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INNOVATION AND E-COMMERCE

**A Cross-Border Comparison of Irish
Manufacturing Plants**

Stephen Roper and Julie Anderson



NORTHERN IRELAND
ECONOMIC RESEARCH CENTRE

Innovation and E-Commerce

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June 2000

Northern Ireland Economic Research Centre

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Preface

This report summarises the key results from the third NIERC survey of innovation activity in Northern Ireland and the Republic of Ireland. Earlier surveys were conducted in 1993 and 1996 and provide a basis for comparison with the current results. The current survey – the Product and Process Development Survey 3 or PPDS3 – covers product and process innovation, public support for innovation activity, the adoption of best practice techniques and, for the first time, Internet usage and E-business.

The PPDS3 survey was funded jointly by the Industrial Research and Technology Unit and the Department of Enterprise, Trade and Investment and Department of Finance and Personnel through their support for the NIERC research programme on ‘Innovation and Industrial Change’. We are grateful for this support and also grateful to DETI staff for their support in making available a sampling frame from the Inter-departmental Business Register for Northern Ireland. We are also indebted to staff in Forfás for the provision of a sampling frame for the Republic of Ireland.

Looking at the survey results, two changes are particularly notable since 1996. First, there has been a sharp increase in the proportion of plants making radical process improvements. This is related to the rapid adoption of new IT-based production and production management systems and to the adoption of new forms of production organisation. Secondly, there has also been a sharp increase in the proportion of firms’ sales derived from new and improved products.

Our data also suggests that 70-80 per cent of manufacturing businesses now have access to the Internet and/or external e-mail. However, only around a tenth of all businesses reported using the Internet for on-line selling.

As in the 1996 survey, levels of innovation, best practice adoption and IT adoption in Northern Ireland tend to lag behind those in the Republic of Ireland. This disparity is most pronounced for plants in the 10-19 employee size-band. One possible explanation is a lack of finance for innovation that was highlighted as a major constraint on innovation activity by 41 per cent of such plants. It is also notable that only 8 per cent of such plants in Northern Ireland received government support with product innovation over the 1996-99 period compared to 32 per cent of similar plants in the Republic of Ireland.

This report marks the beginning of a programme of inter-regional comparisons of innovation activity and best practice adoption involving Northern Ireland. This will be based on similar surveys that have recently been completed in Scotland, Bavaria and Baden-Württemberg (and a further survey now being conducted in the South East of England). These innovation comparisons, together with the R&D benchmark survey that will be conducted this year by the Department of Enterprise, Trade and Investment should provide a much better understanding of the strength of the technological base of Northern Ireland manufacturing.

Executive Summary

Product and Process Innovation

- 1 Between 1996 and 1999, 58 per cent of Northern Ireland manufacturing plants introduced new or improved products compared to 65 per cent in the Republic of Ireland. The Republic of Ireland also had a higher percentage of process innovators (66 per cent) over the 1996-99 period than Northern Ireland (58 per cent) (Section 1.1).
- 2 From 1993-96 to 1996-99 there was little change in the proportion of plants undertaking product innovation in Northern Ireland and the Republic of Ireland. Larger increases were evident in the proportion of plants undertaking process innovation. In the Republic of Ireland the percentage rose from 58 per cent (1993-96) to 66 per cent (1996-99). The process changes taking place were also more radical than those in the earlier period (Section 1.2).
- 3 The percentage of innovating plants was also higher in most sectors and ownership groups in the Republic of Ireland (Table 1.3). For example, in the transport equipment sector 50 per cent of plants in Northern Ireland introduced new or improved products over the 1996-99 period compared to 77 per cent in the Republic of Ireland.
- 4 Among product innovators, innovation intensity – i.e. the number of product changes being made – was also lower in Northern Ireland. On average, plants in Northern Ireland made 17 product changes compared to 30 in the Republic of Ireland (Table 1.4 and Figure 1.1).
- 5 As a result, the average number of product changes per employee for all plants was lower in Northern Ireland (0.38) than the Republic of Ireland (0.60). Plants in the 10-19 employee size-band in Northern Ireland, however, were actually making more product changes per employee (1.25) than their Republic of Ireland counterparts (1.01).
- 6 Products unchanged over the 1996-99 period still account for the largest percentage of sales of plants in both Northern Ireland and the Republic of Ireland. This proportion has declined markedly since 1995, however, falling from 74 to 52

per cent in Northern Ireland and from 70 to 53 per cent in the Republic of Ireland (Table 1.6).

Innovation and Business Performance

- 7 Product innovation is associated in both Northern Ireland and the Republic of Ireland with faster median turnover and employment growth rates and higher median profit margins. In terms of mean growth and profitability the comparison is more mixed (Table 2.1).
- 8 Median profitability and growth rates were also highest for process innovators in both Northern Ireland and the Republic of Ireland. Mean growth and profitability rates were also higher for process innovators in both areas (Table 2.2).
- 9 In both Northern Ireland and the Republic of Ireland, product and process innovation are associated with higher mean and median labour productivity. A positive – albeit weak – relationship is observed between process innovation and value added as a proportion of sales. No such consistent relationship, however, is evident between new product development and the value added share of sales (Section 2.3).

Best Practice Manufacturing Techniques

- 10 The most common best practice production techniques for the whole sample were CAD (54 per cent), CNC/NC equipment (43 per cent) and Computer Aided Manufacturing (38 per cent) with significantly smaller proportions of plants using robotics (17 per cent) and computer integrated manufacturing (19 per cent) techniques (Section 3.2).
- 11 Little significant difference was evident between the proportion of plants in the Republic of Ireland and Northern Ireland using these techniques although, with the exception of AMH, levels of utilisation in Northern Ireland tended to be marginally below those in the Republic of Ireland (Section 3.2).
- 12 As with the production related techniques, marginally smaller proportions of plants in Northern Ireland were using quality certification, TQM and quality circles than in the Republic of Ireland. A more significant difference occurred in JIT, where the proportion of Northern Ireland adopters lags significantly behind that in the Republic of Ireland (Table 3.2).
- 13 Over the 1994-99 period, faster adoption rates were evident in Northern Ireland for quality certification, quality circles and Just in Time. Faster adoption rates

were evident in the Republic of Ireland for CNC equipment, CAD, TQM, robotics and CIM (Section 3.3).

Information Technology and E-Business

- 14 70-80 per cent of manufacturing businesses with more than 10 employees in both Northern Ireland and the Republic of Ireland now have access to the Internet and/or external e-mail. The proportion of plants having each capability is slightly higher in the Republic of Ireland.
- 15 As plant size increases information technology capability also increases both in Northern Ireland and the Republic of Ireland (Section 4.2).
- 16 Use of the Internet and E-commerce are very similar in the Republic of Ireland and Northern Ireland, with marginally higher levels of Internet adoption and usage in the Republic of Ireland. Three-quarters of plants reported using the Internet for information gathering. Two fifths of plants reported using the Internet to raise the external profile of the company. A quarter to a third of plants reported using the Internet for sharing information within the firm and for purchasing, and only a tenth of all plants reported using the Internet for on-line selling (Section 4.3).

Innovation Constraints and Public Support for Innovation

- 17 Financial constraints on innovation were seen as most important reflecting both the lack of investment finance and the low perceived rate of return from innovation. Overall, 40 per cent of plants in Northern Ireland and 39 per cent in the Republic of Ireland, for example, said that a low rate of return was an important constraint on their innovation activity, while around a third emphasised a lack of finance and paucity of opportunities (Table 5.1).
- 18 Human and technical resource and difficulties associated with plants' market environment were typically said to be less important. Only around a fifth of all plants, for example, regarded a lack of managerial and/or technical skills as an important constraint on their innovation activity (Table 5.1).
- 19 Northern Ireland plants tend to place slightly more emphasis on constraints related to their lack of finance and the low rate of return anticipated from innovation. Republic of Ireland plants on the other hand tended to place more emphasis on resource constraints and their market environment.

- 20 Around a quarter of all plants received support for their product development activities from 1996-99 with around 1 in 8 firms obtaining public support for process development. Smaller proportions of plants in both Northern Ireland and the Republic of Ireland received public help with non-specific R&D and adopting best practice.
- 21 Public support in Northern Ireland remains more strongly biased towards capital investment than that in the Republic of Ireland: lower proportions of Northern Ireland plants received support for product and process development and R&D with a larger proportion of plants (37 per cent) receiving support for capital investment than that in the Republic of Ireland (27 per cent) (Table 5.3).
- 22 Significant differences also exist between the proportions of plants in each size-band receiving public support. Notably the proportion of plants in the 10-19 size-band receiving support for each activity with the exception of exporting was higher in the Republic of Ireland than in Northern Ireland. For example, 32 per cent of plants in the 10-19 size-band received support with product development in the Republic of Ireland compared to only 8 per cent in Northern Ireland.

Chapter 1: Product and Process Innovation

1.1 Introduction

Innovation relates to the market application of existing knowledge and has been defined as *'the commercial application of knowledge or techniques in new ways or for new ends. It may involve radical innovation or incremental innovation. In each case the innovator achieves a competitive advantage, at least until another company catches up or goes one better.'*

In other words innovation is a business activity that is stimulated by, and changes, a firm's market position. As such, innovation may or may not be linked to significant technological advance. This view of innovation differs significantly from the traditional view which typically stresses the technological content and impetus for product and process changes. This difference of view is important in terms of the measurement of innovation activity. If innovation is regarded as a technologically defined process then technological criteria can be employed in defining innovations. If innovation is seen instead as a business process with uncertain technological content, a less restrictive definition – or set of definitions – may be appropriate.

To capture the various dimensions of innovative activity from the radical to the incremental the PPDS3 focuses on a number of definitions of innovative activity associated with changing products and processes and the commercial success of these product and process changes. More specifically the PPDS3 focuses on:

- The proportion of plants introducing new or improved products and processes over the 1996-99 period; variations in these measures between Northern Ireland and the Republic of Ireland and between plant size-bands, sectors and ownership categories.
- The intensity of innovation activity measured by the number of new or improved products per plant or per person employed.
- The percentage of sales derived from new or improved products.

Each of these measures is discussed in turn in the following sections. Subsequent sections of the report focus on the association between these product and process changes and plants' financial performance.

1.2 The Extent of Innovative Activity

The key measure of the extent of product and process development activity in the PPDS3 is the proportion of plants introducing new or improved products or processes over the 1996-99 period.

