6 Innovation panel surveys in Germany

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1. INTRODUCTION

Surveying innovation activities of enterprises has a long tradition in Germany. The first large-scale survey instrument dates back to 1979 when the Munich-based Ifo Institute introduced its 'Ifo Innovation Test'. It used a methodology that was close to that later proposed in the *Oslo Manual*, distinguishing product and process innovation and collecting information on innovation activities and expenditure as well as some context information such as information sources for innovation, objectives of innovation activity and factors that hamper innovation. The survey is part of the Institute's wider activities to collect information on business climate and expectations in the manufacturing sector. The sample of the Ifo Innovation Test is drawn from Ifo's monthly business climate survey and is confined to the manufacturing sector (including mining and quarrying). Conducted annually since its start, the Ifo Innovation Test is probably the longest-lasting innovation panel survey in the world.[1] Although it has influenced the methodological work on innovation surveys, the Ifo Innovation Test does not fully apply the standards set by the *Oslo Manual* or those by the EU Commission's regulation on innovation statistics, which restricts international comparison. In addition, the survey's size is confined to about 1000 observations per year, which further limits its analytical potential in terms of sector breakdown.

In order to set up a survey that fully complied with the *Oslo Manual* (OECD 1992) and that could contribute to the then newly established Community Innovation Surveys (CIS), another innovation panel survey was introduced in Germany in 1993, the Mannheim Innovation Panel (MIP). This survey got its name from the city where the organization that conducts the survey is located, which is the Centre for European Economic Research (ZEW).[2] Commissioned by the Federal Ministry of Education and Research (BMBF), the MIP covers all production sectors (including mining, energy and water supply and construction) and a large number of service sectors, including trade, transportation, financial intermediation and business-related services. While the MIP shares many features of other national CIS, it holds some distinct characteristics that may make it worth discussing the experience gained from this survey instrument in more detail. First, and in contrast to most other CIS ventures, the MIP is an annual panel survey which provides more opportunity to analyse persistence of innovation activities and causal effects between innovation input and output, as well as between innovation and other firm activities such as firm performance, than repeated cross-sectional surveys can offer. Second, the survey goes beyond the standard CIS questionnaires and includes information on firm performance (e.g. profitability, gross value added) and a firm's market environment (including measures on competition). Third, the MIP has been attempting from its beginning to combine new approaches to measuring innovation discussed in the academic literature with the need for applying internationally harmonized concepts and keeping basic definitions constant over time to allow time-series analysis. Finally, firm data from the MIP have been merged with company data from other sources, including patent and trade mark data, credit rating data as well as data on public funding of R&D and innovation, which offers a multiplicity of new opportunities for empirical investigations.

Section 2 of this chapter considers methodological aspects of innovation panel surveys. It starts with an overview of the methodology of the MIP in terms of sampling, questionnaire and survey method. Subsequently, the panel structure of the data set is presented, followed by an analysis of the determinants of a firm's decision to participate regularly in the panel. Section 4 gives an overview of the development of various innovation indicators over time. In Section 5 an example is given of how the special virtues of the MIP have been exploited in empirical innovation research with the focus on one of the research questions sketched above; specifically, the analytical findings are discussed on the persistence of innovation activities. The chapter concludes with a discussion of the importance of longitudinal panel data for the analysis of the activity of innovation.

2. THE MANNHEIM INNOVATION PANEL

Sample

The MIP sample is a stratified random sample that covers enterprises with five or more employees from a wide area of economic activities. The original sample drawn in 1993 included mining, manufacturing, energy and water supply, and construction as well as a few service sectors (wholesale trade, real estate, computer activities management consulting, engineering, sewage and refuse disposal). In 1995, the panel was expanded to cover retail trade, sale and repair of motor vehicles, renting activities and various business-related services, and in 2001, film and broadcasting (NACE Rev.

1.1 groups 92.1 and 92.2) have been added. In 2005, construction, retail trade, sale and repair of motor vehicles, real estate and renting activities were taken out of the random sample as there was little demand for analyses of these sectors, while the large number of enterprises in the population required a substantial share in the survey's resources. The decision to drop these sectors was supported by the fact that the concept of innovation turned out to be difficult to apply to these sectors, and by the lack of reporting requirements for CIS. It is important to note, however, that for panel purposes firms from these discarded sectors that had responded to the survey before 2005 remained in the panel sample after 2005 and were contacted in later survey waves. As a consequence, the sector composition of responding firms did not change substantially.

The sample is stratified by sector, size class and region. The number of cells varies by year owing to changes in the sector coverage (Table 6A.1) and sector classification schemes.[3] Currently, the MIP sample consists of 896 strata: 55 divisions and 1 group of NACE Rev. 2.0 (all divisions of sections B, C, D, E, H, J, K plus divisions 46, 69, 71, 72, 73, 74, 78, 79, 80, 81, 82 and group 70.2), 8 size classes (5 to 9, 10 to 19, 20 to 49, 50 to 99, 100 to 249, 250 to 499, 500 to 999, 1000 and more employees) and two regions (western and eastern Germany including Berlin). The sampling is disproportionally drawn; that is, the drawing probability varies by cell. Higher drawing probabilities are applied to cells from larger size classes, cells from eastern Germany and cells with a high variation of innovation activities. A minimum of ten enterprises per cell are drawn.

As mentioned, the original sample was drawn in 1993 from a firm database called the Mannheim Enterprise Panel (MEP).[4] As no information on the variation of innovation activities by cells was available at that time, variation in labour productivity (sales per employee) was used as a proxy instead. From the beginning, the survey was designed as a panel. In subsequent years, the original sample has been refreshed biennially to compensate for panel mortality and to account for the foundation of new firms. Panel mortality includes firms that ceased business as well as small and medium-sized firms (up to 499 employees) that did not respond in four consecutive survey waves. Large firms remain in the sample irrespective of their response behaviour. The same holds true for any firm that leaves the target population by either changing its main economic activity to a sector outside the core sectors or by shrinking below the five employee threshold.

Table 6A.2 reports the sector distribution of the MIP sample by survey years. About half of all firms are from manufacturing and almost a quarter belongs to business-related services. Firms from these sectors are clearly overrepresented compared to the total population, which is also true for mining, energy and water supply, sewage, transport, storage and communication, and financial intermediation.

In addition to the random sample, the MIP deliberately addresses an additional sample of firms that have received public funding for R&D and innovation activities. These firms were drawn from a database of recipients of public R&D grants provided by the BMBF. The main purpose of including publicly funded firms is to generate a database for evaluation purposes (see for empirical applications Aschhoff 2010; Czarnitzki et al. 2007; Hussinger 2008; Schmidt and Aerts 2008). These firms are not considered for weighting purposes, except when a publicly funded enterprise has entered the MIP through random sampling.

The original gross sample of the MIP in 1993 comprised 13318 firms. After the extension to service sectors in 1995, the sample size increased to 22201. In order to keep survey costs down, the sample has been confined to a subsample of firms every second year. When drawing this subsample the same stratification features apply, but drawing probabilities are reduced. At the same time, in each cell, firms that responded in the past receive priority in drawing over non-responding firms. This practice started in 1996 for service firms and in 1998 for all firms, and has been continued since. As a result, sample size varies by year in a biennial rhythm (see Table 6.1). Since response rates are clearly higher in years with a reduced sample thanks to the focus on previously responding firms as well as due to a shorter questionnaire (the following subsection on the questionnaire provides more details), the size of the net sample does not vary in the same way.

Over time, the sample size has been increased to compensate for a somewhat falling response rate, to allow for a more detailed sector breakdown of the sample and to increase the drawing quota (gross sample as a percentage of total population), which was 11.4 per cent in the 2011 wave. Depending on the survey year, for 5 to 18 per cent of the firms in the gross sample a neutral loss has been recorded because either the firm ceased operation or it could not be successfully contacted despite several attempts. The large variation in the share of neutral losses first and foremost represents different efforts of contacting non-responding firms and of identifying firms that ceased business. In 2011, particular efforts were undertaken both to clean the data by removing firms that were no longer operating and by contacting all firms that did not respond to the initial postal mail by telephone, including a manual check of all invalid telephone numbers. As a result, a large number of neutral losses have been identified. In other survey years, the share of neutral losses is likely to be underestimated.

Response rates in uneven years with a full sample was 26.6 per cent

Table 6.1 Sample size and response characteristics of the MIP, 1993–2011

Survey year	Gross sample	Responses	Non-response interviews	Drawing quota[a]	Share of neutral losses[b]	Net response rate[c]	Coverage rate[d]	Total sample rate[e]
1993	13318	2854	992	12.9	6.0	22.8	30.7	4.3
1994	12663	3064	0	12.6	3.8	25.1	25.1	3.7
1995	22201	5633	1097	5.8	4.6	26.6	31.8	1.9
1996	9944	2281	815	10.7	6.0	24.4	33.1	3.6
1997	21576	4789	1920	6.5	11.0	24.9	34.9	2.0
1998	10668	3704	1893	3.1	6.2	37.0	55.9	1.7
1999	22385	4786	3869	7.0	15.6	25.3	45.8	2.7
2000	12929	3993	1996	3.7	4.9	32.5	48.7	1.9
2001	24032	4845	4014	7.4	4.2	21.0	38.5	2.7
2002	14225	3877	3832	3.9	3.0	28.1	55.9	2.7
2003	26215	4538	3853	8.0	4.7	18.2	33.6	2.7
2004	20572	3892	3766	6.5	16.0	22.5	44.3	2.7
2005	33107	5207	4235	12.5	8.5	17.2	31.2	3.4
2006	21003	4728	3816	7.8	8.4	24.6	44.4	3.2
2007	30162	5215	4231	11.0	3.2	17.9	32.4	3.4
2008	21058	6110	4580	6.4	9.7	32.1	56.2	3.5
2009	35195	7061	4960	11.0	10.1	22.3	38.0	3.8
2010	24009	6226	5459	7.7	7.1	27.9	52.4	3.8
2011	35531	6851	8721	11.4	18.2	23.6	53.6	5.0

Notes:

a. Gross sample as a percentage of total population (only for that part of the gross sample that belongs to the current target population of the MIP; 1993–2003 excluding film and broadcasting; 1993–98 excluding energy and water supply); break in series in 2008 due to revised total population figures.
b. Closed firms and firms that could not be contacted for other reasons as a percentage of the gross sample.
c. Responses as a percentage of the gross sample adjusted for neutral losses.
d. Responses plus non-response interviews as a percentage of the gross sample adjusted for neutral losses.
e. Responses plus non-response interviews as a percentage of the total population.

Source: ZEW.

in 1995 and fell to 17.2 in 2005 but could be increased again to 23.6 per cent in 2011, mainly resulting from higher efforts in following up through telephone contact and by offering an online variant of the questionnaire from 2008 onwards. Compared to other CIS, the response rates are very low, owing to the non-mandatory status, a longer and more complex questionnaire than the standard CIS questionnaire (see next section) and the less official status of the organization that executes the survey (by contrast with statistical offices). In addition, there was a decision to deliberately refrain from urging firms unwilling to participate in the survey to respond. In one attempt to do so, the result was that the quality of responses in terms of accuracy, completeness and reliability fell significantly, including a substantial share of firms reporting no innovation activities despite clear evidence that such activities did exist (as revealed by corresponding statements on the Internet, in company reports or through press releases).

