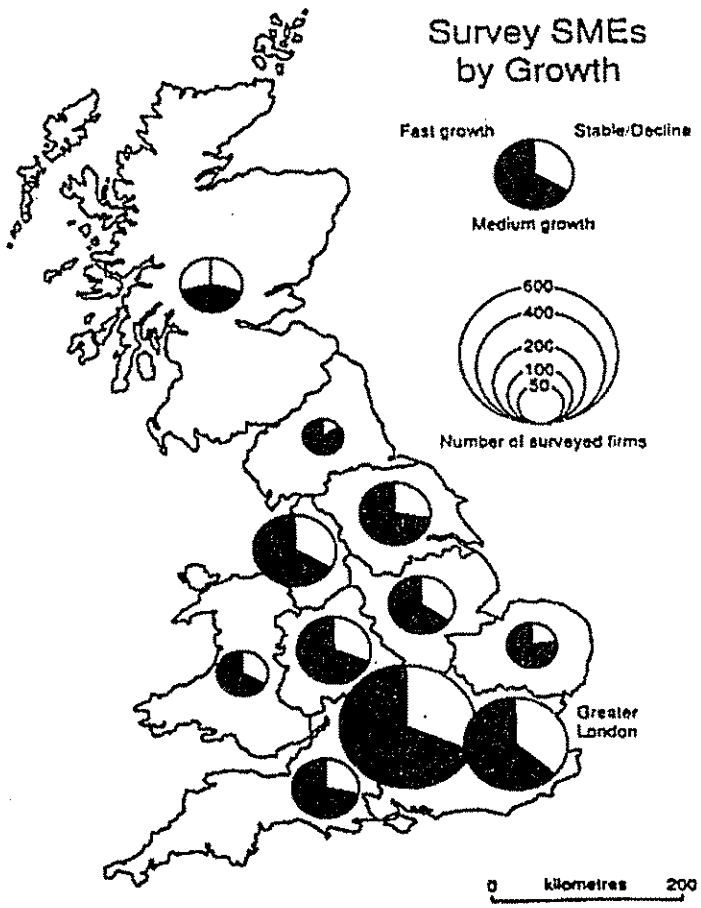

Survey SMEs
by Size
Larger
Micro
Medium
Small
Type of firm
500
400
200
100
50
Number of surveyed firms
Greater
London
0
kilometres
200

The sector map shows that the service enterprises make up an appreciably greater proportion of London and ROSE firms than of those in any other region, whereas manufacturing SMEs predominate in the East and West Midlands, Yorkshire and Humberside, the North West, and Wales. This is of course exactly in line with the findings in north-south sectoral differences reported in Chapter Seven, with their implications for firm size structures and workforce skill composition. Interestingly, however, Scotland has the highest proportion of service SMEs after the South East, while the South West and East Anglia have a majority of manufacturing SMEs.

The firm size map reveals that Greater London and ROSE are also differentiated by a particularly high proportion of micro firms, compared with all other regions, whereas larger and medium-sized firms are proportionately most frequent in the East Midlands, Yorkshire and Humberside, Scotland, Wales and Northern England. The relatively rural regions of East Anglia and the South West have high proportions of small and micro firms.

Perhaps in contrast, the map of SMEs by age reveals relatively few regional differences. All regions of Britain appear to have participated to a significant degree in the 1980s survey of new and small firm formation. That said, however, it is true that the proportion of new young firms set up since 1980 is greater than average in Greater London, East Anglia, the South West and, perhaps surprisingly Northern England, whereas older firms are more common in Welsh, East and West Midlands, and Yorkshire and Humberside samples.


Survey SMEs
by Age
Newer
Older
Type of firm
600
400
200
100
50
Number of surveyed firms
Greater
London
0
kilometres
200


Survey SMEs
by Growth
Fast growth
Stable/Decline
Medium growth
600
400
200
100
50
Number of surveyed firms
Greater
London
0
kilometres
200

Finally, and perhaps most interestingly, the map of surveyed SMEs by growth rates shows that the region with the highest proportion of declining or stable firms is in fact Greater London, followed by the North West and the East Midlands. This further supports the earlier finding (Chapter Seven) of a clear association between poor SME employment performance and conurbation location, since the first two areas are of course Britain's most urbanised regions. In contrast, fast growth SMEs are most frequent in East Anglia. Britain's most rural region, followed interestingly by Northern England and Scotland. The former of these also records the smallest proportion of stable/declining firms, with East Anglia second in this respect. Medium growth SMEs are most frequent in the West Midlands, the North, and Yorkshire and Humberside.