Table 1.1 summarises this data for Northern Ireland and the Republic of Ireland and also includes comparable data from an earlier NIERC innovation survey covering the 1993-96 period (Roper and Hewitt-Dundas, 1998). The table suggests that from 1996-99, 58 per cent of Northern Ireland plants introduced new or improved products, significantly below the 65 per cent of plants in the Republic of Ireland which introduced new or improved products over this period. Other key findings were:

- The Republic of Ireland also had a significantly higher percentage of process innovators (66 per cent) over the 1996-99 period than Northern Ireland (58 per cent).
- There was little change from 1993-96 to 1996-99 in the proportion of plants undertaking product innovation in both Northern Ireland and the Republic of Ireland. For example, in Northern Ireland there was an increase from 57 per cent (1993-96) to 58 per cent (1996-99).
- The gap between the proportion of innovating plants in Northern Ireland and the Republic of Ireland decreased between 1993-96 and 1996-99 for both types of innovation. For example, the difference between the proportion of plants undertaking process innovation in the Republic of Ireland and Northern Ireland fell from 11.9 percentage points to 8.2 percentage points over the 1996-99 period.

Plants undertaking process innovation in the PPDS3 were also asked whether their process innovations were associated with significant organisational change. In both areas the percentage of plants undertaking process innovation associated with significant organisational change increased sharply from 1993-96 to 1996-99. The suggestion is that the process changes being made over the latter period were more radical (and less incremental) than those being made over the earlier period.

Earlier innovation surveys both in Ireland and elsewhere suggest that the proportion of innovating plants is positively related to plant size-band. And, as Table 1.2

indicates, the PPDS3 is no different, with higher proportions of plants undertaking both product and process innovation in the larger size-bands. Again, however, the proportion of innovating plants is generally higher in the Republic of Ireland, with the exception of the relatively small number of plants in the 500 plus employee size-band where the proportion of innovating plants in Northern Ireland was marginally higher than that in the Republic of Ireland. Significant differences existed in the lower proportion of product innovators in the 10-19 size-band in Northern Ireland, the lower proportion of process innovators in the 100-499 size-band in Northern Ireland, and the *higher* proportion of process innovators in the 500 plus size-band in Northern Ireland.

Table 1.1: Product and Process Activity: 1993-1999

	Northern Ireland		Republic of Ireland	
	1993-1996	1996-1999	1993-1996	1996-1999
n	286	403	447	598
Product Innovation (% of plants)	56.5**	58.3**	65.9	65.2
Process Innovation (% of plants)	45.9**	57.5**	57.8	65.7
<i>Of which:</i>				
<i>With significant organisational change (%)</i>	26.9	44.3	33.8	49.5
<i>No significant organisational change (%)</i>	19.0	13.2	24.0	16.2

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample F-tests were used to examine whether the proportion of innovating plants in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

**Table 1.2: Percentage of Plants Undertaking Product and Process Innovation
Activity: By Plant Size-band**

	Plant Size-band				All Plants
	10-19 %	20-99 %	100-499 %	500 plus %	
Northern Ireland					
Product Innovation	42.1*	56.4	73.0	100.0	58.5
Process Innovation	40.2	58.4	65.3*	100.0*	57.6
Republic of Ireland					
Product Innovation	57.2	62.7	75.4	90.6	65.1
Process Innovation	51.6	65.2	77.2	85.1	65.8

Notes Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample sizes are as follows for Northern Ireland; 10-19 employees, 91; 20-99 employees, 234; 100-499 employees, 90; 500 plus employees, 11; all plants, 418. Republic of Ireland; 10-19 employees, 110; 20-99 employees, 329; 100-499 employees, 169; 500 plus employees, 19; all plants, 631.

Sample F-tests were used to examine whether the proportion of innovating plants in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Reflecting the aggregate and plant size-band results, the percentage of innovating plants was also higher in most sectors and ownership groups in the Republic of Ireland although these differences were generally not statistically significant (Table 1.3). Other points suggested by the sectoral and ownership analysis were:

- The proportion of innovative plants was higher in the externally-owned group in both Northern Ireland and the Republic of Ireland. Indigenously-owned plants were significantly less likely to be making both product and process innovations in Northern Ireland.
- In the electrical and optical equipment, mechanical engineering and chemicals sectors the proportion of innovating plants was above average for both product and process innovation in Northern Ireland and the Republic of Ireland.
- The proportion of product and process innovators was below average in the paper and printing and metals and metal fabrication sectors in Northern Ireland and the Republic of Ireland.

Table 1.3: Percentage of Plants Undertaking Product and Process Innovation by Industry and Ownership: 1996-1999

	Northern Ireland			Republic of Ireland		
	Product Innovation		Process Innovation	Product Innovation		Process Innovation
	n	%	%	n	%	%
A. By Industrial Sector						
Food, Drink and Tobacco	75	64.2	55.3**	103	69.9	69.0
Textiles and Clothing	65	68.4	54.7	51	63.9	45.5
Wood and Wood Products	21	53.3	55.2	22	70.6	70.8
Paper and Printing	30	21.5	52.8	40	30.0	58.0
Chemicals	14	71.0	76.0	51	73.3	77.1
Metals and Metal Fabrication	42	41.9	47.0	73	57.7	55.0
Mechanical Engineering	28	72.5	74.8	51	74.5	66.9
Electrical and Optical Equipment	30	77.9	66.5	102	76.7	70.5
Transport Equipment	18	49.7	71.0	18	76.9	71.2
Other Manufacturing	83	65.7	59.0	118	62.0	71.4
All Plants	406	59.6	58.1	629	65.1	65.6
B. By Ownership						
Indigenously-owned	329	54.0**	54.8**	446	63.1	62.1
Externally-owned	85	77.9	66.9	172	69.9	74.7
All Plants	414	58.6	57.2	618	64.8	65.3

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample F-tests were used to examine whether the proportion of innovating plants in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

1.3 Innovation Intensity

While the proportion of innovating plants gives a general indication of the level of innovative activity in the Northern Ireland and Republic of Ireland manufacturing sectors it provides little guide to the intensity of plants' innovation activity. In particular, it tells us nothing about the *number* of product changes made by each plant either in absolute terms or relative to plant size. This is the focus of this section.

Table 1.4 and Figure 1.1, for example, give the average number of product changes made by product innovators in each size-band over the 1996-99 period. As we might expect the number of product changes generally increases with plant size-band, with Northern Ireland plants on average making significantly fewer product changes (17) than their Republic of Ireland counterparts (30).

Innovators in Northern Ireland were, on average, also making fewer product changes in every employment size-band with the exception of the relatively small number of plants with more than 500 employees. For example, from 1996 to 1999 plants in the 10-19 employee size-band in Northern Ireland made an average of 8.8 product changes compared to 11.4 in the Republic of Ireland.

Table 1.4: Average Number of Product Changes: By Plant Size-band

	Employment Size-band				All Plants
	10-19	20-99	100-499	500 plus	
Northern Ireland	8.8**	13.2	21.5*	39.7	16.5
Republic of Ireland	11.4	31.9	33.7	30.1	29.8

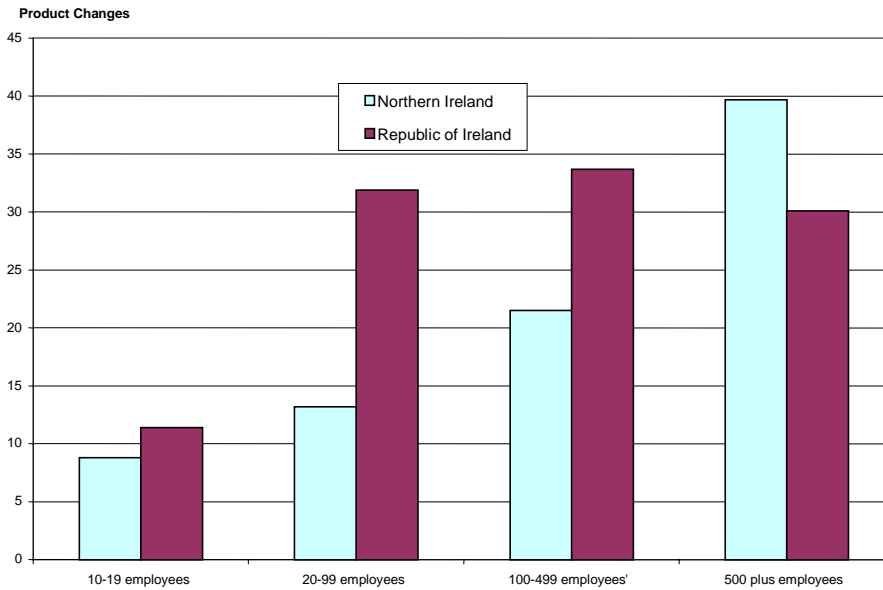
Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 234; 100-499 employees, 90; 500 plus employees, 11; all plants, 418. Republic of Ireland; 10-19 employees, 110; 20-99 employees, 329; 100-499 employees, 169; 500 plus employees, 19; all plants, 631.

Mann-Whitney U tests were used to examine whether the Northern Ireland and Republic of Ireland samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Figure 1.1: Average Number of Product Changes: By Plant Size-band



Notes and Sources: See Table 1.4

Table 1.5 Average Number of New/Improved Products Per Employee

	Employment Size-band				All Plants
	10-19	20-99	100-499	500 plus	
Northern Ireland	1.25**	0.39	0.09*	0.02	0.38*
Republic of Ireland	1.01	0.72	0.19	0.04	0.60

Notes Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

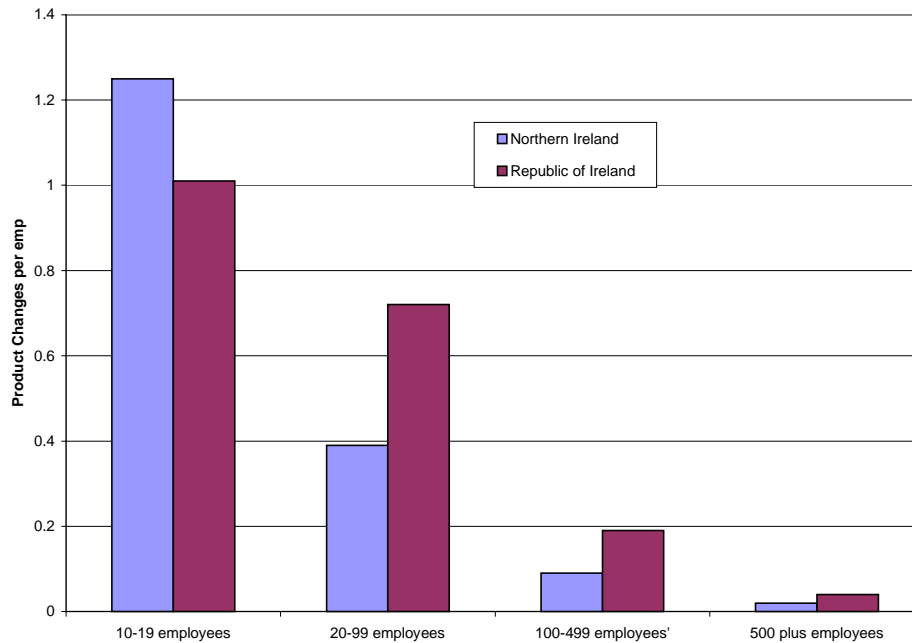
Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 234; 100-499 employees, 90; 500 plus employees, 11; all plants, 418. Republic of Ireland; 10-19 employees, 110; 20-99 employees, 329; 100-499 employees, 169; 500 plus employees, 19; all plants, 631.