Since a low response rate may result in a biased net sample of responding firms in terms of the share of innovative firms, a non-response survey has been undertaken in each survey wave (except for 1994) among a stratified random sample of non-responding firms. In the non-response survey firms are asked on the telephone whether they have introduced product or process innovation, providing them the very same definition of both types of innovation as in the mail questionnaire. In addition, information on ongoing or abandoned innovation activities and in-house R&D activities is collected. In order to check the firm's stratification variable, firms are asked for the number of employees and a short description of the main good or service. The size of the non-response survey increased from a sample of about 1000 firms to more than 8700 firms in 2011. The results show that, in most years, the share of innovating firms (i.e. having introduced at least one product or process innovation during the previous three-year period) is significantly higher[5] among the non-responding than among the responding firms. Only in two survey years (1993 and 2005) is the opposite result found, and only in 2007 are differences not statistically significant (Table 6.2).

These results suggest that innovating firms are more likely to refuse to respond to the innovation survey. This would reflect a cost-minimizing behaviour of firms since the effort to respond to the survey is significantly higher for innovating than for non-innovating firms, as a large number of questions are only addressed to firms with product or process innovation activities. Interestingly, negative effects are found for the first year and for 2005 when the sample size has been significantly enlarged and a large number of not-yet-surveyed firms were added to the sample. This suggests that innovating firms are more willing to participate in the survey in the first year in which they are approached but become reluctant to participate in further years due to the high response burden imposed on them. In the next section the determinants of participating in the panel survey will be investigated more closely.

However, it may be argued that the results of a mail and a telephone survey cannot be compared as circumstances under which respondents answer are quite different. While respondents to a mail survey have

Table 6.2 Share of innovating firms among responding and non-responding firms, 1993–2011

	'93	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11
Responding	79.8	63.6	56.7	58.6	64.6	57.8	65.3	53.8	51.8	53.2	53.3	61.3	50.5	55.3	48.9	50.9	46.3	52.5
Non-responding	58.6	65.6	71.8	78.1	74.4	76.6	75.2	62.6	63.7	59.5	64.7	60.5	61.8	58.7	60.4	63.6	61.7	59.6
ME of NR survey	−16.4	11.8	22.2	21.5	10.3	17.6	9.3	8.9	14.7	8.5	13.4	−3.6	8.3	0.5	8.4	12.9	13.4	4.7
significant at 1% level	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes		yes	yes	yes	yes

Notes: ME: marginal effect (percentage points) of the effect of the non-response (NR) interview on the probability of being an innovator, estimated by probit models including log of no. of employees, industry and regional dummies.

Source: ZEW.

sufficient time to read and consider the definition, can see the questions that follow, and have a list of examples for product and process innovation at hand, respondents on the telephone have to react immediately and may be more likely to misunderstand the concept of innovation.

One simple test for a potential survey instrument bias is to analyse firms that responded in years $t-1$ and $t+1$ through the mail or online questionnaire and did not respond in year t, but provided information in year t through the non-response survey. If firms from this group were non-innovators in $t-1$ and $t+1$ (as collected from the mail survey), they should by definition also be a non-innovator at t (as collected by the non-response survey) since in each year the question on product and process innovation refers to the introduction of corresponding innovations in the previous three-year period. Reciprocally, firms that were innovators in $t-1$ and $t+1$ should also be innovators at t. A total of 737 firms fall in this group. For the large majority of firms, consistent answers are found. However, for 16.8 per cent the innovator status collected from the non-response survey was not consistent with that from the encircling mail surveys. A total of 20.9 per cent of firms that reported being non-innovators in the preceding and subsequent mail surveys stated that they were innovators in the non-response survey in between (Table 6.3). In contrast, 13.7 per cent of firms reporting innovator status in the mail surveys reported being non-innovators in the non-response survey. This result shows that there is inconsistency in firm responses on the introduction of product and process innovation over time, which can have various causes

Table 6.3 Consistency of innovator status of firms with three consecutive responses in the MIP by type of survey instrument

Type of survey instrument in $t-1$ and $t+1$	Status in $t-1$ and $t+1$	Type of survey in t	Status in t: non-innovator (%)	Status in t: innovator (%)	Share of inconsistent responses in t (%)*
Mail	non-innovator	NR	79.1	20.9	16.8
Mail	innovator	NR	13.7	86.3	
Mail	non-innovator	Mail	86.9	13.1	11.6
Mail	innovator	Mail	10.2	89.8	
NR	non-innovator	NR	76.3	23.7	12.0
NR	innovator	NR	8.5	91.5	

Note: * Inconsistent result given the assumption that information in $t-1$ and $t+1$ is correct.

Source: ZEW.

(see the section Innovation Indicators: A Longitudinal Perspective). However, inconsistencies also occur if the group of firms with three consecutive mail responses is examined (11.6 per cent with an innovator status at t not consistent with the status in $t - 1$ and $t + 1$) and with three consecutive non-response interviews (12.0 per cent). Inconsistencies are larger when firms were non-innovators in $t - 1$ and $t + 1$, but there is no clear bias to report an innovator status when being surveyed through a telephone interview.

Questionnaire

As the MIP is the German contribution to the CIS, the questionnaire is based on the harmonized CIS questionnaire for the respective survey year and applies the standard definitions as provided by the *Oslo Manual*. However, the MIP questionnaire goes beyond standard CIS questionnaires in several respects. First, the MIP includes questions on financial data since data protection regulation in Germany does not allow for merging firm data from the MIP (or any other non-official source) with official enterprise statistics. Basic economic variables, however, that go beyond sales and employment figures are needed for many research questions. Currently, financial information includes capital expenditure, fixed assets, labour costs, costs of material, energy and purchased services, expenditure for training, marketing expenditure, profit-to-sales ratio and exports. Some of this information (capital expenditure, exports) was gathered in early CIS questionnaires but was later dropped from the survey. Except for export figures, financial information is obtained in the MIP only in years when the full sample is surveyed. In order to establish annual time-series data, information is not only collected for the current year but also for the previous year. Since all firms are asked to provide financial information, these variables can be used to analyse effects of innovation on financial performance as well as interaction between innovation expenditure and other types of investment in tangibles and intangibles (e.g. Czarnitzki and Kraft 2010, 2012). In addition, the MIP obtains information on a firm's business environment on an irregular basis, including the number of competitors, market share, the significance of certain product market features and the role of different types of competition.

Second, the information collected on innovation activities is more detailed than in the standard CIS questionnaire. For example, the MIP captures the amount of cost savings due to process innovation in order to better quantify the likely economic impacts of process innovation. Since 2003, an additional output measure for product innovation, the sales share due to new products that have no predecessor product within the firm and which therefore broaden a firm's product range, is used to capture another dimension of product novelty that complements the new-to-the-market question (see Rammer et al. 2009 for a discussion of the two concepts of novelty). In the same year, a further output indicator for process innovations that aim at improving the quality of goods and services was introduced. This indicator measures the change in sales that can be attributed to such quality-improving process innovations. In addition, the MIP continues to survey the number of employees engaged in R&D activities as well as the share of graduate employees, information that the harmonized CIS questionnaire no longer collects. The MIP also collects data on planned innovation for the year of the survey and the following year in terms of both activities (product, process) and expenditure. Differences between planned and later actually realized innovation activities and expenditure can provide valuable information on the uncertainty of the environment for innovation or on changes in innovation strategy (e.g. Dobbelaere et al. 2009).

Third, questions on characteristics of the innovation process in the MIP go beyond the standard CIS questions on cooperation, information sources, objectives and consequences, public support, hampering factors and the use of IP protection methods. These additional questions are strongly driven by data needs of policy makers and of academic researchers both from the ZEW and from other institutions,[6] and vary over time. In recent years, additional innovation questions included, among others, the financing of innovation, innovation activities in foreign countries, sources of innovation (stimulated by the work of Mansfield 1998 on public research as a source of industrial innovation), the role of trademarks and marketing for innovation, innovation collaboration along value-added chains, infringement of IP and the role of IP in helping and restraining innovation, management of innovation projects, and the effects of economic crises on innovation activities.

An important issue when designing an innovation questionnaire is the degree to which questions attempt to take into account industry specificities. While innovation is a phenomenon relevant to all industries, how economic activities are being renewed differs considerably. Designing a questionnaire specific to a certain industry would clearly facilitate accurate response and would allow for addressing issues particularly relevant for one industry (and omitting those less relevant). However, cross-sector comparability would be greatly lost by this approach. Nevertheless, the MIP followed this approach in 1995 when a large number of service sectors were surveyed for the first time. Following extensive face-to-face interviews with service firms and cognitive testing, a survey design for service sectors was chosen that deviated substantially from the one introduced two years earlier in the production sector (which was in line with CIS 1). Innovations were defined by distinguishing three types, namely new or improved services for customers (product innovation), new or improved processes introduced within the firm (process innovation), and improvements in the organization of internal procedures. The last was not regarded as a process innovation but was introduced to avoid firms reporting what would now be called organizational innovation as process innovation.[7] For each type of innovation a list of typical examples was given on a separate page. Firms were asked to provide a short description of the most important innovation for each type, which allowed *ex post* analyses of how well the concept of innovation was understood. Another question obtained information on the link between the reported innovations and technologies. Innovation expenditures were surveyed as a total figure, followed by a qualitative assessment of the significance of certain components (roughly in line with the current list of innovation activities in the CIS) because interviews suggested that smaller firms in particular were not able to estimate figures for individual expenditure categories. On the contrary, other innovation-related questions on information sources, cooperation partners, R&D activities and hampering factors used the same design and wording as for the production sector. The service industry questionnaire contained additional questions on economic variables that were specifically designed for the service sector, for example the type of international activity or the type of service delivered, or IT investment.

In subsequent years, the questionnaires for both sectors gradually converged. Since 2003 a single questionnaire has been used. There were several reasons for this. First, the harmonized CIS 2 questionnaire (conducted in 1997) proposed a similar methodology for both the goods- and services-producing sectors based on the first revision of the *Oslo Manual* in 1997 (OECD/Eurostat 1997), including a uniform definition of innovation and innovation expenditure that made the main rationale for two versions obsolete. Second, interest in high comparability of survey results between goods and services producers, both from policy and from research (e.g. for analysing differences in determinants and outcomes of innovation), called for a unification of methodological approaches. Third, practical reasons in terms of simplifying the questionnaire, and its shipping and processing, as well as queries about what to do with firms that changed economic activity between the two sectors (sending the same version in order to maintain consistency over time, or sending the version that fitted the sector affiliation, with potential for confusing the firm and reducing comparability of firm data over time) played a role, too. Between 1997 and 2002, separate questionnaires were used to omit or add certain questions for the service sector (e.g. the question on sales share of new products was not used in the CIS 2 service sector version of the questionnaire) and to allow more space for presenting separate lists of innovation examples for goods- and services-producing sectors.