Appendix B: The 1995 CBR Survey Method, Sample Attrition and the CBR SME Panel Database

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We carried out an analysis of the 1995 sample for any attrition and non-response bias. This involves using data from the 1991 survey to compare the characteristics of firms which by 1995 had failed, were still trading but no longer responding or were still responding. As shown in Table B1, we divide the firms which were still responding in 1995 into those which completed the full questionnaire and those which completed the shorter questionnaire, thus creating four separate groups for sampling and attrition bias tests.

Table B1 Groups for attrition and non-response bias tests

	Frequency	Percent
Group 1: Postal Response	681	34.3
Group 2: Other Responses	317	16.0
Group 3: No Response and Alive	594	29.9
Group 4: Failed Firms	394	19.8
Total	1986	100.0

The response groups are mutually exclusive and independent. To test whether the response groups are all from the same population One-Way Anova and Likelihood Ratio Chi-Square tests were performed according to the following business characteristics relating to the 1991 survey.

The tests used to analyse the attrition and non-response bias include the One-Way Anova test and the Likelihood Ratio Chi-Square test and the results are reported in Table B2. Before presenting the results of these tests, we describe the tests and the decision criteria by which they are applied. The One-Way Anova (Bonferroni) test is a multiple

comparison procedure to determine which means are significantly different from each other. This test is preferred to making individual pair comparisons because if one makes comparisons using the same means, the probability that one comparison will turn out to be statistically significant increases even if all population means are equal. The Bonferroni test adjusts the significance level to the number of comparisons one is making. The assumptions required for this procedure are: (i) each of the groups is an independent random sample from a normal population; and (ii) in the population the variance of the groups are equal.

The Likelihood Ratio Chi-Square test of Independence is a procedure that tests whether the observed frequency of categorical variables in a cross tabulation are statistically independent. For the Chi-Square to be a good approximation of the distribution it has been recommended that the expected values must not be smaller than 5. The minimum expected values are reported below. The Likelihood Ratio Chi-Square test supplements the One-Way Anova in that the assumptions required for the latter may not always be satisfied by the data (see below). If the One-Way Anova test identified a group to be different from the others, then the Likelihood Ratio Chi-Square test was run again on the remaining groups to determine whether there were significant differences in their means.

Table B2 Business characteristics for attrition and non-response bias tests

Characteristic	Categories with respect to 1991 survey
Employment size	Micro, Small, Medium, Larger
Turnover size (£th.)	$T<100$; $100\leq T<1000$; $1000\leq T<10000$;$10000<T$
Business Activity	Manufacturing, Services
Age	Older, Younger
Profit margin (%)	lower 50th percentile; upper 50th percentile
Export Levels (£th.)	$X=0$; $0<X<100$; $100\leq X<1000$; $1000\leq X$
Innovation	Innovating; Non-Innovating

Tables B3-B23 show the results of all the tests for attrition and non-response bias. All the tests show that the failed firms, i.e. group 4, are different from the rest. The failing firms are more likely than other firms to be smaller with respect to both employment and turnover, in the service sector, younger, have lower profit margins, and exporting less. This suggests that there is significant bias due to attrition in the 1995 sample. Another way of stating this is that the panel database enables us to identify particular risk categories for SME failure.

With the exception of turnover size, none of the means in the remaining groups are different at the 10 percent level of significance when the failed firms are excluded. In the case of turnover size, the Likelihood Ratio Chi-square test indicates that groups 1, 2 and 3 are not significantly different, whereas the One-Way Anova test suggests that the firms still trading but not responding in 1995 (group 3) are likely to have significantly higher turnover than firms responding to the full postal questionnaire. This implies that, with the possible exception of bias with respect to turnover, the 1995 sample does not display a significant non-response bias regardless of whether responding firms completed the full or the shorter questionnaires.

Table B3 The Distribution of Employment Size and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
Micro	1	184	70	157	135	546	27.9
Small	2	376	183	310	211	1080	55.2
Medium	3	66	32	59	21	178	9.1
Larger	4	47	32	57	18	154	7.9
Total		673	317	583	385	1958	
% Total		34.4	16.2	29.9	19.7		100

Table B4 One-Way Anova (Bonferroni) Test for Employment Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	1.96				
Group 2	2.08				
Group 3	2.02				
Group 4	1.79	*	*	*	
F Ratio 8.5765					
F Prob. 0.00					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B5 Likelihood Ratio Chi-Square Test for Employment Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	30.61826	9	0.00034	24.93
All Groups excluding Group 4	7.36368	6	0.28852	27.40