Mann-Whitney U tests were used to examine whether the Northern Ireland and Republic of Ireland samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Despite the larger average number of product changes in larger plants there is a general tendency for innovation surveys to suggest that the number of product changes increases more slowly than employment. In other words, the number of product changes introduced per employee tends to decline with plant size. This general result is confirmed by the PPDS3. Table 1.5 and Figure 1.2 give the average number of product changes per employee in each plant size-band.

Figure 1.2: Product Change per Employee: By Size-band



Notes and Sources: See Table 1.5.

As we would expect from the overall number of product changes the average number of product changes per employee for all plants is significantly lower in Northern Ireland (0.38) than the Republic of Ireland (0.60). The results for the different plant size-bands, however, lead to a somewhat different interpretation than might be suggested simply by the absolute number of product changes. First, for plants in the 20-99 and 100 plus size-bands, plants in the Republic of Ireland were making more product changes both in absolute terms and relative to employment. In other words, innovation intensity among Republic of Ireland plants in these plant size-bands was greater than that in Northern Ireland. Second, among plants with 500 plus employees the absolute number of product changes being made was higher in Northern Ireland but the number of product changes per employee was actually higher in the Republic of Ireland. Third, for plants in the 10-19 employee size-band the smaller average size of the Northern Ireland plants meant that despite lower absolute numbers of product changes per plant they were actually making more product changes per employee than their Republic of Ireland counterparts.

1.4 Sales of New and Improved Products

The final indicator of innovation activity in the PPDS3 – an indicator of innovation success – is the proportion of sales derived from new and improved products. Table 1.6 summarises this data for Northern Ireland and Republic of Ireland plants for 1995 and 1998. Although in both years unchanged products make up the largest percentage of sales in both areas, this proportion has declined markedly since 1995. This reduction was greater for Northern Ireland (from 73.8 to 52.0 per cent) than that in the Republic of Ireland (from 69.5 to 53.1 per cent). The decline in the percentage of sales derived from unchanged products was matched by an increase in the proportion of sales derived from new or improved products. Indeed, the proportion of sales derived from each type of new and improved product actually rose in both Northern Ireland and the Republic of Ireland between 1995 and 1998. The most notable growth occurred in the more radical categories of product change with particularly sharp increases in the proportion of sales accounted for by products newly introduced for the first time and technically improved products.

Table 1.6: Average Percentage of Sales Derived from New, Improved and Unchanged Products

	Northern Ireland		Republic of Ireland	
	1996 n=270	1999 n=214	1996 n=415	1999 n=341
New products sold for the first time (% sales)	10.0	15.5	9.9	18.6
New products made before (% sales)	2.2	6.0	3.9	8.9
Technically improved products (% sales)	7.9	18.1	11.5	12.6
Appearance improved products (% sales)	5.8	8.4	5.3	6.8
Unchanged products (% sales)	73.8	52.0	69.5	53.1

Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Source: PPDS3

Chapter 2: Innovation and Business Performance

2.1 Introduction

The main issue addressed in this section is whether the PPDS3 survey provides evidence of a positive link between innovation in either new products or processes and business performance. Previous studies have, by and large suggested that such a positive link does exist. Evidence reviewed by Storey (1994) for small firms suggested that out of eight studies of the impact of the introduction of new products on small business performance, five suggested a significant positive link. Other studies (e.g. Barkham et al, 1996; Roper, 1999) have re-emphasised this link alongside positive evidence from earlier NIERC surveys (see, for example, Roper and Hewitt-Dundas, 1998, pp. 54-59).

In the PPDS3, information was sought on plants' turnover and employment growth over the 1996-99 period and on various profit and loss account items for the 1998 business year. The availability of this profit and loss data marks out the PPDS3 from many other innovation surveys and allows the construction of value added and profitability measures. In particular we calculate a profit indicator as sales less the cost of materials and fuel and total labour costs. Value added we define as the difference between sales and the cost of materials. Neither measure takes account of capital costs or investments.

In the following sections we compare the financial performance of innovating and non-innovating plants. These basic bivariate comparisons have the advantage of simplicity but do not take account of any differences in the size-band or sectoral composition of the two groups. The aggregate comparisons should therefore be treated with some caution and sectoral and size-band comparisons are also given wherever possible.

2.2 Innovation, Growth and Profitability

Baseline comparisons of the turnover and employment growth and profit margins of product innovators and those plants not introducing any new or improved products over the 1996-99 period are given in Table 2.1. Table 2.2 gives similar figures for those introducing and not introducing new or improved processes over the 1996-99

period. In both tables comparisons are given for both mean and median profitability and growth rates.

The tables suggest that product innovation is associated in both Northern Ireland and the Republic of Ireland with faster median turnover and employment growth rates and higher median profit margins. In other words the average product innovator in both areas was faster growing and had higher median profitability than the average non-innovator. In terms of mean comparisons the situation is less straightforward, with mean turnover growth in both areas being higher for product innovators. By contrast, mean employment growth was faster for innovators in the Republic of Ireland but slower in Northern Ireland, while mean profit margins were higher for non-innovators in both areas (Table 2.1). With the exception of employment growth in Northern Ireland, the distribution of profitability and growth of innovating firms was significantly different (ie with higher mean and median) than that of non-innovators.

Table 2.1: Product Innovation, Growth and Profitability

	Mean Indicators		Median Indicators	
	Non-Innovators	Innovators	Non-Innovators	Innovators
A. Northern Ireland (n=418)				
Sales Growth 1996-99 (% pa)	6.5	7.6*	2.3	3.8
Empl. Growth 1996-99 (% pa)	22.3	20.8	5.0	10.0
Profit Margin 1998 (%)	24.7	23.2	24.2	25.7
B. Republic of Ireland (n=631)				
Sales Growth 1996-99 (% pa)	11.3	11.5*	5.4	7.4
Empl. Growth 1996-99 (% pa)	30.2	35.4**	10.0	15.0
Profit Margin 1998 (%)	30.6	27.6	28.1	29.0

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the product innovator and product non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

As with product innovation, median profitability and growth rates were highest for process innovators in both Northern Ireland and the Republic of Ireland. Mean growth and profitability rates were also higher, however, for process innovators in both areas (Table 2.2). To some extent this pattern reflects the findings of earlier surveys for Northern Ireland and the Republic of Ireland with Roper and Hewitt-Dundas, 1998, p. 55 noting that ‘Process innovation had a markedly more significant turnover growth effect than did that related to new and improved products. In terms of employment growth ... process changes were again associated with a larger proportionate effect.’ Differences between the distribution of profit and growth rates of process innovators and non-innovators were all significant with the exception of profit margins in Northern Ireland.

Table 2.2: Process Innovation, Growth and Profitability

	Mean Indicators		Median Indicators	
	Non-Innovators	Innovators	Non-Innovators	Innovators
A. Northern Ireland (n=418)				
Sales Growth 1996-99 (% pa)	4.8	8.8**	2.3	3.5
Empl. Growth 1996-99 (% pa)	3.9	8.6**	1.7	3.2
Profit Margin 1998 (%)	23.6	24.1	25.0	25.0
B. Republic of Ireland (n=631)				
Sales Growth 1996-99 (% pa)	8.3	12.6**	3.9	7.4
Empl. Growth 1996-99 (% pa)	8.3	10.7**	2.3	4.8
Profit Margin 1998 (%)	27.7	29.4*	26.7	30.0

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the process innovator and process non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

As indicated earlier, however, these aggregate comparisons reflect differences in the composition of the groups of innovators and non-innovators as well as the effect of innovation per se. Some of this potential compositional bias can be removed by looking at figures for each sector or plant size-band. This is, however, associated with its own difficulties, particularly in sectors and size-bands where the size of the non-

innovating group is small (see, for example, Table 1.2). Tables 2.3 and 2.4 below compare turnover growth rates for product innovators and non-innovators in Northern Ireland and the Republic of Ireland respectively, while Tables 2.5 and 2.6 give similar figures for process innovators and non-innovators.

In Northern Ireland, median turnover growth rates were higher for product innovators in every sector with the exception of electrical and optical engineering (Table 2.3). Similarly mean turnover growth rates were higher in all sectors, again with the exceptions of mechanical engineering and transport equipment. Results for the Republic of Ireland also suggest higher median sales growth for product innovators in all but two sectors (paper and printing, wood and wood products). Mean turnover growth rates were also generally higher among product innovators in the Republic of Ireland. As in Northern Ireland, the exceptions to this general pattern were in the engineering sectors (Table 2.4). Similar results have been found by other studies. Roper and Hewitt-Dundas (1998) also noted, for example, that innovating engineering firms in Northern Ireland and the Republic of Ireland from 1993-96 also had lower turnover growth rates than their less innovative counterparts. Two possible explanations exist for this result. First, it could reflect the true pattern with product innovation having markedly different financial implications for plants in different sectors. This seems an unlikely explanation given the generality of the positive association between product innovation and turnover growth in the Republic of Ireland. More likely perhaps is that the patchy results are linked to the relatively small size of the non-innovating group in some sectors (particularly in engineering where innovation rates are generally high).