It is difficult to assess whether services would need a separate approach to survey innovation and whether the initial approach followed in the MIP would be more appropriate. A simple test reveals that the questionnaire used in 1995, specifically designed for the service sector, yielded a significantly higher innovator share in the services- than in the goods-producing sectors compared to the unified version used in 1997 for which no significant effect was found.[8] From this finding it cannot be established, however, which version better captures actual innovation activities in the service sector.

3. PANEL PARTICIPATION

Although the MIP is a panel survey, the net sample of responses represents a highly unbalanced sample. The total number of firms that have been surveyed at least once during the 19 years from 1993 to 2011 (excluding firms that were identified as neutral losses in the first year they were surveyed) is 97 432; the total number of questionnaire responses received in the same period amounts to 89 654. Only 27 906 firms out of the total sample filled out the questionnaire at least once. The average number of responses per responding firm is 3.21.

The high number of firms with zero responses results from the strategy to remove firms from the sample (except for large firms) if they did not respond for four consecutive years. In addition, many firms have been first sampled in recent years and have only had a few occasions to participate. A further reason is high panel mortality, which steadily reduces the number of firms from a certain sampling year contained in the current panel sample. In 2011, only 12 per cent of firms initially sampled in 1993 were still part of the sample. As a consequence, the 2011 sample consists only of 5.3 per cent of firms that have been sampled from the first year on (see Table 6.4). After five years, less than a quarter of the original sample size remains. Panel mortality is the result of various events, including closures, mergers, demand by firms to be taken out of the sample and continuing refusal to respond to the questionnaire.

The unbalanced nature of the MIP is also due to regular refreshments of the sample in order to compensate for panel mortality. The 2011 sample, for example, consisted of one-third of firms that were first sampled in this year and another 36 per cent sampled in the previous six years. This

Table 6.4 Sample size of the MIP by sampling year, 1993–2011

Sampling year	Size in sampling year[a]		Survey year[a]											Sample size in 2011[b]	
			1993	1994	1995	1997	1999	2001	2003	2005	2007	2009	2011		
	total	%	(Sample size in sampling year = 100)											total	%
1993	12642	13.0	100	86	47	35	29	29	26	19	17	16	12	1563	5.4
1994	1086	1.1		100	90	78	48	41	41	29	26	24	19	208	0.7
1995	14248	14.6			100	84	58	35	27	19	17	14	11	1552	5.4
1997	2119	2.2				100	76	60	39	25	22	18	13	285	1.0
1999	4632	4.8					100	92	51	34	30	25	19	893	3.1
2001	7880	8.1						100	76	48	38	30	23	1825	6.3
2003	7894	8.1							100	61	45	38	28	2234	7.7
2005	14479	14.9								100	39	31	25	3553	12.3
2007	10280	10.6									100	37	28	2926	10.1
2009	12325	12.6										100	35	4287	14.9
2011	9478	9.7											100	9478	32.8
others	369	0.4												51	0.2
Total	97432	100												28855	100

Notes:
a. Figures reported are for survey years in which panel refreshments have taken place.
b. Excluding neutral losses.

Source: ZEW.

implies that many firms have only had a few chances to participate in the panel so far.

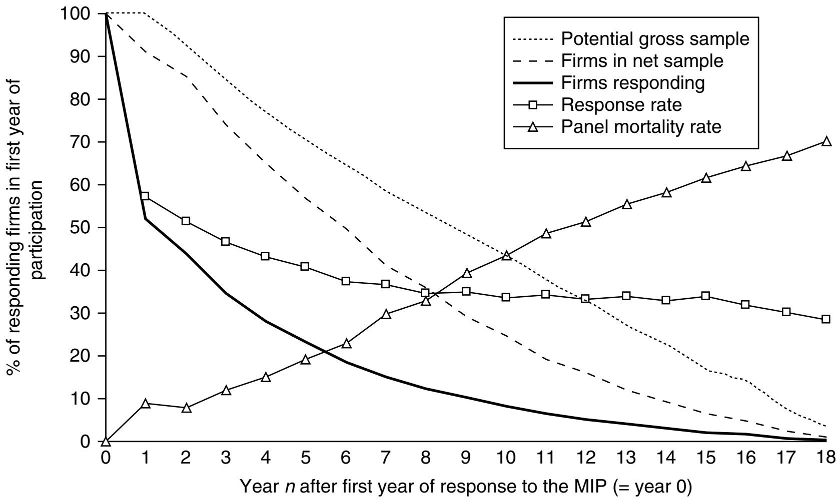
A low average response rate of 24 per cent further lowers panel participation. Response rates do not decline, however, for firms staying in the panel for a long time, but rather increase, which results from the deliberate removal of firms with continuing non-response. In 2011, the response rate did not vary significantly by sampling year except for the newly sampled firms, which show lower response rates in every survey year (see Table 6A.3).

Despite decreasing sample participation, about 50 per cent of all responses received in the MIP up to 2011 were from firms that were sampled in the first three years of the panel (Table 6A.4), although only 14 per cent of all responses received in 2011 were from the first three sampling years.

Figure 6.1 illustrates the participation pattern of responding firms over time. Denoting year 0 as the first year a firm responded, the share of firms responding in the next year (year 1) is 52 per cent as an average across survey years 1994 to 2010. A total of 9 percentage points of the 48 per cent of non-responding firms in the consecutive year result from panel mortality, giving a 57 per cent response rate for those firms still surviving in year 1. While the mortality rate steadily increases (up to 70 per cent in year 18, which is for firms that responded the first time in the 1993 survey), the response rate of still surviving firms falls to 35 per cent for year 8 and remains at this level until year 15, afterwards slowly declining again. As a consequence of both developments, only 1.9 per cent of the initial sample (243 firms in absolute figures) also responded in the most recent survey year, 2011. However, most of these firms did not participate in every single year but show some gaps.

Figure 6.1 also shows that the maximum number of responses that can be obtained in subsequent panel years constantly decreases over time, which simply represents that only firms from the initial sampling year had the theoretical chance to respond in every following year, while firms with more recent sampling years naturally were able to participate only in a smaller number of years.

From the original sample drawn in 1993 (which consisted primarily of manufacturing firms), just 7.3 per cent of firms were part of the sample in every year up to 2011 (Table 6.5). Out of this small balanced sample, only a dozen (1.2 per cent) responded every single year, clearly indicating the difficulty of motivating firms to carry the burden of constant participation in a voluntary survey. The share of firms with continuous response in every year they were contacted increases only slightly with younger sampling years. For the 2001 sampling year, for example, only 2 per cent



Notes:
Potential gross sample: share of firms that responded in year $t = 0$ (= first year the firm was part of the MIP sample) and could have been part of the sample in year $t + n$.
Firms in net sample: share of firms that responded in year $t = 0$ and were part of the sample in year $t + n$ and were not classified as neutral loss due to firm closure or continuous non-response.
Firms responding: share of firms that responded in year $t + 0$ and responded in year $t + n$.
Response rate: share of firms responding in year $t = 0$ and year $t + n$ in total net sample of firms in year $t + n$ that responded in year $t = 0$.
Panel mortality rate: share of firms responding in year $t = 0$ and that were not part in the net sample in year $t + n$ either due to firm closure or elimination from the sample due to continuous non-response.

Source: ZEW.

Figure 6.1 Participation in the MIP over time

of firms that were part of the sample in all 11 years from 2001 to 2011 also responded in all 11 years, although the sample size of this sampling year has been confined to only 13.3 per cent of its original size by 2011 due to firm closure and repeated non-response. This finding suggests that only a very small fraction of firms can be attracted to participate permanently in a survey as complex as the innovation survey, and most get lost very early from the group of firms that provide balanced panel observations.

A multivariate analysis of the probability of responding to the MIP reveals that the number of times a firm was previously part of the sample has a positive effect on survey participation, which simply reflects the strategy to take firms out of the sample if they refuse to respond for several consecutive years. Firm age has a positive though non-linear effect.

Table 6.5 Sampling and response behaviour in the MIP by sampling year

Sampling year	Firms that were part of the sample in every year from sampling year until 2011 (as a percentage of all firms in the sampling year)	Firms that responded in every year from sampling year until 2011 (as a percentage of all firms in the sampling year)	Average response rate from sampling year until 2011 (% of all sampled firms)
1993	7.3	1.2	28.4
1994	9.2	3.0	24.5
1995	6.4	2.8	27.5
1997	7.6	3.1	26.7
1999	9.5	2.0	21.2
2001	13.3	2.0	21.6
2003	19.0	3.0	20.1
2005	19.2	4.6	20.2
2007	25.7	6.6	21.0
2009	32.7	13.2	21.1
2011	100.0	16.0	16.0
Others	18.2	7.5	21.4
Total	24.7	10.3	23.9

Source: ZEW.

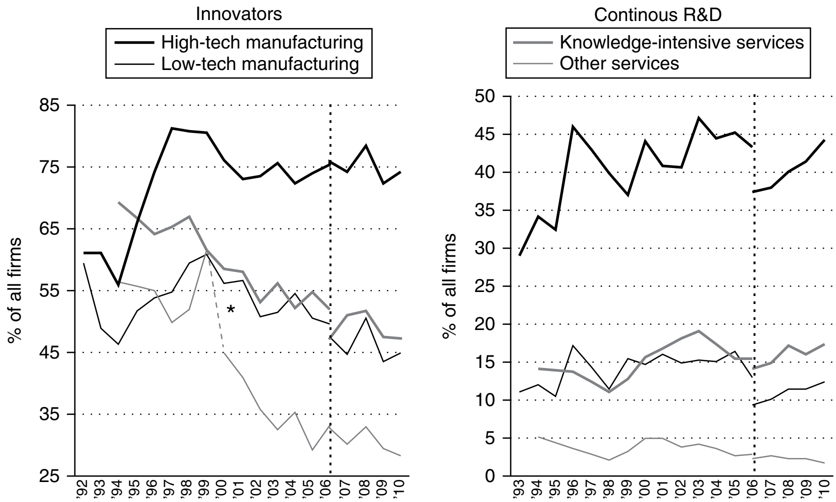
Firms older than 12 years at the time of the survey show higher response probability, as do very young firms. Firm size has a negative effect, again with some non-linearity. The highest response rates can be observed for firms with around 20 employees. Corporations are more likely to participate than partnerships, and firms from eastern Germany show a higher response probability than western ones.

4. INNOVATION INDICATORS: A LONGITUDINAL PERSPECTIVE

Innovation surveys offer a variety of firm-based innovation indicators, ranging from expenditure on innovation activities to indicators on the occurrence of certain innovation activities (typically expressed as the share of firms showing a certain activity) and indicators of innovation results (such as the share of sales generated by new products). Up to now, these indicators have not been used very widely in studies on innovation performance, in contrast with R&D or patent indicators (see Smith 2005; Dodgson 2000). One reason is the concern about the reliability of these indicators, as they show high variation over time in certain countries. This variation is unlikely to represent real changes in innovation behaviour of firms, but may rather result from changes in sample composition (see Hollanders and van Cruysen, 2008 and Chapter 4 in this volume). For the German innovation survey, this limitation should be less severe thanks to the panel character of the sample. In addition, the annual survey allows the establishment of long annual time-series data for innovation indicators, which provides a sound base for analysing the reliability of indicators derived from innovation surveys.