Table B6 The Distribution of Turnover (£000s) and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
T<100	1	26	12	16	28	82	4.6
100≤T<1000	2	287	125	204	173	789	43.9
1000≤T<10000	3	259	133	262	137	791	44.0
10000<T	4	48	26	50	11	135	7.5
Total		620	296	532	349	1797	
% Total		34.5	16.5	29.6	19.4		100.0

Table B7 One-Way Anova (Bonferroni) Test for Turnover Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	2.5306				
Group 2	2.5845				
Group 3	2.6504	*			
Group 4	2.3754	*	*	*	
F Ratio 11.453					
F Prob. 0.000					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B8 Likelihood Ratio Chi-Square Test for Turnover Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	38.50370	9	0.00001	13.507
All Groups excluding Group 4	9.96845	6	0.12599	11.039

Table B9 The Distribution of Business Activity and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
Manufacturing	1	358	187	334	171	1050	52.9
Services	2	323	130	260	223	936	47.1
Total		681	317	594	394	1986	
% Total		34.3	16.0	29.9	19.8		100.0

Table B10 One-Way Anova (Bonferroni) Test for Business Activity Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	1.4743				
Group 2	1.4101				
Group 3	1.4377				
Group 4	1.5660	*	*	*	
F Ratio 7.284					
F Prob. 0.0001					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B11 Likelihood Ratio Chi-Square Test for Business Activity Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	21.68324	3	0.00008	149.402
All Groups excluding Group 4	4.00709	2	0.13486	141.973

Table B12 The Distribution of Firm Age and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
Before 1980	1	358	159	307	150	974	50.4
After 1979	2	311	151	263	235	960	49.6
Total		669	310	570	385	1934	
% Total		34.6	16.0	29.5	19.9		100.0

Table B13 One-Way Anova (Bonferroni) Test for Firm Age Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	1.4649				
Group 2	1.4871				
Group 3	1.4614				
Group 4	1.6104	*	*	*	
F Ratio 8.620					
F Prob. 0.000					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B14 Likelihood Ratio Chi-Square Test for Firm Age Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	25.73141	3	0.00001	153.878
All Groups excluding Group 4	0.57939	2	0.74849	145.094

Table B15 The Distribution of Profit Margins and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
Lower 50th Percentile	1	251	114	204	165	734	50.0
Upper 50th Percentile	2	278	125	222	110	735	50.0
Total		529	239	426	275	1469	
% Total		36.0	16.3	29.0	18.7		100.0

Table B16 One-Way Anova (Bonferroni) Test for Profit Margin Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	1.5255				
Group 2	1.5230				
Group 3	1.5211				
Group 4	1.4000	*	*	*	
F Ratio 4.5782					
F Prob. 0.0034					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B17 Likelihood Ratio Chi-Square Test for Profit Margin Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	13.71977	3	0.00331	119.419
All Groups excluding Group 4	0.01849	2	0.99080	113.895

Table B18 The Distribution of Exports (£000s) and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
X=0	0	381	182	329	246	1138	61.7
0<X<100	1	105	33	74	54	266	14.4
100≤X<1000	2	95	56	81	47	279	15.1
1000≤X	3	54	30	61	16	161	8.7
Total		635	301	545	363	1844	
% Total		34.4	16.3	29.6	19.7		100.0

Table B19 One-Way Anova (Bonferroni) Test for Export Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	0.7197				
Group 2	0.7807				
Group 3	0.7688				
Group 4	0.5399	*	*	*	*
F Ratio 4.5237					
F Prob. 0.0036					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B20 Likelihood Ratio Chi-Square Test for Export Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	24.56118	9	0.00350	26.280
All Groups excluding Group 4	9.05060	6	0.17075	29.470

Table B21 The Distribution of Innovation (1986-90) and Response Groups

Value Label	Value	Group 1	Group 2	Group 3	Group 4	Total	% Total
Non-Innovating	0	150	75	143	113	481	30.3
Innovating	1	405	183	329	187	1104	69.7
Total		555	258	472	300	1585	
% Total		35.0	16.3	29.8	18.9		100.0

Table B22 One-Way Anova (Bonferroni) Test for Innovation Categories

	Mean Value	Group 1	Group 2	Group 3	Group 4
Group 1	0.7297				
Group 2	0.7093				
Group 3	0.6970				
Group 4	0.6233	*			
F Ratio 3.5811					
F Prob. 0.0134					

(*) Indicates 5% significant differences which are shown in the lower triangle

Table B23 Likelihood Ratio Chi-Square Test for Innovation Categories

Groups	Value	DF	Significance	Min. Expected Frequency
All Groups	10.46813	3	0.01498	78.295
All Groups excluding Group 4	1.36474	2	0.50542	73.886