Table 2.3: Turnover Growth Rates for Product Innovators and Non-Innovators in Northern Ireland: By Sector, Size-band and Ownership

	Mean Indicators			Median Indicators	
	Non-Innovators	Innovators	Non-Innovators	Innovators	
	n	% pa	% pa	% pa	% pa
A. By Industrial Sector					
Food, Drink and Tobacco	75	1.9	5.7**	-0.9	2.3
Textiles and Clothing	65	2.5	3.7	-0.7	1.7
Wood and Wood Products	21	6.7	6.8	2.0	2.3
Paper and Printing	30	2.1	10.2**	2.3	10.1
Chemicals	14	5.8	12.6	4.6	5.3
Metals and Metal Fabrication	42	9.2	12.3	3.8	9.0
Mechanical Engineering	28	11.7	7.6	2.3	2.3
Electrical and Optical Equipment	30	16.8	4.8	24.8	3.8
Transport Equipment	18	8.3	25.5	2.9	24.9
Other Manufacturing	83	7.2	7.7	2.3	2.9
All Plants	406	6.1	7.5	2.0	3.8
B. Plant Size-band					
10-19 Employees	91	3.6	5.7	2.3	3.8
20-99 Employees	234	8.0	10.0*	2.3	5.3
100-499 Employees	90	5.1	5.1	2.3	2.3
500 plus Employees	11		1.9		0.1
All Plants	418	6.5	7.6	2.3	3.8
C. Ownership					
Indigenously-owned	329	7.1	8.6**	2.3	5.3
Externally-owned	85	2.9	5.1	0.7	0.4
All Plants	414	6.6	7.7	2.3	3.8

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the Northern Ireland product innovator and product non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Table 2.4: Turnover Growth Rates for Product Innovators and Non-Innovators in the Republic of Ireland : By Sector, Size-band and Ownership

	Mean Indicators			Median Indicators	
	Non-Innovators	Innovators	Non-Innovators	Innovators	
	n	% pa	% pa	% pa	% pa
A. By Industrial Sector					
Food, Drink and Tobacco	103	11.6	12.9	3.9	8.2
Textiles and Clothing	51	3.3	5.7	-0.8	3.9
Wood and Wood Products	22	9.1	6.8	8.2	6.8
Paper and Printing	40	6.6	6.1	5.4	3.0
Chemicals	51	6.8	10.1	5.4	8.2
Metals and Metal Fabrication	73	12.7	13.4	5.4	6.8
Mechanical Engineering	51	17.8	7.9	5.4	6.8
Electrical and Optical Equipment	102	12.8	13.7	4.8	8.2
Transport Equipment	18	29.2	16.2	9.0	13.5
Other Manufacturing	118	14.9	12.5	6.8	8.2
All Plants	629	11.3	11.5	5.4	6.8
B. Plant Size-band					
10-19 Employees	110	16.2	15.4	5.4	10.9
20-99 Employees	329	9.9	10.9**	5.4	7.4
100-499 Employees	169	7.6	10.6	4.5	5.4
500 plus Employees	19	0.1	6.7	0.1	5.4
All Plants	631	11.0	11.4	5.4	7.4
C. Ownership					
Indigenously-owned	446	11.8	12.2**	5.4	8.2
Externally-owned	172	9.2	9.8	2.4	5.4
All Plants	618	11.3	11.5	5.4	7.4

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the Republic of Ireland product innovator and product non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

In terms of process innovation, a more mixed picture emerges, at least for Northern Ireland. In six sectors (food, drink and tobacco, wood and wood products, paper and printing, metals and fabrication, transport equipment and other manufacturing) both mean and median turnover growth rates were higher for process innovators (Table 2.5). In the other five sectors mean and median turnover growth rates were either higher for non-innovators or suggested conflicting results. For the Republic of Ireland, however, where sample sizes are larger, a more uniform pattern emerges with both mean and median turnover growth rates being higher for process innovators in eight of the ten sectors (Table 2.6). As with product innovation the more uniformly positive relationship between process innovation and turnover growth in the Republic of Ireland, and the more mixed results in Northern Ireland are likely to be related to sample size (and in particular the size of the non-innovating group).

Similar issues relating to sample size are also evident in comparisons of plants with more than 100 employees where the proportion of innovating plants tends to be high and the number of non-innovating plants is therefore small. Looking therefore at plants with less than 100 employees only, suggests that in Northern Ireland product and process innovation is unambiguously associated with more rapid turnover growth (Tables 2.3 and 2.5). For the Republic of Ireland a generally similar pattern emerges with the exception of mean sales growth among plants with 10-19 employees (Tables 2.4 and 2.6).

Product and process innovation in indigenously-owned plants of all sizes in both Northern Ireland and the Republic of Ireland is also associated with more rapid turnover growth (Tables 2.3-2.6). For externally-owned plants in the Republic of Ireland the same association also exists – innovative plants tend to grow faster (Tables 2.4 and 2.6). In Northern Ireland, however, the evidence points the other way with process innovation associated both with slower mean and median sales growth and product innovation associated with lower median but higher mean growth rates. Again, however, this result may be linked to the relatively small size of the group of non-innovating, externally-owned plants in Northern Ireland.

Table 2.5: Turnover Growth Rates for Process Innovators and Non-Innovators in Northern Ireland: By Sector, Size-band and Ownership

	n	Mean Indicators		Median Indicators	
		Non-Innovators	Innovators	Non-Innovators	Innovators
		% pa	% pa	% pa	% pa
A. By Industrial Sector					
Food, Drink and Tobacco	75	1.0	7.1**	-0.9	2.3
Textiles and Clothing	65	4.1	2.7	2.3	-0.9
Wood and Wood Products	21	-1.0	13.0*	0.1	5.3
Paper and Printing	30	2.8	5.7	2.6	4.9
Chemicals	14	20.4	7.6	13.5	5.3
Metals and Metal Fabrication	42	9.7	10.7	3.8	8.2
Mechanical Engineering	28	13.6	7.5	4.7	2.3
Electrical and Optical Equipment	30	3.9	10.1	5.6	0.7
Transport Equipment	18	7.0	19.5	2.9	24.9
Other Manufacturing	83	2.2	10.8**	0.7	3.8
All Plants	406	4.4	8.7	2.3	2.9
B. Plant Size-band					
10-19 Employees	91	2.6	7.3**	2.3	2.3
20-99 Employees	234	6.1	11.4**	1.7	5.3
100-499 Employees	90	3.6	5.7	2.3	2.3
500 plus Employees	11	.	1.6	.	0.1
All Plants	418	4.8	8.8	2.3	3.5
C. Ownership					
Indigenously-owned	329	4.6	10.5**	2.3	4.7
Externally-owned	85	5.8	3.9	2.3	-0.4
All Plants	414	4.8	9.0	2.3	3.8

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the Northern Ireland process innovator and process non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Table 2.6: Turnover Growth Rates for Process Innovators and Non-Innovators in the Republic of Ireland: By Sector, Size-band and Ownership

	n	Mean Indicators		Median Indicators	
		Non-Innovators	Innovators	Non-Innovators	Innovators
		% pa	% pa	% pa	% pa
A. By Industrial Sector					
Food, Drink and Tobacco	103	7.2	13.2	4.2	6.5
Textiles and Clothing	51	3.1	6.9*	0.8	4.5
Wood and Wood Products	22	5.3	8.6	6.4	6.8
Paper and Printing	40	5.8	6.7	3.0	5.4
Chemicals	51	9.3	9.3	5.4	8.2
Metals and Metal Fabrication	73	7.6	16.9**	3.9	8.2
Mechanical Engineering	51	9.0	11.2	5.4	6.8
Electrical and Optical Equipment	102	6.3	16.4	4.8	8.2
Transport Equipment	18	18.9	18.6	2.4	13.5
Other Manufacturing	118	15.9	12.0	10.9	7.4
All Plants	629	8.3	12.6	3.9	6.8
B. Plant Size-band					
10-19 Employees	110	11.8	19.4**	3.9	13.5
20-99 Employees	329	6.6	12.0**	3.9	7.7
100-499 Employees	169	5.3	11.0	5.9	5.4
500 plus Employees	19	3.9	6.5	3.9	5.4
All Plants	631	7.7	12.7	3.9	7.4
C. Ownership					
Indigenously-owned	446	8.6	13.6**	4.8	8.2
Externally-owned	172	7.8	10.0	3.9	5.4
All Plants	618	8.4	12.6	4.2	6.8

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the Republic of Ireland process innovator and process non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

2.3 Innovation and Value Added

Information from the PPDS3 also provides some insight into the effect of product and process development on levels of value added per employee (labour productivity) and the proportion of sales that is accounted for by value added. Product innovation can affect labour productivity in a number of ways. For example, the unit value of a product may be increased if its performance or desirability is enhanced. Alternatively, product innovation may lead to increased levels of physical productivity if new products are easier to manufacture or are manufactured by more capital intensive methods. Process innovation is less likely to impact on the unit value of products, although product quality improvements may give substantial market advantages. Such developments are perhaps more likely to lead to reduced unit costs or increased physical productivity thereby increasing the value added share of sales.

Table 2.7 gives value added per employee and value added as a percentage of sales for innovators and non-innovators in 1998. All figures are given in Sterling and data for plants in the Republic of Ireland have been converted to Sterling using an average 1998 exchange rate. The first key result suggested by the table is that in both Northern Ireland and the Republic of Ireland product and process innovation are associated with higher mean and median labour productivity. In other words, in innovating plants, value added per employee was higher than that in non-innovators. Secondly, a positive – albeit weak – relationship is observed between process innovation and value added as a proportion of sales. No such consistent relationship, however, is evident between new product development and the value added share of sales. Indeed, for both mean and median indicators in the Republic of Ireland and the mean indicator in Northern Ireland, value added as a share of sales was actually greater for product non-innovators.