The share of innovating firms is a key indicator of the spread of innovation-based competitive strategies within the firm population. The indicator is defined as the percentage of firms that have introduced at least one new or significantly improved product or new or significantly improved process in the three years before the end of the reference year. The level of this indicator is driven by the behaviour of small firms, as they make up the vast majority of all firms in the population. For the target sectors of the MIP, 86 per cent of all firms with five or more employees have fewer than 50 employees, and a further 13 per cent have between 50 and below 500. Over the past two decades, the share of innovators shows a downward trend in service sectors (Figure 6.2). Low-tech manufacturing reports a low innovator share for the early 1990s (note that the period 1992–94 was characterized by a significant recession in Germany), followed by a strong increase until 1999 and a declining trend until 2010. In high-tech manufacturing the share of innovating firms has been stable since the end of the 1990s, clearly exceeding the level of the three other sectors.[9]

For each of the sectors there is strong annual fluctuation, which is surprising when taking into account that the innovator share in each year refers to product and process innovations introduced in the previous three years. The unbalanced nature of the MIP may explain some of this fluctuation. Averaged across all survey years, the net sample of responding firms plus non-responding firms interviewed on their innovation activities through a non-response survey in year t consists of 52 per cent of firms that were also surveyed through one of the two instruments in year $t-1$, which means that almost half of the sample on which weighted results for the share of innovators is based were not present in the net sample of the previous year. It may be that some firms do not properly refer to a three-year reference period but rather to innovations introduced in the reference year. This would explain some inconsistencies in the sequence of innovator and non-innovator status over time (see the section on the MIP above and the next section on the Persistence of Innovation). In some years the fluctuation of the share of innovating firms goes in the same direction in



Notes:
Break in series in 2006 due to transit from NACE Rev. 1.2 to NACE Rev. 2.0 and a change in the statistical base for population figures.
* Break in series for the share of product/process innovators for other services in 2000 due to alterations in the survey question on product and process innovation.
All figures are extrapolated to the total population of firms with five or more employees.
Years are reference years of the surveys.

Source: ZEW.

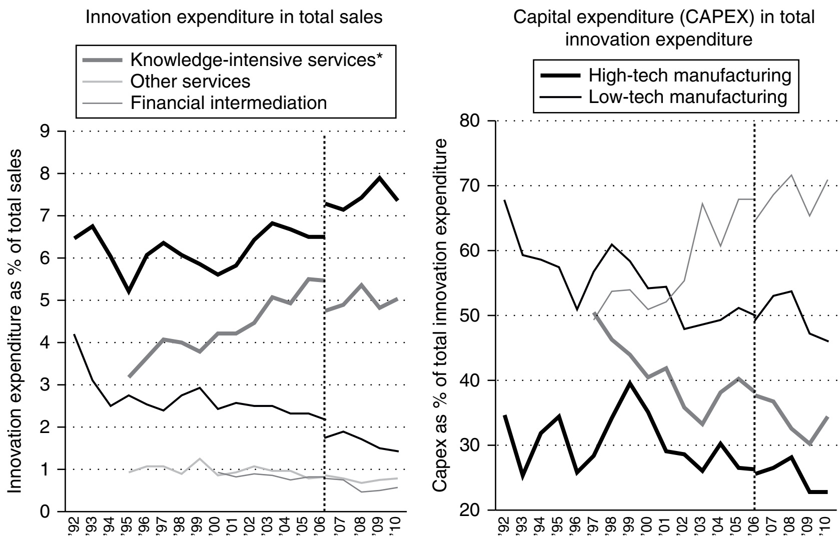
Figure 6.2 Share of product/process innovators and share of firms with continuous in-house R&D activity in Germany by sector, 1992–2010

all sectors (e.g. upwards in 2008 and downwards in 2009), which may be associated with business cycle fluctuations. In reference year 2000, the sharp fall in the share of innovators, particularly in other services (from 62 to 45 per cent), can be attributed to some extent to a change in the explanatory notes to the definition of product innovation in the trade business. In contrast to previous surveys, firms in retail and wholesale were explicitly advised from the 2001 survey onwards that reselling innovative goods developed and introduced by other firms is not to be considered a product innovation by retailers or wholesalers, which resulted in a significant drop in the number of product innovations in the trade business.

Another CIS-based indicator on the diffusion of innovative activities in the firm population is the share of firms with in-house R&D activities on a continuous basis. In contrast to the innovator share, this indicator shows an upward trend for most sectors, although the indicator is affected by a break in series in 2006 due to the new NACE classification and changes in the statistical base used for population figures. Again, significant annual fluctuation can be observed despite a three-year reference period for in-house R&D activities.

A key input indicator for innovation is the amount of money spent on innovation activities. The total amount of innovation expenditure in German manufacturing and service sectors doubled in nominal terms between 1995 and 2010, from €60.7 billion to €121.3 billion. This expenditure includes internal and external R&D, expenditure on the acquisition of machinery, equipment, software and other intangibles used for developing and introducing product or process innovation, and expenditure on training, marketing, design and other innovation-related activities. Across all sectors, innovation expenditure in Germany is about twice the amount of R&D expenditure. The growth rate of total innovation expenditure is higher than that for business enterprise intramural R&D expenditure. This does not necessarily imply that non-R&D innovation activities become more important over time. Since innovation expenditure includes costs of intramural and external innovation activities, double counting of innovation efforts by expenditure data may occur. For example, a firm purchasing and implementing a novel production technology will report these process innovation expenses as innovation expenditure. The firm that developed the new technology will most likely consider the development activities as own innovation effort, too, and report the associated costs as innovation expenditure. Similar cases can be made for a marketing campaign on a new product developed by an advertising firm, or for engineering and design activities for new products purchased from other firms. Since the CIS does not distinguish between intramural and external expenditure, the amount of double counting of innovation expenditure remains unclear.

Innovation expenditure as a percentage of sales shows an upward trend in high-tech manufacturing and in knowledge-intensive services (excluding financial intermediation) (Figure 6.3). In other services, this indicator is rather stable over time, while low-tech manufacturing and financial intermediation show a downward trend. Annual fluctuation is less articulated than for innovator shares. This may be attributed to the fact that the amount of innovation expenditure is largely driven by rather few very large firms, which are all represented in the weighted results in every year. Capital expenditure on innovations (i.e. acquisition of machinery, equipment, software and other intangibles) shows higher variations over time, which largely reflects investment cycles. The share of capital expenditure in total innovation expenditure tends to increase in other services, where



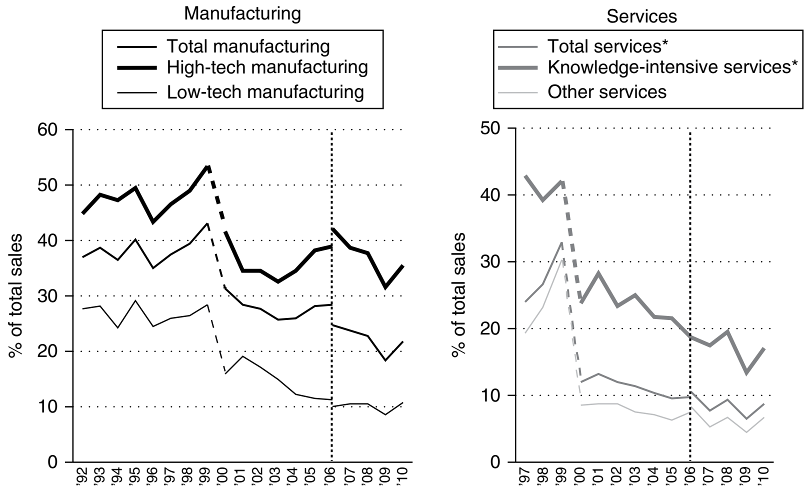
Notes:
Break in series in 2006 due to transit from NACE Rev. 1.2 to NACE Rev. 2.0 and a change in the statistical base for population figures.
*Excluding financial intermediation for innovation expenditure as a share of sales.
All figures are extrapolated to the total population of firms with five or more employees.

Source: ZEW.

Figure 6.3 Innovation expenditure in total sales and capital expenditure in total innovation expenditure in Germany by sector, 1992–2010

capital expenditure currently accounts for about two-thirds of total innovation expenditure. In knowledge-intensive services and low-tech manufacturing this share is decreasing while high-tech manufacturing shows quite high fluctuations without a clear trend. When linking innovation-related capital expenditure to total capital expenditure, a rather stable share over time emerges. In high-tech manufacturing, about 50 per cent of total capital expenditure in Germany is devoted to innovation projects, while the other three sectors report an innovation share of capital expenditure of below 25 per cent.

A key advantage of CIS as an empirical basis for innovation research is the presence of an output indicator for product innovation. The share of sales generated by new or significantly improved products introduced during the past three years has been used by many researchers to analyse the determinants of innovation success (see Kleinknecht et al. 2002; Laursen and Salter 2006; Leiponen and Helfat 2010; Lööf and Heshmati



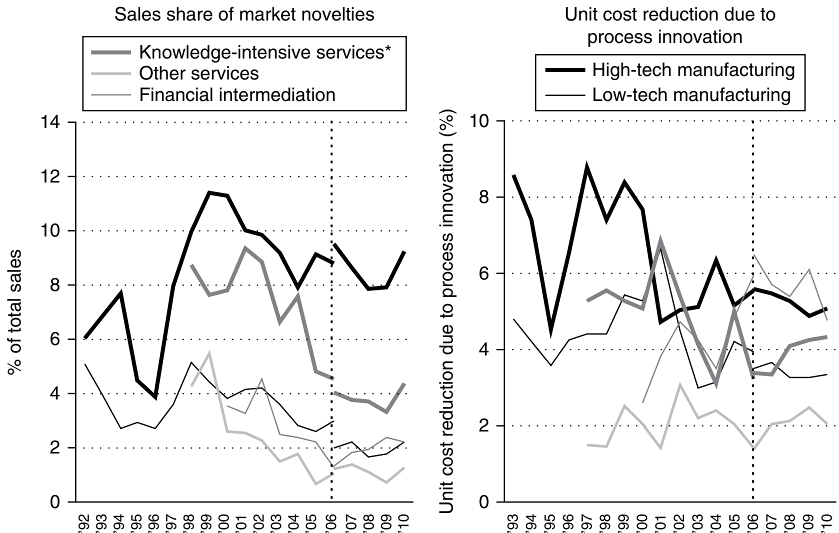
Notes:
Break in series in 2006 due to transit from NACE Rev. 1.2 to NACE Rev. 2.0 and a change in the statistical base for population figures.
* Excluding financial intermediation.
All figures are extrapolated to the total population of firms with five or more employees.

Source: ZEW.

Figure 6.4 Sales share of product innovations in Germany by sector, 1992–2010

2010; Cockburn et al. 2010; Rammer et al. 2009). In the MIP, this indicator has been used since the first survey wave for manufacturing and was introduced to the service sector in 1998. Until 2000, the indicator was split in two categories, share of sales from new products and share of sales from significantly improved products. From 2001 on, both categories were merged into one, following the policy of the harmonized CIS questionnaire. This led to a sharp fall in the sales share of new products (Figure 6.4). In manufacturing, the average share of sales in reference years 1992 to 1999 (i.e. based on the two categories question) was 38.4 per cent, while it was 28.0 per cent in 2000 to 2006 (with the merged categories). In services, the drop was even higher, from 27.9 per cent (1997 to 1999) to 11.2 per cent (2000 to 2006). This finding shows that rather small changes to the survey instrument may have significant consequences for innovation indicators.