Table 2.7: Innovation and Productivity

		New processes since 1996		New products since 1996	
		Non- Innovators	Innovators	Non- Innovators	Innovators
A. Northern Ireland (n=418)					
Value added per employee 1998 (£000)	Mean	33.1	33.8	32.2	34.2
	Median	26.7	27.5	27.1	27.5
Value added as a percentage of sales 1998 (%)	Mean	50.5	50.7	52.4	49.4
	Median	50.0	53.3	51.0	51.5
B. Republic of Ireland (n=631)					
Value added per employee 1998 (£000)	Mean	39.6	63.1**	42.9	61.4
	Median	27.5	32.5	29.0	31.5
Value added as a percentage of sales 1998 (%)	Mean	55.4	55.7	56.4	55.1
	Median	55.6	55.6	56.3	55.3

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Mann-Whitney U tests were used to examine whether the innovator and non-innovator samples were drawn from the same underlying population. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Chapter 3: Adoption of Advanced Manufacturing Techniques (AMT)

3.1 Introduction

In this section we compare the adoption of Advanced Manufacturing Techniques by plants in Northern Ireland and the Republic of Ireland. We examine three specific questions:

- How does the overall level of use of AMT compare in Northern Ireland and the Republic of Ireland?
- How does the level of adoption of AMT differ between plant size-bands and sectors?
- How has the rate of adoption of AMT differed in Northern Ireland and the Republic of Ireland?

Throughout this section we focus on two groups of AMT, related to production technologies and more organisational approaches. In Section 3 we focus more directly on IT adoption and capability and plants' use of the Internet and E-business applications.

Table 3.1 outlines the specific AMT we consider. Six production-related techniques are considered including the use of Computer Aided Design (CAD) and Computer Numerically Controlled machinery (NC/CNC) and more recent developments such as Computer Aided Manufacturing (CAM) and Computer Integrated Manufacturing (CIM). Four organisational techniques are also considered relating to quality assurance schemes (e.g. ISO9000), total quality management (TQM), quality circles and the use of Just in Time inventory control (JIT).

In the PPDS3, plants were asked to indicate those techniques they are currently using and whether each technique was *first* introduced prior to 1994, during the 1994-96 period or post-1996. While this information is useful in profiling the spread or diffusion of these techniques between firms it provides little information on the extent or intensity with which plants are using each technique (although see Crone and Roper, 1999, pp. 46-60).

Table 3.1: AMT Considered in the PPDS3

A. Production Techniques

Computer Numerically Controlled or Numerically
Controlled Equipment

Robotic Production Equipment

Automated Materials Handling

Computer Aided Design

Computer Aided Manufacturing

Computer Integrated Manufacturing

B. Organisational Techniques

Quality Certification (e.g. ISO 9000)

Total Quality Management

Quality Circles

Just In Time Inventory Management

3.2 Use of Advanced Manufacturing Technologies

Table 3.2 summarises the percentages of plants in Northern Ireland and the Republic of Ireland using each of the advanced manufacturing techniques outlined in Table 3.1. The most common production techniques for the whole sample were CAD (54 per cent), CNC/NC equipment (43 per cent) and Computer Aided Manufacturing (38 per cent) with significantly smaller proportions of plants using robotics (17 per cent) and Computer Integrated Manufacturing (19 per cent). Significant differences were evident between the proportion of plants in the Republic of Ireland and Northern Ireland using robotics and CIM, with levels of utilisation in Northern Ireland generally below those in the Republic of Ireland.

Table 3.2: Percentage of Plants Using AMT

	Northern Ireland %	Republic of Ireland %	All Plants %
n	418	631	1049
A. Production Techniques			
CNC/NC Equipment	44.9	42.1	42.9
Robotics	13.0**	18.0	16.7
Automated Materials Handling	24.6	23.9	24.1
Computer Aided Design	51.2*	55.2	54.1
Computer Aided Manuf.	37.0	37.7	37.5
Computer Integrated Manuf.	16.1**	20.2	19.1
B. Organisational Techniques			
Quality Certific. (e.g. ISO9000)	58.3*	64.3	62.7
Total Quality Management	27.2	30.5	29.6
Quality Circles	10.4	11.5	11.2
Just In Time	16.8**	29.9	26.2

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

Sample F-tests were used to examine whether the proportion of plants using AMT in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Among the organisational techniques considered, by far the most common was quality certification (e.g. ISO9000) which was being used by around two-thirds of plants. Around a quarter of plants reported using TQM, Just in Time inventory management techniques, with smaller proportions using quality circles. As with the production related techniques, marginally smaller proportions of plants in Northern Ireland were using quality certification, TQM and quality circles than in the Republic of Ireland. Statistically significant differences occurred in JIT and quality certification.

Tables 3.3 and 3.4 profile the proportion of plants in each industry using AMT in Northern Ireland and the Republic of Ireland respectively. Unsurprisingly, the proportion of plants using each production technique varies substantially between techniques and sectors. For example, CNC/NC use in the Republic of Ireland was below that in Northern Ireland in all but two (of ten) sectors (i.e. food, drink and tobacco and other manufacturing). Conversely, the use of robotic equipment was more common among Republic of Ireland plants in all but one sector (electrical and optical engineering). For each of the other production related techniques a more uniform pattern of adoption rates was observed between Northern Ireland and Republic of Ireland plants. In terms of the organisational techniques considered, a more mixed pattern emerges with the exception of the use of JIT. This was more common among firms in the Republic of Ireland in all sectors with the sole exception of transport equipment.

In terms of plant size, a clear tendency exists in both Northern Ireland and the Republic of Ireland for the proportion of users of both production and organisational technologies to increase with plant size-band (Tables 3.3 and 3.4). Typically, this means that the proportion of plants in the 10-19 employee size-band using each technique is below the regional average, with plants in the 100 plus employee size-band having an above average probability of using each technique. Typically, the proportion of plants in the 100 plus employee size-band using each technique is 1.5-2.5 that of plants in the 10-19 employee size-band.

As with the general figures for adoption, however (i.e. Table 3.1) little systematic difference exists between the proportion of plants in the 10-19 employee size-band using each technology in Northern Ireland and the Republic of Ireland. A similar result is evident from comparing the proportion of plants in Northern Ireland and the Republic of Ireland with 20-99 employees using each production related technology (Tables 3.3 and 3.4). Each of the organisational techniques, however, was being used by a lower proportion of Northern Ireland plants with 20-99 and 100 plus employees. Northern Ireland plants in the 100 plus employee size-band were also less likely to be using all but one (CAM) of the production related techniques (Tables 3.3 and 3.4).

Table 3.3: Percentage of Northern Ireland Manufacturing Plants Using Production and Organisational AMT

	n	Production Related Techniques						Organisational Techniques			
		CNC	Robotics	AMH	CAD	CAM	CIM	Qcert.	TQM	Qcircle	JIT
A. By Sector											
Food, Drink and Tobacco	75	26.7	9.9	24.2	19.3*	32.6	27.2	51.5*	29.2*	9.9	13.0*
Textiles, Clothing	65	29.9	10.9	11.8	49.4	49.7	9.7	47.4	31.1*	7.5	17.3
Wood Products	21	67.8**	7.3	32.2	35.6	42.2	21.1	54.0	28.4	21.1	21.8
Paper and Printing	30	24.2	0.0*	13.0	49.1	26.0*	9.1	68.7	13.0	9.1	15.0**
Chemicals	14	49.5	18.1	34.3	47.6	58.1	27.6	76.2	49.5	13.3	17.1
Metals and Fabrication	42	60.9	5.9	14.3	66.0*	44.8	13.8	62.6	30.5	12.6	18.5
Mechanical Eng.	28	76.5	12.7	33.7	87.4	51.2	12.6	52.7	25.0	21.1	19.0
Electrical and Optical Equip.	30	46.9	41.2	35.8	77.2	25.2	15.5	83.3	44.3	2.6**	16.1**
Transport Equip.	18	73.9	24.2	37.5	67.8	43.0	24.2	56.3	37.5	12.1	57.6
Other Manufacturing	83	44.9	11.8*	29.0	49.2	27.0	14.0	58.5*	16.2	6.5	8.9**
All Plants	406	44.9	13.0	24.6	51.2	37.0	16.1	58.3	27.2	10.4	16.8
B. By Plant Size-band											
10-19 employees	91	31.8	11.2	15.0	52.3	21.3	19.0*	43.9	21.5	6.4	9.4**
20-99 employees	237	48.2	11.8	22.3	46.4	37.1	14.5	59.4	22.0	8.9	16.4**
100 plus employees	90	47.4	17.1**	37.3	61.5*	49.0	17.7**	67.3**	43.6	16.8*	23.4**
All Plants	418	44.9	13.0	24.6	51.2	37.0	16.1	58.3	27.2	10.4	16.8

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

Sample F-tests were used to examine whether the proportion of plants using production and organisational techniques in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the un-weighted sample.

Source: PPDS3

Table 3.4: Percentage of Republic of Ireland Manufacturing Plants Using Production and Organisational AMT

	n	Production Related Techniques						Organisational Techniques			
		CNC	Robotics	AMH	CAD	CAM	CIM	Qcert.	TQM	Qcircle	JIT
A. By Sector											
Food, Drink and Tobacco	103	33.9	12.4	28.8	30.0	34.5	23.3	74.0	41.4	12.7	24.5
Textiles, Clothing	51	26.7	9.9	21.5	56.0	52.5	20.5	42.8	16.5	12.5	26.3
Wood Products	22	28.9	20.4	54.6	41.0	50.9	17.6	48.1	25.0	16.0	34.8
Paper and Printing	40	23.3	8.6	13.9	45.8	55.8	13.9	70.7	21.1	8.6	41.2
Chemicals	51	24.8	18.4	40.3	43.9	42.4	24.0	77.7	41.3	16.7	24.8
Metals and Fabrication	73	58.6	13.0	9.8	81.8	31.9	17.0	56.6	18.2	8.0	28.9
Mechanical Eng.	51	57.2	23.0	13.8	76.5	26.6	21.4	56.7	22.4	3.1	21.9
Electrical and Optical Equip.	102	43.4	29.7	22.9	64.4	42.2	22.8	88.0	47.5	13.8	39.3
Transport Equip.	18	61.3	26.3	16.3	75.6	23.7	11.3	70.6	56.0	22.5	57.3
Other Manufacturing	118	51.2	21.2	29.1	51.9	31.4	19.9	50.0	18.7	9.9	25.2
All Plants	629	42.1	18.0	23.9	55.2	37.7	20.2	64.3	30.5	11.5	29.9
B. By Plant Size-band											
10-19 employees	125	33.9	6.5	9.4	51.3	22.3	7.2	43.3	22.2	2.9	21.5
20-99 employees	329	42.1	13.5	22.3	49.3	38.5	19.8	63.7	27.4	10.6	26.0
100 plus employees	177	49.0	38.0	39.9	71.7	48.9	31.9	83.4	44.3	20.7	45.7
All Plants	631	42.1	18.0	23.9	55.2	37.7	20.2	64.3	30.5	11.5	29.9

Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

Source: PPDS3

3.3 First Adoption of AMT

Table 3.5 and Figure 3.1 give the percentage of manufacturing plants in Northern Ireland and the Republic of Ireland using AMT in 1994, in 1996 and at the time of the PPDS3 survey in late 1999. Interest here focuses on the speed with which plants have adopted each technology and the relative speed of adoption in Northern Ireland and the Republic of Ireland. Policies designed to promote best practice adoption etc. may, for example, stimulate a quicker take-up or spread of CNC equipment, robotics or the other techniques.

The rapidity with which a number of the techniques – particularly those based on IT capabilities – have been adopted is illustrated by the doubling or trebling proportion of plants using each production related technology over the 1994-99 period. Use of robotics, for example, rose from 6.3 per cent of plants in Northern Ireland in 1994 to 13 per cent in Northern Ireland with a very similar increase in the Republic of Ireland.

Table 3.5: Percentage of Plants in Northern Ireland and the Republic of Ireland Using AMT in 1994, 1996 and 1999

	Northern Ireland (n=418)			Republic of Ireland (n=631)		
	1994	1996	1999	1994	1996	1999
A. Production Related Techniques						
CNC/NC Equipment	26.0	34.3	44.9	22.8	30.0	42.1
Robotics	6.3**	9.4	13.0*	8.4	12.3	18.0
Automated Materials Handling	9.4	16.9	24.6	10.2	16.1	23.9
Computer Aided Design	23.1	36.0	51.2	20.5	34.4	55.2
Computer Aided Manuf.	13.5	20.4	37.0	14.6	22.9	37.7
Computer Integrated Manuf.	8.4	11.4	16.1	9.4	14.1	20.2
B. Organisational Techniques						
Quality Certific. (eg ISO9000)	26.4	45.8	58.3	31.1	50.9	64.3
Total Quality Management	12.9	19.8	27.2	11.9	20.3	30.5
Quality Circles	3.2**	4.8	10.4	5.1	7.3	11.5
Just In Time	6.9**	12.6	16.8*	15.5	22.7	29.9

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

Sample F-tests were used to examine whether the proportion of plants using production and organisational techniques in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Differences in the proportion of plants using each technology at the start of the period considered (i.e. in 1994) make it difficult, however, to assess whether adoption in Northern Ireland has actually been slower or faster than that in the Republic of Ireland over the 1994-99 period. This trend is made clearer by taking a simple difference between the proportion of firms using any given technology in Northern Ireland and that in the Republic of Ireland (Table 3.6). Negative figures here suggest that the proportion of firms using any given technique in the Republic of Ireland is above that in Northern Ireland, while positive numbers suggest higher adoption levels in Northern Ireland.

Table 3.6: Difference in Percentages of Plants Using Production and Organisational Technologies in Northern Ireland and the Republic of Ireland: 1994, 1996 and 1999

	1994	1996	1999
	pp	pp	pp
A. Production Related Techniques			
CNC/NC Equipment	3.2	4.3	2.8
Robotics	-2.1	-2.9	-5.0
Automated Materials Handling	-0.8	0.8	0.7
Computer Aided Design	2.6	1.6	-4.0
Computer Aided Manuf.	-1.1	-2.5	-0.7
Computer Integrated Manuf.	-1.0	-2.7	-4.1
B. Organisational Techniques			
Quality Certific. (eg ISO9000)	-4.7	-5.1	-6.0
Total Quality Management	1.0	-0.5	-3.3
Quality Circles	-1.9	-2.5	-1.1
Just In Time	-8.6	-2.9	-13.1

Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

Source: Table 3.5

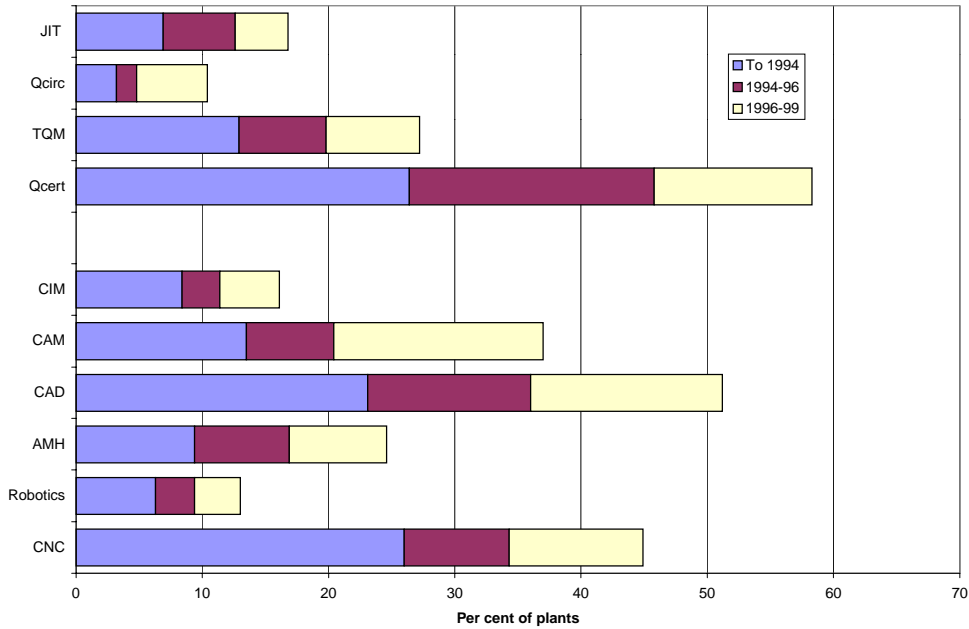
Four configurations are possible defined by whether the initial (i.e. 1994) level of utilisation of each technique was greater in Northern Ireland or the Republic of Ireland and the subsequent speed of adoption. In fact only three of the four possibilities are observed with no cases in which initial adoption rates were higher in

Northern Ireland and the subsequent speed of adoption in Northern Ireland was above that in the Republic of Ireland. The three groupings that are observed are:

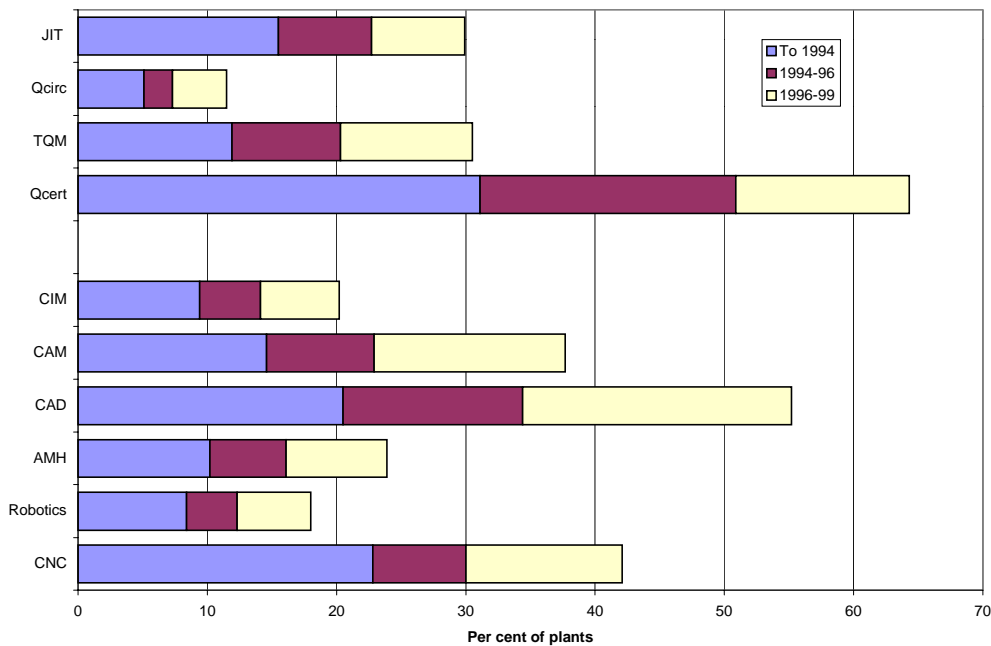
- (a) A higher initial (i.e. 1994) Northern Ireland adoption proportion reduced by faster adoption over the 1994-99 period in the Republic of Ireland. The use of CNC equipment, CAD and TQM fall into this category.
- (b) A higher initial adoption proportion in the Republic of Ireland reduced by faster adoption over the 1994-99 period in Northern Ireland. The use of quality certification, quality circles and JIT inventory management fall into this category.
- (c) A higher initial adoption proportion in the Republic of Ireland and higher subsequent adoption rates in the Republic of Ireland. Robotics and CIM fall into this category.

Figure 3.1: Adoption Profiles for Organisational and Production Techniques in Northern Ireland and the Republic of Ireland

B. Northern Ireland



B. Republic of Ireland



Note: Figure relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (see Appendix 1).