Another indicator of product innovation success that is not affected by changes in the way the information is collected in the questionnaire is the



Notes:
Break in series in 2006 due to transit from NACE Rev. 1.2 to NACE Rev. 2.0 and a change in the statistical base for population figures.
* Excluding financial intermediation.
All figures are extrapolated to the total population of firms with five or more employees.

Source: ZEW.

Figure 6.5 Sales share of market novelties and unit cost reduction due to process innovation in Germany by sector, 1992–2010

sales share of market novelties. Market novelties are new products that have not been introduced into the market by any other firm before. The relevant market is defined by the innovating firm and need not refer to the world market but may relate to national or regional markets. This indicator shows rather high values both in manufacturing and services in the late 1990s and early 2000s (Figure 6.5). In this period, many firms exploited the new potential of IT applications to place new-to-the-market products. The indicator exhibits a downward trend until 2009 and rose again in 2010.

In contrast to the standard CIS questionnaire, the MIP also uses an indicator of process innovation success. Directly following the question on the introduction of process innovation, firms are asked whether any of these process innovations led to a reduction in the unit costs of production. Firm replying 'yes' are then asked to estimate the magnitude of unit cost reduction due to process innovation in the reference year of the survey. This indicator fluctuates quite strongly. High-tech manufacturing reports high unit costs reductions in the second half of the 1990s, followed by a rather stable development since 2001 at around 5 per cent. Low-tech manufacturing has the highest value in 2001, followed by a period of rather low unit cost reductions in recent years. Financial intermediation achieved high cost savings driven by process innovations in the past years (around 6 per cent), while other services were able to lower unit costs by about 2 per cent every year thanks to process innovation.

5. PERSISTENCE OF INNOVATION

One major virtue of innovation panel data is the fact that they illuminate the dynamics of firms' innovation behaviour. In a dynamic perspective, the question of whether firms persistently innovate, innovate discontinuously or whether they refrain from innovating over a long period of time and how this behaviour can be explained has gained importance in the last decade (see Flaig and Stadler 1994; Cefis and Orsenigo 2001; Cefis 2003; Peters 2009; Raymond et al. 2010). This is due to the fact that, for instance, endogenous growth models greatly differ in their underlying assumptions about the innovation frequency of firms (see, e.g., Romer 1990; Aghion and Howitt 1992). Permanent innovation activities are furthermore regarded as key to improving long-run firm performance and competitiveness. The empirical literature, however, has recently started to investigate performance effects of persistent innovation behaviour (Johansson and Lööf 2010). Since the dynamics of innovation behaviour are also likely to be related to the business cycle, the question of whether firms remain engaged in innovation projects has furthermore attracted greater attention in the current economic crisis.

The MIP data support the investigation of the dynamics of innovation over nearly 20 years, from 1992 to 2010 in manufacturing and from 1996 to 2010 in services. Persistence occurs when a firm that has innovated in one period innovates once again in the subsequent period. As already mentioned, innovation surveys collect data to measure innovation from an input and output perspective. Table 6.6 sheds light on the persistence of innovation input by depicting one-year transition probabilities of innovation activities. A firm is defined to have innovation activities if it spends a positive amount on innovation projects in a given year t. Since the MIP is an unbalanced panel, evidence is provided for three different samples: firms with at least four; at least seven, and at least ten (services) or 13 (manufacturing) consecutive observations. A first striking result is that there is a high and very similar degree of persistency in all three panels. Therefore the focus is on the sample with at least four consecutive

Table 6.6 Innovation activities: one-year transition probabilities (per cent), 1992–2010

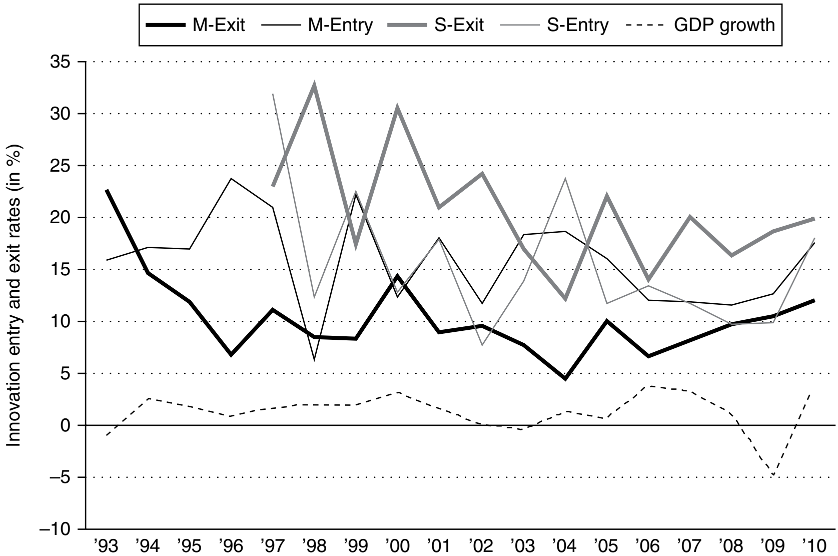
Innovation status in t	Innovation status in $t + 1$ Panel with at least . . . consecutive observations								
	4			7			13 (M) / 10 (S)		
	Non-inno	Inno	Total	Non-inno	Inno	Total	Non-inno	Inno	Total
Manufacturing									
Non-inno	84.5	15.5	100.0	85.0	15.0	100.0	87.8	12.2	100.0
Inno	9.8	90.2	100.0	9.0	91.0	100.0	7.6	92.4	100.0
Total	38.1	61.9	100.0	36.9	63.1	100.0	38.6	61.4	100.0
Number of obs.			*37068*			*18775*			*4435*
Services									
Non-inno	85.3	14.7	100.0	85.8	14.2	100.0	86.4	13.6	100.0
Inno	20.5	79.5	100.0	20.3	79.7	100.0	21.5	78.5	100.0
Total	57.6	42.4	100.0	58.7	41.3	100.0	61.0	39.0	100.0
Number of obs.			*21942*			*8972*			*4139*

Notes: Inno and Non-inno are dummy variables indicating firms with and without innovation activities. A firm is defined to have innovation activities if it spends a positive amount on innovation projects in year t. M and S denote manufacturing and services. In services, the time period is from 1996 to 2010.

Source: ZEW.

observations. Around 90 per cent of manufacturing firms engaged in innovation activities in one year t remain innovative in the subsequent period. Innovation activities reveal themselves to be highly persistent in services as well, although service firms are less likely to continue innovation activities in the next year (79 per cent). The lower persistence might, for instance, reflect shorter average development times in services, fewer technological opportunities, less demand for innovation, or smaller sunk costs in R&D. The degree of persistence is likewise high for non-innovative firms. In both manufacturing and services, roughly 85 per cent of them also refrain from innovation in the following period, while 15 per cent entered into innovation activities. That also means that the probability of being innovative in period $t + 1$ was about 74.4 and 64.8 percentage points higher for innovators than for non-innovators in t in manufacturing and services, respectively, which can be interpreted as another measure of persistence.

As the decision to start with new innovation projects or to stop investing

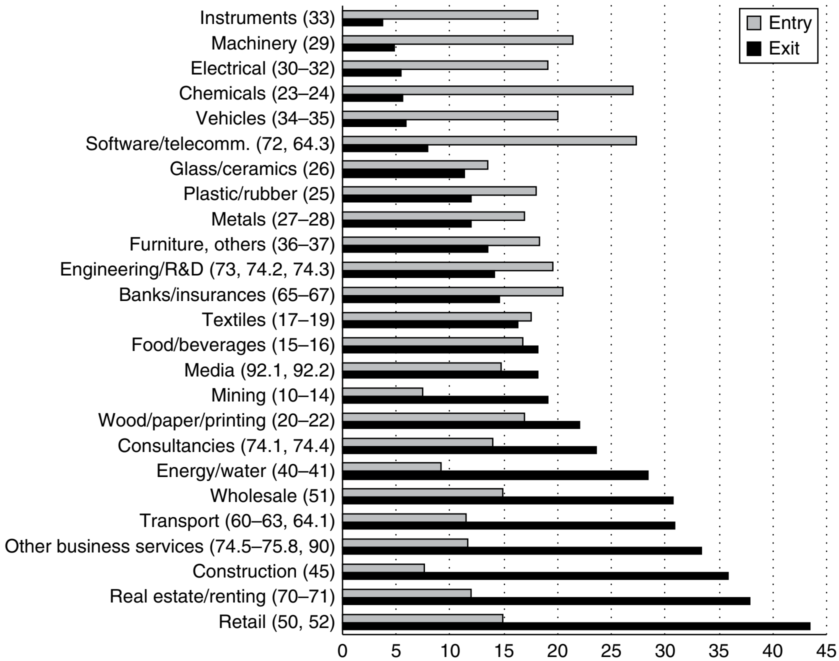


Notes: Sample: unbalanced panel with all firms with at least four consecutive observations. M and S denote manufacturing and services, respectively. The innovation entry rate in any given year t is defined as the share of non-innovative enterprises in year $t - 1$ which start innovation activities in year t. Similarly, the innovation exit rate in year t measures the share of innovative companies in year $t - 1$ which flow out of innovation activities in year t. GDP growth denotes the annual percentage change of real GDP.

Source: ZEW; real GDP growth; download from Eurostat server 22.06.2012.

Figure 6.6 Innovation entry and exit rates and business cycles, 1993–2010

in them might be related to the business cycle, Figure 6.6 contrasts the innovation entry and exit rates with the annual growth in GDP. Overall, it turns out that innovation exit rates in manufacturing have been rather stable from 1996 onwards. Interestingly, exit rates fluctuate more in services and all in all they seem to exhibit a decreasing trend over time.[10] In both manufacturing and services, entry rates move very similar over time. Furthermore, the figure reveals that the decision to start innovation projects is more volatile than the decision to stop them.[11] Despite fluctuations over time, no clear pattern of entry and exit rates over the business cycle can be observed. In manufacturing, the correlation coefficient between growth in GDP and entry is only slightly positive (0.009). The effect is stronger and negative between GDP growth and exit rates (−0.140). However, neither correlation is statistically significant. The same holds for services, where both correlations turn out to be positive. In contrast to manufacturing, the decision to exit from innovation is less



Notes: See Figure 6.6. Figures in parentheses give NACE Rev. 1.2 codes.

Source: ZEW.

Figure 6.7 Innovation entry and exit rates by industry, 1993–2010

correlated with the business cycle than the decision to start an innovation project (0.123 compared to 0.253).

Figure 6.7 and Table 6.7 illustrate innovation persistence by industry and size classes. Broadly speaking, three groups of industries emerge. The first group is characterized by very small exit rates and high entry rates. This group consists of high-tech industries such as precision instruments, electrical engineering, vehicles, machinery, chemicals and telecommunication. The figures imply that the firms steadily pursue innovation activities for a long period of time and even if they stop for a given year, they have a high likelihood of starting again in the next period. The second group of firms, which consists of glass/ceramics up to media, can be described as having similar entry and exit rates. All other manufacturing industries (except for wood/paper) as well as technical services and financial intermediation belong to this group. The third group, starting with mining (Figure 6.7) exhibits very high exit rates and small to moderate entry rates.