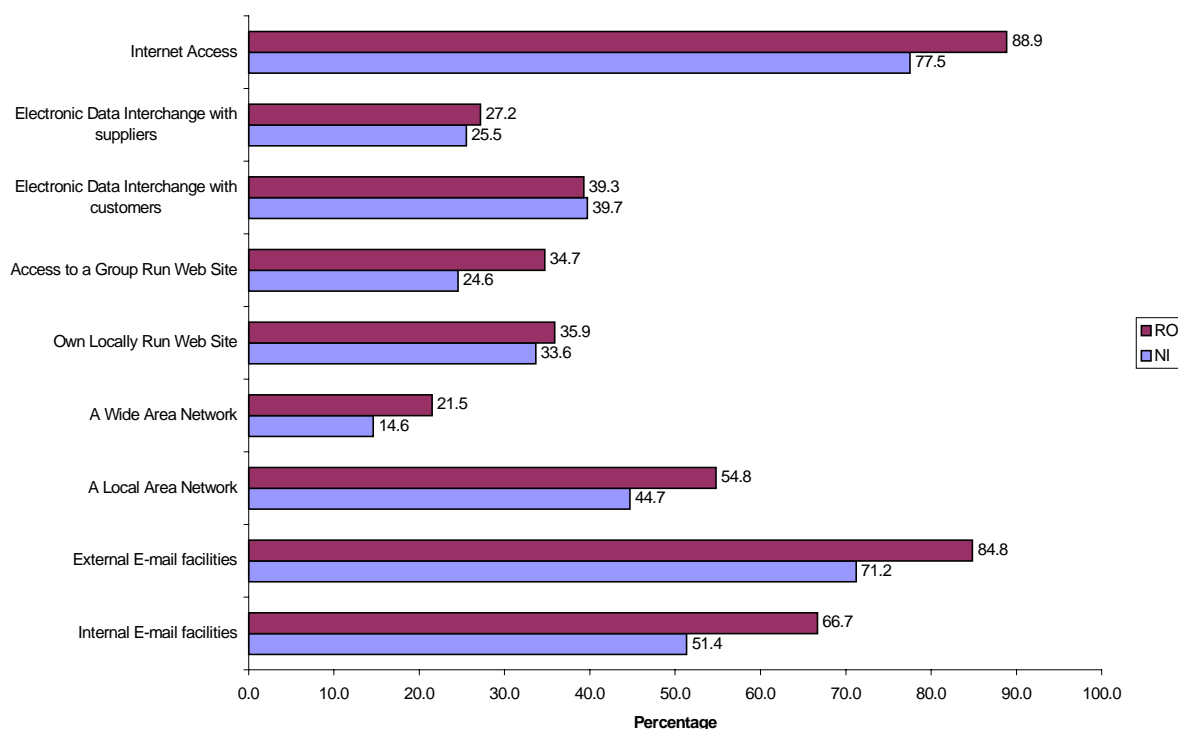
Source: PPDS3

Chapter 4: Information Technology and E-Business

4.1 Introduction

Following the same approach as the last section, this section considers the adoption of information technology and E-business applications by manufacturing plants in Northern Ireland and the Republic of Ireland. Overall, we find that 70-80 per cent of manufacturing businesses with more than 10 employees in both Northern Ireland and the Republic of Ireland now have access to the Internet and/or external e-mail. Section 4.2 profiles these levels of capability in more detail comparing plants' IT capability by size-band, by ownership and by sector. Section 4.3 focuses more specifically on E-business applications and examines the way in which plants in different areas, size-bands and sectors are currently using the Internet.

Figure 4.1 Average Percentage of Plants with Information Technology



Note: Figure relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Source: PPDS3

4.2 Information Technology Capability

Figure 4.1 gives the percentage of all manufacturing plants in Northern Ireland and the Republic of Ireland having different IT capabilities. A striking feature of the figure is the similarity between the general profile of IT capability in Northern Ireland and the Republic of Ireland. In each case, however, the proportion of plants having each capability is higher in the Republic of Ireland.

The most notable differences between plants in Northern Ireland and the Republic of Ireland occur in their e-mail and Internet capability. External e-mail, for example, was available to 67 per cent of Northern Ireland plants and 85 per cent of plants in the Republic of Ireland. Access to the Internet is available to 78 per cent of Northern Ireland plants compared to 89 per cent of plants in the Republic of Ireland. Comparison of EDI capability suggests a much smaller gap between Northern Ireland and Republic of Ireland plants with few significant differences in the proportion of plants having each capability.

In the last section we highlighted the positive association noted between the adoption of AMT and plant size. It is therefore no surprise to find that as plant size increases information technology capability also increases both in Northern Ireland and the Republic of Ireland (Table 4.1). For example in Northern Ireland the percentage of plants using internal e-mail increases from 25.4 per cent in the 10-19 employee size-band to 100 per cent in the 500 plus size-band.

Table 4.1: Average Percentage of Plants with Information Technology by Size-band

	Size-band				All Plants %
	10-19 %	20-99 %	100-499 %	500 plus %	
Northern Ireland					
Internal E-mail facilities	25.4**	48.1**	79.3**	100.0	51.6
External E-mail facilities	46.4**	71.7**	90.7*	100.0	71.3
A Local Area Network	12.4**	43.7**	72.0	100.0	44.9
A Wide Area Network	3.2	8.6**	34.5	59.8**	14.7
Own Locally Run Web Site	20.1	35.5	35.8*	70.9	33.5
Access to a Group Run Web Site	14.9	20.3**	39.4**	64.5**	24.7
EDI with customers	20.8	34.4	66.3	83.0	39.9
EDI with suppliers	11.8*	22.2	39.4	81.0	25.7
Internet Access	58.0**	78.9**	90.6	100.0	77.6
Republic of Ireland					
Internal E-mail facilities	46.5	63.3	89.9	92.0	66.6
External E-mail facilities	72.6	84.5	97.1	82.5	84.9
A Local Area Network	30.2	53.6	75.9	86.8	54.8
A Wide Area Network	11.3	15.2	41.0	74.6	21.6
Own Locally Run Web Site	26.2	33.8	47.0	55.7	35.8
Access to a Group Run Web Site	23.0	26.8	59.6	86.8	34.7
EDI with customers	26.9	35.5	56.4	67.9	39.2
EDI with suppliers	21.3	22.0	40.9	64.0	27.1
Internet Access	83.1	87.7	96.3	92.0	88.8

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 234; 100-499 employees, 90; 500 plus employees, 11; all plants, 418. Republic of Ireland; 10-19 employees, 110; 20-99 employees, 329; 100-499 employees, 169; 500 plus employees, 19; all plants, 631.

Sample F-tests were used to examine whether the proportion of plants with information technology in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Table 4.2: Average Percentage of Plants with Information Technology by Sector and Ownership

	Northern Ireland					Republic of Ireland				
		EDI with Suppliers or Customers	Locally/Group Run Web Site	External E-mail	Internet Access		EDI with Suppliers or Customers	Locally/Group Run Web Site	External E-mail	Internet Access
	n	%	%	%	%	n	%	%	%	%
By Sector										
Food, Drink and Tobacco	75	48.0	41.6	66.0**	69.8**	103	43.1	44.2	81.2	89.5
Textiles and Clothing	65	45.0	43.0**	72.9	76.6	51	46.7	66.5	83.4	84.9
Wood and Wood Products	21	38.3	56.5	63.1*	80.8	22	37.8	35.2	85.1	91.5
Paper and Printing	30	60.1	44.5	73.9*	81.7	40	41.7	50.6	86.1	88.5
Chemicals	14	38.2	64.5	81.8	82.7	51	37.5	83.5	94.7	96.3
Metals and Metal Fabrication	42	50.1	45.6	77.5	86.8	73	43.8	52.0	77.6	84.4
Mechanical Engineering	28	63.3	63.3	87.8	87.8	51	36.2	59.9	85.9	87.3
Electrical and Optical Equipment	30	30.4	66.8	86.1	89.1	102	51.6	69.1	93.0	90.9
Transport Equipment	18	46.8	55.4	76.8**	90.8	18	57.3	71.4	100.0	100.0
Other Manufacturing	83	28.7	48.9	66.4*	74.1*	118	32.7	46.4	80.2	86.8
All Plants	406	44.3	49.2	72.8	79.1	629	42.2	55.8	84.8	88.8
By Ownership										
Indigenously-owned	329	41.7	45.0*	66.9**	75.7**	446	39.2	49.7	81.9	87.5
Externally-owned	85	52.8	63.8	86.9	83.6**	172	51.3	73.8	93.6	93.4
All Plants	414	43.9	48.7	70.9	77.3	618	42.3	55.8	84.9	89.0

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample F-tests were used to examine whether the proportion of plants with information technology in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Distinguishing between externally and locally-owned plants also suggests that IT adoption rates are higher among externally-owned plants, both in Northern Ireland and the Republic of Ireland (Table 4.2). For example, Internet access was available to 76 per cent of locally-owned plants in Northern Ireland compared to 84 per cent of externally-owned plants.

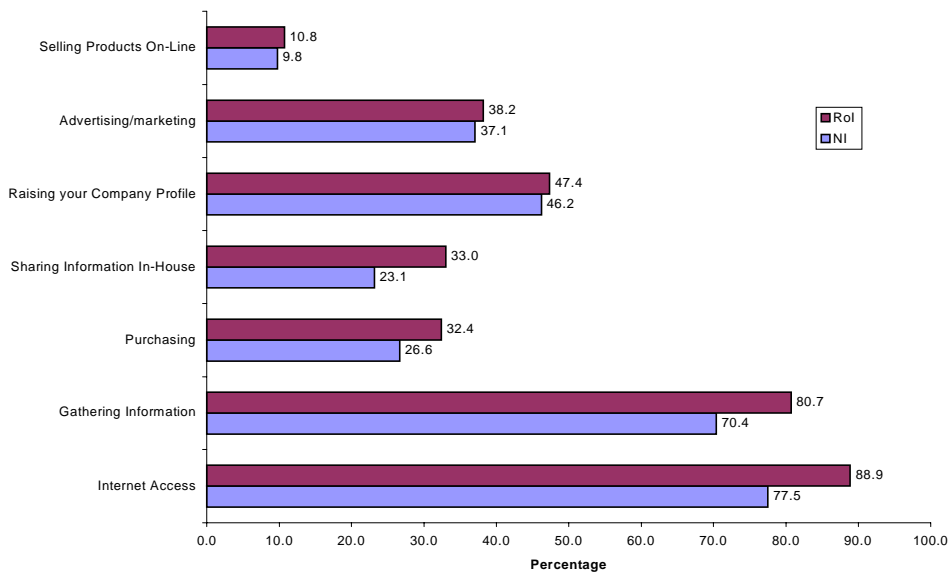
IT adoption rates also vary significantly between sectors although the general pattern of higher adoption rates among Republic of Ireland plants is relatively uniform. The transport equipment sector is the only sector where IT adoption rates are uniformly above average for plants in both Northern Ireland and the Republic of Ireland, with other manufacturing plants having uniformly below average adoption rates in both areas.

4.3 Internet Use and E-Commerce

In this section we examine the use that companies are making of the Internet and E-commerce. Figure 4.2 summarises the basic data relating to the percentage of plants in Northern Ireland and the Republic of Ireland having and using the Internet. Again the general picture is very similar in the Republic of Ireland and Northern Ireland, with marginally higher levels of Internet adoption and usage in the Republic of Ireland. Other key points are:

- Three-quarters of plants reported using the Internet for information gathering.
- Two fifths of plants reported using the Internet to raise the external profile of the company although a smaller proportion of plants reported using the Internet for marketing.
- A quarter to a third of plants reported using the Internet for sharing information within the firm and for purchasing.
- A tenth of all plants reported using the Internet for on-line selling.