Table 6.7 Innovation activities: one-year transition probabilities by size classes, 1992–2010

Innovation status		Size class: number of employees in *t*							
Year *t*	Year *t* + 1	<10	10–19	20–49	50–99	100–249	250–499	500–999	1000+
Manufacturing									
Non-inno	Non-inno	90.8	87.8	84.0	82.3	80.7	75.0	79.6	76.8
	Inno	9.2	12.2	16.0	17.7	19.3	25.0	20.4	23.2
Inno	Non-inno	24.0	18.9	15.6	11.4	8.6	6.2	4.2	1.7
	Inno	76.0	81.1	84.4	88.6	91.4	93.8	95.8	98.3
Services									
Non-inno	Non-inno	87.9	85.2	85.6	83.5	85.0	80.3	78.3	80.6
	Inno	12.1	14.8	14.4	16.5	15.0	19.8	21.7	19.4
Inno	Non-inno	27.6	25.7	22.1	17.4	22.7	23.0	10.8	4.9
	Inno	72.4	74.3	77.9	82.6	77.3	77.0	89.2	95.1

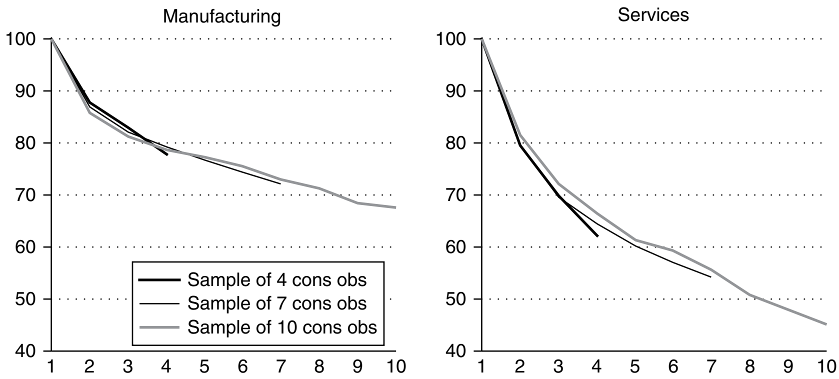
Note: Sample: Unbalanced panel with all firms with at least four consecutive observations.

Source: ZEW.

This interplay of entry and exit describes a situation where many firms are not engaged in innovation projects and just innovate occasionally. If they start innovation projects, these are of a rather short time horizon, as 20 to 45 per cent of the innovating firms already cease to innovate in the subsequent year.

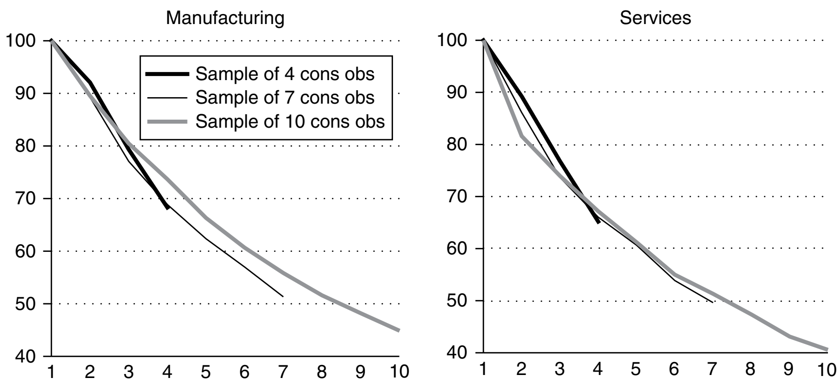
Table 6.7 highlights that innovation behaviour is more stable in larger firms, though also relatively enduring in small firms. In manufacturing, the probability of remaining innovative steadily increases from 76 per cent in firms below ten employees up to 98 per cent in firms with more than 1000 employees. In services, this linear increasing trend is not seen, as firms with between 20 and 499 employees are equally likely to stay on the innovation path in the next year. At the same time, the figures suggest that the propensity for non-innovators to take up such activities steadily rose as well. The entry rates increase with firm size, although firms with 250–499 employees in manufacturing and 500–999 employees in services show the highest propensity to start innovation projects.

Instead of using one-year transition probabilities, another way of looking at persistence of innovation activities is to examine survival rates. Figures 6.8 and 6.9 display survival rates of different innovator and non-innovator cohorts. The survival rate for the innovator cohort



Source: ZEW.

Figure 6.8 Survival rates of initial innovator cohorts, manufacturing and services



Source: ZEW.

Figure 6.9 Survival rates of initial non-innovator cohorts, manufacturing and services

in year s is the proportion of innovators in year $t = 1$ (the year in which the firms enters the panel) that is still innovating in year $t + s$, for $s = 1, 2, \ldots S - 1$, with S being the number of consecutive observations of the panel. Similarly, the survival rate of the non-innovator cohort in year s is the proportion of non-innovators in year $t = 1$ that continuously refrain from innovating in year $t + s$. In order to investigate whether survival rates depend on the number of years an individual firm is observed in the data, survival rates are presented for different samples. In a nutshell, survival rates of different samples (for joint periods) differ only slightly. In particular, panels with a longer time dimension do not consist of firms with lower survival rates for non-innovators. And survival rates of initial innovators are only marginally higher in these panels. This suggests that, if at all, sample selection problems are of minor importance in this analysis.

In manufacturing, roughly four out of five initially innovating firms are still innovating after four years. After seven years a share of 73 per cent is still engaged in innovation projects. This proportion only decreases slightly to 68 per cent after ten years. That is, more than two out of three initial innovators incessantly innovate in the following ten years. In terms of persistence, survival rates reveal larger differences between manufacturing and services than one-year transition probabilities. With 66 per cent, the four-year survival rate for initial innovators is already lower than the proportion in manufacturing after ten years. Interestingly, the highest drop-out rates can be found as early as in the first two periods. That is why 56 per cent and 45 per cent of the initial innovators are still observed to be continuously engaged in innovation projects after seven and ten years.

In contrast to the innovator cohort, the survival rates of initial non-innovator cohorts are more similar in manufacturing and services. In services, 67 per cent, 51 per cent and 40 per cent of initial non-innovators still refrain from innovation activities after four, seven and ten years respectively. On the other hand, these figures imply that six out of ten firms that did not perform innovation activities in the first year of observation have started to do so in the next ten years. In manufacturing the corresponding figure is 45 per cent after ten and 40 per cent after 13 years. An analysis based on a balanced subsample has furthermore shown that those firms that experienced at least one change in their innovation behaviour exhibit a stronger tendency to return to the initial innovation status (Peters 2009).

Instead of persistence in innovation input, Table 6.8 considers persistence in innovation from an output perspective. Since innovation output indicators are defined for a three-year period, three-year transition probabilities are calculated in order to avoid the problem of overlapping periods. For all three output indicators (product innovation, process innovation and market novelties), the probability of remaining an innovator is very high, though somewhat smaller than from an input perspective. Furthermore, there is a clear pattern in both manufacturing and services: product innovators are more likely to remain product innovators in the subsequent period (around 83 per cent and 63 per cent) than process innovators (69 per cent and 57 per cent) and firms having introduced market novelties (68 per cent and 52 per cent). Compared to patent statistics, in particular the latter figures are unexpectedly high, meaning that

Table 6.8 Innovation output: three-year transition probabilities, 1992–2010

Innovation status in *t*	Innovation status in *t* + 3 Panel with at least . . . consecutive observations								
	4			7			13 (M) / 10 (S)		
	Non-X	X	Total	Non-X	X	Total	Non-X	X	Total
Manufacturing									
Non-PD	82.1	17.9	100.0	83.3	16.7	100.0	86.1	13.9	100.0
PD	17.0	83.0	100.0	15.8	84.2	100.0	12.1	87.9	100.0
Total	45.9	54.1	100.0	45.2	54.8	100.0	45.7	54.3	100.0
Non-PC	80.3	19.7	100.0	80.9	19.1	100.0	81.9	18.1	100.0
PC	30.8	69.2	100.0	29.5	70.5	100.0	28.8	71.2	100.0
Total	57. 5	42.5	100.0	56.8	43.2	100.0	57.7	42.3	100.0
Non-MN	88.5	11.5	100.0	88.7	11.3	100.0	90.1	9.9	100.0
MN	32.1	67.9	100.0	31.0	69.0	100.0	31.4	68.6	100.0
Total	69.7	30.3	100.0	68.9	31.1	100.0	71.0	29.0	100.0
Services									
Non-PD	87.1	12.9	100.0	89.2	10.8	100.0	89.8	10.2	100.0
PD	36.9	63.2	100.0	34.5	65.5	100.0	36.0	64.0	100.0
Total	68.8	31.2	100.0	70.1	29.9	100.0	68.7	31.3	100.0
Non-PC	85.3	14.7	100.0	86.8	13.2	100.0	87.2	12.8	100.0
PC	42.9	57.1	100.0	43.3	56.7	100.0	49.7	50.3	100.0
Total	72.8	27.3	100.0	74.5	25.5	100.0	74.8	25.2	100.0
Non-MN	94.9	5.1	100.0	94.9	5.1	100.0	95.3	4.7	100.0
MN	48.4	51.6	100.0	47.3	52.8	100.0	52.2	47.8	100.0
Total	86.8	13.3	100.0	87.0	13.0	100.0	89.7	10.3	100.0

Note: X denotes dummy variables indicating whether an enterprise introduced a product innovation (PD), process innovation (PC) or market novelty (MN), respectively.

Source: ZEW.

for instance two out of three manufacturing firms with market novelties in period *t* develop further market novelties in the subsequent period. In services it is every second firm.

In contrast to that, non-product innovators have a smaller likelihood of becoming innovators in the next period than process innovators. This also holds for both manufacturing and services. The smallest entry rates can be observed for firms without market novelties in period *t*. Just 11 per cent and 5 per cent of firms without such innovations in manufacturing and in services are able to subsequently develop and introduce a market novelty.

The previous tables and figures have shown that innovation behaviour is persistent to a large degree. However, these figures do not unveil the drivers of this phenomenon. In general, there are three sources of persistency: state dependence, and observed and unobserved firm heterogeneity. First, there might exist a causal behavioural effect in a sense that the decision to innovate in one period in itself increases the probability of innovating in the next period. This is called true state dependence. Sunk costs in setting up R&D facilities might be one explanation for state dependence as they act as a barrier to entry in innovation activities but also to exit from innovation activities (Sutton 1991). A second argument put forward in the literature is that innovations involve dynamic increasing returns (Nelson and Winter 1982; Malerba and Orsenigo 1993). Experience in innovation is associated with dynamic increasing returns in the form of learning-by-doing and learning-to-learn effects that enhance knowledge stocks and, as a consequence, the probability of future innovations. The fact that knowledge accumulates over time should therefore induce state dependence in innovation behaviour. The hypothesis that success breeds success might be a third explanation. Successful innovations might positively affect the condition for future innovations as successful innovators possess larger market power, more financial means and a larger set of technological opportunities (Phillips 1971; Mansfield 1968; Stoneman 1983; Nelson and Winter 1982).

But on the other hand, firms may also possess certain attributes that make them more likely to innovate. To the extent that these characteristics themselves are persistent over time, they will induce persistence in innovation behaviour as well. Such firm-specific attributes can be classified into observable characteristics, such as firm size, human capital or financial resources, and unobservable ones. For instance, technological opportunities, managerial abilities or risk attitudes are important for firms' decision to innovate, but are typically not observed (unobserved heterogeneity).

Disentangling sources of persistence is interesting from a policy point of view. If innovation behaviour is state dependent, public innovation subsidies are supposed to have a more sustained effect because they not only stimulate current innovation activities but are likely to induce a permanent change in favour of innovation. If, on the contrary, individual heterogeneity induces persistent behaviour, support programmes are unlikely to have long-lasting effects, and economic policy should concentrate more on measures that have the potential to improve innovation-relevant firm-specific factors and circumstances (Peters 2009).

In order to disentangle these three different sources, Peters (2009) and Raymond et al. (2010) have suggested estimating a dynamic random effects probit model. In addition to the lagged innovation status and observed explanatory variables, the model controls for unobserved heterogeneity.

In order to be able to estimate the model, Wooldridge (2005) has suggested explaining individual heterogeneity by the initial innovation status in the first observation period, the mean values of time-varying explanatory variables and additional time-constant explanatory variables.[12] Table 6.9 provides corresponding estimation results for manufacturing and services. The impact of variables that are controlled for in the estimation are firm size, credit rating, age, group status, training expenditure, share of high-skilled employees, export share, public subsidies, eastern Germany, foreign parent companies, public limited companies and private partnerships (for measurement details see notes to Table 6.9).[13]

The results by and large confirm the results found by Peters (2009) for the period 1994–2002. That is, all three sources are important drivers of innovation persistence, with lagged innovation activity being the most important one. The estimation results reveal that after conditioning on observed explanatory variables and unobserved individual heterogeneity, the probability to innovate in year t is still 31.5 and 33.4 percentage points higher for firms with innovation activities in year $t - 1$ than for prior non-innovators in manufacturing and services, respectively. This effect is highly significant in both samples and confirms the hypothesis that innovation behaviour is driven by true state dependence. In order to evaluate the quantitative importance, this effect is compared with the unconditional difference in the probability of innovating for prior innovators and non-innovators of 74.4 and 64.8 percentage points in manufacturing and services, respectively. As can be seen in Table 6.10, it turns out that in manufacturing roughly 42.5 per cent can be explained by true state dependence. In contrast to the results found by Peters (2009), the effect of state dependence is even higher for service firms at about 51 per cent. These estimates are based on the assumption that individual heterogeneity takes its average value (PEA: partial effect at the average value), which might reflect only a small proportion of firms. As an alternative, Wooldridge (2005) suggested calculating the average partial effect (APE) averaged across the distribution of the individual heterogeneity as well. Using the alternative measure, Table 6.10 shows that the state dependence effect is somewhat lower, but still ranging between 31 and 36 per cent in manufacturing and services, respectively.

Furthermore, it turns out that initial innovation status is also highly significant in both samples. This implies a substantial correlation between firms' initial innovation status and individual unobserved heterogeneity. Another important finding is that in addition to past innovation experience, knowledge provided by skilled employees has a crucial influence on generating innovations over time. In both industries, firms' effort to train their employees, and in services also the share of high-skilled employees,

Table 6.9 Dynamic random effects probit estimates

	Manufacturing		Services	
	Marg. effect	s.d.	Marg. effect	s.d.
Structural				
$Inno_{-1}$	0.315***	(0.013)	0.334***	(0.015)
Size	0.023	(0.015)	0.001	(0.021)
Rating	−0.010	(0.010)	−0.004	(0.024)
Age	0.003	(0.009)	0.012	(0.018)
Group	0.051***	(0.012)	0.054***	(0.018)
No training (1/0)	−0.124**	(0.005)	0.017	(0.066)
Training expenditure	0.009*	(0.052)	−0.009	(0.008)
High-skilled employees	0.067	(0.060)	−0.034	(0.056)
Export	0.325***	(0.074)	0.261	(0.161)
$Export^2$	−0.386***	(0.078)	−0.662***	(0.179)
Public	0.195***	(0.013)	0.237***	(0.035)
Foreign	−0.025	(0.019)	0.027	(0.036)
East	−0.055***	(0.012)	−0.036**	(0.014)
Public limited company	0.025	(0.025)	0.144***	(0.032)
Private partnership	−0.006	(0.015)	0.018	(0.017)
Time dummies (*p*-value)	0.000***		0.000***	
Individual heterogeneity				
$Inno_0$	0.286***	(0.015)	0.271***	(0.017)
M_Size	0.025	(0.015)	0.043**	(0.021)
M_Rating	0.001	(0.018)	−0.007	(0.029)
M_Age	−0.019*	(0.011)	−0.038*	(0.019)
M_Group	−0.018	(0.019)	0.020	(0.026)
M_No training	−0.351***	(0.066)	−0.518***	(0.085)
M_Training expenditure	0.042***	(0.008)	0.061***	(0.011)
M_High-skilled	0.108	(0.073)	0.139**	(0.065)
M_Export	0.184***	(0.051)	0.420***	(0.112)
M_Public	0.203***	(0.023)	0.315***	(0.043)
Industry dummies	0.000***		0.000***	
Sigma	0.611	(0.027)	0.502	(0.032)
Rho	0.272	(0.016)	0.201	(0.020)
LR: rho = 0	328.44 (1)***		127.52 (1)***	
LogLikelihood	−8882.5		−6892.4	
LR test	6921.4 (56)***		3883.86 (46)***	
McFadden R^2	0.280		0.220	
Correct predictions (in %)	87.67		83.53	
Correct predicted 1	90.97		77.04	
Correct predicted 0	82.33		88.32	
Number of observations	31 060		18 041	
Number of firms	5299		3518	

Table 6.9 (continued)

Notes: Firm size: log number of employees in year $t-1$; rating: credit rating in year $t-1$ (score between 100 and 600); age: log number of years; group: dummy variable indicating that a firm belongs to an enterprise group in year t; no training: dummy variable indicating that a firm did not invest in training in year $t-1$; training expenditure: log training expenditure per employee if a firm invests in training in year $t-1$; high-skilled: share of employees with a university or college degree in year $t-1$; export: export to sales ratio in year $t-1$; public: dummy variable indicating that the firm got public subsidies for innovation in year $t-1$; foreign: dummy variable indicating that a firm has a foreign parent company; east: dummy variable indicating that a firm is located in eastern Germany; public limited company and private partnership: dummy variables indicating that a firm is a public limited company and private partnership, respectively (reference group: private limited liability companies. M_ denotes individual mean values of the corresponding variable. Sigma is the estimated standard deviation of the individual effect. Rho is the fraction of variance that is due to individual heterogeneity. Sample: unbalanced panel with at least four consecutive observations.

Source: ZEW.

Table 6.10 *Importance of state dependence effects in manufacturing and services*

	Observed (unconditional) probabilities			PEA				APE			
	$P(1\|1)$	$P(1\|0)$	Diff.	$\hat{P}(1\|1)$	$\hat{P}(1\|0)$	$\hat{P}EA$		$\hat{P}(1\|1)$	$\hat{P}(1\|0)$	$\hat{A}PE$	
						Abs.	In %			Abs.	In %
Manuf.	0.902	0.155	0.744	0.871	0.555	0.316	*0.424*	0.770	0.539	0.230	*0.308*
Services	0.795	0.147	0.648	0.619	0.285	0.333	*0.514*	0.569	0.336	0.233	*0.360*

Notes: $\hat{P}(1|1)$ and $\hat{P}(1|0)$ denote estimates of the conditional probability of innovating in year t for an innovator and non-innovator in year $t-1$ given the explanatory variables x, respectively. *PEA*: partial (marginal) effect at the average value of the individual heterogeneity. *APE*: average partial effect (averaged across the distribution of the individual heterogeneity).

Source: ZEW.

significantly explain individual heterogeneity across firms. Finally, even after accounting for many observed differences across firms, unobserved heterogeneity still matters for innovation persistence. The importance of unobserved heterogeneity in explaining the total variance can be gauged from the estimated rho. Unobserved heterogeneity still explains roughly 20 and 27 per cent of the variance in the innovation behaviour in services and manufacturing, respectively.

6. CONCLUSION

Panel data on innovation activities of firms offer a variety of opportunities for analysing innovation behaviour and its determinants and outcomes in more depth than is possible with cross-section data. This chapter presented one survey that provides such panel data for a large sample of firms from Germany, the so-called Mannheim Innovation Panel (MIP). The chapter was strongly focused on methodological issues, as these largely affect the analytical potential of the data. As the MIP is a voluntary survey that uses a complex questionnaire and collects a variety of firm information that goes beyond mere innovation data, which both put a serious burden on responding firms, panel participation is a data quality issue. While there were just 1.2 per cent of the original sample in the first year of the panel (1993) that participated in all 19 survey years, including 2011, decreasing panel participation is both a matter of panel mortality (firm closure and resistant non-response over many years) and of discontinuous response. Another important methodological issue is the potential selection bias of responding firms with respect to their innovation behaviour. In the MIP survey, a large non-response survey is conducted every year that shows that in most years responding firms are biased towards non-innovating firms, which may be attributed to the higher costs for innovating firms of replying to the questionnaire.

Innovation panel data can be used both for producing time-series data of innovation indicators and for analysing innovation behaviour over time. Innovation indicators based on panel data may be less susceptible to arbitrary movements due to changes in the sample of surveyed firms than cross-section surveys conducted only from time to time, particularly if panel firms become familiar with the underlying concepts of the questionnaire and respondents remain the same over some period. Innovation indicators produced from the MIP show indeed a rather stable development, although changes in survey methodology can result in break in series, and annual fluctuations reflecting the business cycle or other changes in the economic environment can be large for some indicators.

Analysing firms' innovation behaviour over time shows a high degree of persistence. Persistence of innovation is more prevalent in manufacturing than in services. It is also higher for larger firms and for firms in more R&D-intensive industries. When explaining persistence of innovation, state dependence, observed firm heterogeneity and unobserved heterogeneity do matter, although past innovation experience tends to be the most important driver. These findings reinforce the need of panel data and of accounting for dynamics in explaining innovation behaviour in empirical innovation research.

The analytical potential of panel data of course does not end with persistence analysis. Modelling the links between innovation input and output, and the underlying time lag between both, is another important study area. Peters (2008) used panel data to estimate productivity effects of innovation based on a model framework proposed by Crépon, Duguet and Mairesse (CDM) (1998). While most applications of the CDM model use cross-section data, employing panel data and carefully controlling for selectivity and endogeneity biases yields a lower estimated elasticity of innovation output (sales with new products) of about 4 per cent which is lower than the elasticity found by CDM (1998) and other studies (see Griffith et al. 2006; Parisi et al. 2006; Hall et al. 2008; Criscuolo and Haskel 2003; Janz et al. 2004; Polder et al. 2009; van Leeuwen and Klomp 2006 and the recent survey by Hall 2011) that are based on cross-section data.

This finding calls for more detailed analysis of the impacts of innovation on firm performance using firm panel data. Many national CIS provide few opportunities for such analysis since most have been conducted only every two or four years, and linking individual survey waves often results in a small and unrepresentative panel (with a strong focus on large firms). In addition, standard CIS data contain little information on firm performance and assets such as value added, profits or capital stock. When adding such data from other sources, the panel may become even smaller. The MIP was intended to respond to this need for firm panel data on innovation activities and firm performance that span a longer time period and cover both manufacturing and service sectors. While some econometric panel studies have been performed with this data (see Peters 2008, 2009; Schwiebacher 2012), a large potential for empirical analyses has yet to be exploited.

NOTES

1. For a recent description of the data, see Lachenmaier (2007). Recent empirical findings can be found in Becker and Egger (2009) or Lachenmaier and Rottmann (2011).
2. The survey is conducted by the ZEW in cooperation with the Institute for Applied Social Science (infas). From 1995 to 1998 and since 2005, the Fraunhofer Institute for Systems and Innovation Research (ISI) has been another partner in this undertaking.
3. The original sample was based on the sector classification scheme NACE Rev. 1. In 2009, sampling was adapted to the new industry classification NACE Rev. 2.0.
4. This panel is a joint effort of ZEW and Creditreform, Germany's largest credit-rating agency. The MEP includes literally all economically active enterprises in Germany, although some enter the database only several years after foundation. A comparison of the MEP with the Business Register of the Federal Statistical Office, established for the first time in 2006, shows a very high compliance both in terms of the number of enterprises and the size and sector distribution. ZEW constructs the MEP by merging twice a year a copy of the current state of Creditreform's enterprise data with previous copies of

this data, including data cleaning for multiple entries and identification of firm closures. The MEP contains, among others things, data on an enterprise's economic activity (NACE 5-digit), location and number of employees.

5. Statistical significance is analysed through a multivariate analysis (probit models) that takes into account industry, size and regional effects on the probability of being an innovator since the samples of responding and non-responding firms are not completely equally distributed in terms of sectors, size classes and regions.
6. The MIP is accompanied by a scientific advisory board consisting of academics, industry representatives and innovation policy makers, that provides, among other advice, crucial input to the questionnaire design.
7. Organizational innovation, along with market development, did not enter the *Oslo Manual* definition of innovation until the third edition (OECD/Eurostat 2005).
8. This was done by estimating a simple probit model on the probability of introducing a product or process innovation for the 1995 and 1997 samples separately with controls for size, sector, region and a few firm-specific characteristics while considering a dummy variable for firms that responded to the service sector variant of the questionnaire.
9. The sector classification is based on OECD (2007) and adjusted for NACE Rev. 2.0. For NACE Rev. 2.0, high-tech manufacturing includes divisions 20, 21 and 26 to 30, low-tech manufacturing includes divisions 5 to 19, 22 to 25 and 31 to 39. Knowledge-intensive services include divisions 58 to 66 and 69 to 73, while other services include divisions 46, 49 to 53, 74 and 78 to 82.
10. This is not related to the fact that a few less innovative industries such as retail and renting have been discarded from the sample. The figures look very similar over time if these industries are excluded in all time periods.
11. The standard deviation of entry and exit rates is 4.4 and 4.2 in manufacturing and 6.6 and 5.7 in services, respectively.
12. Wooldridge (2005) shows that under the additional assumptions of strict exogeneity of the explanatory variables and a normally distributed individual effect, the likelihood function turns out to be the same as in a standard probit model, with the initial innovation status and mean values of the explanatory variables as additional regressors.
13. The variables foreign, east, public limited company and private partnership can vary across individuals and time. However, due to the fact that hardly any variation showed up within a firm, the individual mean values are left out in order to avoid strong multicollinearity.

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APPENDIX: ADDITIONAL INFORMATION ON THE MIP SURVEY

Table 6A.1 Sector coverage of the MIP, 1993–2012

NACE Rev. 1		NACE Rev. 2	
C (Mining and Quarrying)	1993–2007	B (Mining and Quarrying)	2007–12
D (Manufacturing)	1993–2007	C (Manufacturing)	2007–12
E (Electricity, Gas and Water Supply)	1993–2007	D (Energy Supply)	2007–12
F (Construction)	1993–2004	E (Water Supply, Sewage, Recycling)	2007–12
50 (Sale/Repair of Motor Vehicles)	1995–2004		
51 (Wholesale Trade)	1995–2007	46 (Wholesale Trade)	2007–12
52 (Retail Trade)	1995–2004	H (Transportation and Storage)	2007–12
I (Transport, Storage, Communication)	1995–2007	J (Information & Communication)	2007–12
J (Financial Intermediation)	1995–2007	K (Financial and Insurance Act.)	2007–12
70 (Real Estate)	1995–2004	69 (Legal and Accounting Act.)	2007–12
71 (Renting of Machinery etc.)	1995–2004	70.2 (Management Consulting)	2007–12
72 (Computer Activities)	1993–2007	71 (Architecture and Engineering)	2007–12
73 (Research and Development)[a]	1993–2007	72 (Research and Development)[a]	2007–12
74.1 (Legal Advice, Consulting etc.)	1995–2007	73 (Advertising, Market Research)	2007–12
74.2/74.3 (Architecture, Engineering, Technical Testing)	1993–2007	74 (Other Professional, Scientific and Technical Activities)	2007–12
74.4–74.8 (Advertising, Employment Act., Security Act., Services to Buildings, Other Business Support Act.)	1995–2007	78 (Employment Activities)	2007–12
		79 (Travel Agencies)	2007–12
		80 (Security Activities)	2007–12
90 (Sewage and Refuse Disposal)	1993–2007	81 (Services to Buildings)	2007–12
92.1/92.2 (Motion Picture, Radio and Television)	2002–2007	82 (Other Business Support Activities)	2007–12

Note: a. Excluding public research organizations.

Source: ZEW.

Table 6A.2 Sector distribution of the MIP sample, 1993–2011

Survey year	NACE Rev. 1.1									Total
	C	D	E, 90	F	G	I	J	K, 92.1, 92.2	All other	
1993	1.5	79.9	3.9	5.9	1.8	0.1	0.0	6.9	0.1	100.0
1994	1.1	84.0	4.1	6.1	0.0	0.0	0.0	4.8	0.0	100.0
1995	0.7	45.5	4.0	5.3	12.1	6.1	6.0	20.3	0.1	100.0
1996	0.8	49.6	4.5	5.5	10.0	5.3	5.3	18.9	0.2	100.0
1997	0.6	43.7	3.7	3.7	14.0	7.1	6.6	20.3	0.2	100.0
1998	0.8	44.4	4.3	2.9	12.9	7.7	6.8	20.0	0.2	100.0
1999	0.9	43.0	2.9	2.4	13.5	8.5	6.2	22.1	0.5	100.0
2000	1.1	40.7	3.3	2.6	14.0	9.0	6.4	22.4	0.5	100.0
2001	1.2	42.1	3.6	3.0	11.5	9.0	4.7	24.5	0.5	100.0
2002	1.3	45.1	3.3	2.0	10.8	8.5	4.2	24.6	0.4	100.0
2003	1.2	45.6	4.6	2.5	7.8	8.1	4.3	25.3	0.4	100.0
2004	1.3	47.0	4.3	2.5	7.3	7.6	4.5	25.2	0.4	100.0
2005	1.6	50.4	5.7	1.9	5.7	7.8	4.7	21.8	0.5	100.0
2006	1.6	51.6	5.4	2.2	5.5	7.2	4.4	21.6	0.6	100.0
2007	1.4	51.3	5.5	1.7	5.3	7.4	3.8	23.2	0.5	100.0
2008	1.3	52.2	5.6	1.5	5.1	7.4	3.8	22.6	0.5	100.0
2009	1.3	51.7	5.6	1.5	4.9	7.6	3.5	23.4	0.7	100.0
2010	1.4	51.4	5.9	1.2	4.7	7.7	3.6	23.5	0.6	100.0
2011	1.2	51.8	5.5	1.4	4.6	7.5	3.6	23.6	0.8	100.0
Total	1.2	49.3	4.7	2.4	7.8	7.4	4.4	22.2	0.5	100.0
Total population, 2006[a]	0.2	17.7	0.9	13.0	20.4	5.4	1.0	15.5	25.9	100.0

Notes: a. Firms with five or more employees according to the Business Register of the Federal Statistical Office, excluding agriculture, hunting and fishing, and public administration.

Source: ZEW; Federal Statistical Office.

Table 6A.3 Response rates in the MIP by sampling year, 1993–2011

Sampling year	’93	’94	’95	’96	’97	’98	’99	’00	’01	’02	’03	’04	’05	’06	’07	’08	’09	’10	’11	Total
1993	23	25	35	29	33	36	33	37	25	32	26	27	29	29	24	36	29	30	28	29
1994		23	26	21	23	32	27	33	21	29	20	26	24	24	21	33	23	23	23	25
1995			23	19	22	41	25	36	27	37	24	27	29	32	26	38	31	34	31	28
1997					25	28	23	40	18	29	21	26	26	29	25	38	28	35	30	26
1999							21	20	15	20	18	24	24	24	21	34	24	27	26	21
2001									20	22	15	20	20	25	20	32	26	29	27	22
2003											14	18	18	24	19	28	22	27	25	20
2005													11	21	21	33	24	28	26	20
2007															11	29	25	31	28	21
2009																	17	24	27	21
2011																			16	16
Total	23	25	27	24	25	37	25	32	21	28	18	23	17	25	18	32	22	28	24	24

Notes: Response rate: share of responding firms as a percentage of the sample excluding neutral losses.
Note that from 1998 on, surveys in even years deliberately focus on firms with frequent response in prior years, resulting in higher response rates.

Source: ZEW.

Table 6A.4 Composition of responding firms by sampling year, 1993–2011

Sampling year	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	No. of responses	
	Share of firms from respective sampling year in total no. of responses (%)																			Total	%
1993	100	92	37	64	30	31	24	26	18	23	19	17	13	13	10	10	8	8	6	21 226	23.7
1994		8	4	9	4	4	3	3	2	2	2	2	1	1	1	1	1	1	1	2088	2.3
1995			59	26	55	52	44	49	28	32	21	21	15	15	12	11	8	9	7	21 321	23.8
1997					11	12	8	8	5	6	4	4	3	3	2	2	1	2	1	3302	3.7
1999							19	14	14	14	10	11	7	7	6	6	4	4	3	5692	6.3
2001									32	21	20	21	14	15	11	12	9	10	7	8525	9.5
2003											25	23	17	17	13	13	9	11	8	7013	7.8
2005													30	28	23	22	16	17	14	8603	9.6
2007															22	22	13	15	12	5206	5.8
2009																	30	23	18	4768	0.0
2011																			22	1515	1.7
others	0	0	0	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	395	0.4
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	89 654	0.0

Note: Response rate: share of responding firms as a percentage of the sample excluding neutral losses.
Note that from 1996 on, surveys in even years deliberately focus on firms with frequent response in prior years.

Source: ZEW.