Figure 4.2: Average Percentage of Plants' Usage of the Internet



Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Source: PPDS3

As we noted for the use of information technology, use of the Internet also tends to increase with plant size-band in both Northern Ireland and Republic of Ireland (Table 4.3). One notable exception is the selling of products on-line in Northern Ireland, with 11.1 per cent of plants in the 20-99 employee size-band compared to 9 per cent of plants with 100-499 employees and only 5 per cent of those with 500 plus employees. Once again the difference between Northern Ireland and the Republic of Ireland also tends to be greatest for plants in the smaller employment size-bands. For example, for plants in the 10-19 employee size-band for Internet purchasing the difference between Northern Ireland and the Republic of Ireland is 17.7 percentage points. For plants in the 20-99 employee size-band this differential is reduced to 3.3 pp and to 0.2 pp for plants in the 500 plus employee group. Indeed, for plants with 500 plus employees Internet usage by Northern Ireland plants tends to be more common than in the Republic of Ireland.

Table 4.3: Average Percentage of Plants' Usage of the Internet by Size-band

	Size-band				All Plants %
	10-99 %	22-99 %	100-499 %	500 plus %	
Northern Ireland					
Internet Access	58.0**	78.9**	90.6	100.0	77.6
Gathering Information	52.4	71.6	80.8*	100.0	70.4
Purchasing	11.1*	27.6	38.9	37.8	26.8
Sharing Information In-House	7.0	19.4*	40.7**	77.5	23.3
Raising your Company Profile	25.7	48.4	55.2	80.6	46.2
Advertising/Marketing	25.5	39.5	35.3	75.6	36.9
Selling Products On-Line	6.6	11.1	9.0	5.0	9.5
Republic of Ireland					
Internet Access	83.1	87.7	96.3	92.0	88.8
Gathering Information	70.7	80.2	89.6	92.0	80.7
Purchasing	28.2	30.9	39.1	23.5	32.0
Sharing Information In-House	21.0	27.5	54.8	61.0	33.0
Raising your Company Profile	43.4	45.2	55.3	50.8	47.2
Advertising/Marketing	30.3	37.9	46.3	35.8	38.2
Selling Products On-Line	7.0	11.0	12.4	15.7	10.7

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 234; 100-499 employees, 90; 500 plus employees, 11; all plants, 418. Republic of Ireland; 10-19 employees, 110; 20-99 employees, 329; 100-499 employees, 169; 500 plus employees, 19; all plants, 631.

Sample F-tests were used to examine whether the proportion of plants' use of the Internet in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Table 4.4: Average Percentage of Northern Ireland Plants' Use of the Internet: By Sector and Ownership

	n	Internet Access %	Gathering Information %	Purchasing %	Sharing Info In-House %	Raising your Company Profile %	Advertising or Marketing %	Selling Products On-Line %
By Sector								
Food, Drink etc	75	69.8**	61.5	13.0	16.9**	30.8	19.3	5.1
Textiles and Clothing	65	76.6	65.6	28.9	25.0	42.6	29.5**	13.9
Wood and Wood Products	21	80.8	76.1	33.2	7.9	53.8	48.1	9.4
Paper and Printing	30	81.7	72.6	24.1	22.4	61.1**	43.8	15.3*
Chemicals	14	82.7	69.1	47.3	33.6	46.4	38.2	8.2
Metals and Fabrication	42	86.8	81.7	30.1	20.6	53.0	46.2	11.9
Mechanical Eng	28	87.8	81.7	27.6	57.2	63.3	60.3	21.4**
Electrical and Optical	30	89.1	83.2	55.7	38.9	64.2	50.7	5.6**
Transport Equipment	18	90.8	84.3	30.5	26.6	35.7	40.6	3.8
Other Manufacturing	83	74.1*	68.8	24.4	14.5	45.2	37.1	6.2
All Plants	406	79.1	71.7	27.3	23.4	47.0	37.6	9.8
By Ownership								
Indigenously-owned	329	75.7**	69.1	25.7	18.9	45.6	36.9	10.4
Externally-owned	85	83.6**	75.3*	29.9	38.3*	48.1	37.6	6.8
All Plants	414	77.3	70.3	26.3	22.7	46.1	37.0	9.7

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample F-tests were used to examine whether the proportion of plants' use of the Internet in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Table 4.5: Average Percentage of the Republic of Ireland Plants' Use of the Internet: By Sector and Ownership

	n	Internet Access %	Gathering Information %	Purchasing %	Sharing Info In-House %	Raising your Company Profile %	Advertising or Marketing %	Selling Products On-Line %
By Sector								
Food, Drink etc.	103	89.5	79.3	20.7	32.3	37.3	32.0	8.9
Textiles and Clothing	51	84.9	81.3	31.0	25.5	56.6	53.2	24.7
Wood, Wood Products	22	91.5	68.8	38.3	16.3	30.0	25.5	10.4
Paper and Printing	40	88.5	80.1	15.1	24.2	33.7	28.0	1.8
Chemicals	51	96.3	92.5	47.5	61.7	55.7	30.8	6.8
Metals and Fabrication	73	84.4	76.4	38.7	31.2	53.3	38.2	7.2
Mechanical Eng	51	87.3	85.5	41.6	30.5	57.3	41.9	3.7
Electrical and Optical	102	90.9	86.0	39.0	48.6	56.7	47.8	18.3
Transport Equipment	18	100.0	100.0	46.2	31.6	52.0	50.3	0.0
Other Manufacturing	118	86.8	73.1	29.4	23.3	42.8	35.2	12.7
All Plants	629	88.8	80.7	32.2	33.1	47.2	38.0	10.8
By Ownership								
Indigenously-owned	446	87.5	78.0	30.3	26.4	46.6	39.5	10.6
Externally-owned	172	93.4	88.9	40.2	52.6	48.3	34.0	12.1
All Plants	618	89.0	80.8	32.8	33.0	47.0	38.1	11.0

Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Source: PPDS3

Tables 4.4 and 4.5 summarise the percentage of plants in Northern Ireland and the Republic of Ireland respectively using the Internet by sector and ownership type. As before externally-owned plants are more likely to use the Internet for each activity than locally-owned firms. The only exception is the selling of products on-line which was being undertaken by 10 per cent of indigenously-owned plants but only 7 per cent of externally-owned firms.

Sectoral differences are again marked, with plants in some sectors (notably food, drink and tobacco, other manufacturing and paper and printing (in the Republic of Ireland)) having generally lower levels of Internet usage. Other sectors – notably chemicals and the engineering sectors – have above average levels of Internet use. Perhaps the significant sectoral variations, however, occur in terms of on-line selling which is being undertaken by 21 per cent of mechanical engineering firms in Northern Ireland and 24.7 per cent of textiles and clothing firms in the Republic of Ireland.

Chapter 5: Innovation Constraints and Support for Innovation Activity

5.1 Introduction

In previous sections we highlighted the positive association between innovation and various business performance indicators and the fact that Northern Ireland plants typically lag a few percentage points behind their Republic of Ireland counterparts in most innovation indicators. In this section we consider the barriers or constraints which plants in Northern Ireland and the Republic of Ireland identify to their innovation activity and compare the profile of assistance being provided in Northern Ireland and the Republic of Ireland. In terms of the latter question the focus is on the proportion of plants in Northern Ireland and the Republic of Ireland which have received assistance for different types of innovation activity.

5.2 Constraints on Innovation Activity

As part of the PPDS3 plants were asked to indicate the importance of a number of possible barriers or constraints on their innovation activity on a 1 to 5 scale. Tables 5.1 and Figure 5.1 give the proportions of plants in Northern Ireland and the Republic of Ireland indicating that each factor was either an 'important' or 'very important' constraint on their innovation activity. As usual in such surveys (see, for example, Roper and Hewitt-Dundas, 1998, Table 8.1, p.61) financial constraints were seen as most important reflecting both the lack of investment finance and the low perceived rate of return from innovation. Overall, 40 per cent of plants in Northern Ireland and 39 per cent in the Republic of Ireland, for example, said that a low rate of return was an important constraint on their innovation activity, while around a third emphasise a lack of finance and paucity of opportunities. Human and technical resources and difficulties associated with plants' market environment were typically said to be less important. Only around a fifth of all plants, for example, regarded a lack of managerial and/or technical skills as an important constraint on their innovation activity.

Table 5.1: Constraints on Innovation

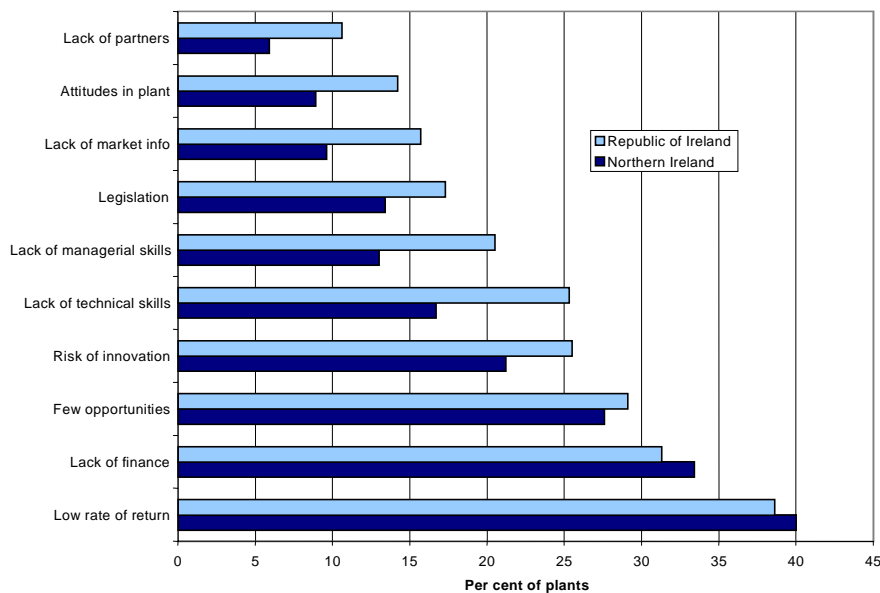
	Regional Indicator		All Plants	
	Northern Ireland	Republic of Ireland		
	n	418	631	1049
Low rate of return	40.0	38.6	39.0	
Lack of finance	33.4	31.3	31.9	
Few opportunities	27.6	29.1	28.7	
Risk of innovation	21.2	25.5	24.3	
Lack of technical skills	16.7**	25.3	22.9	
Lack of managerial skills	13.0**	20.5	18.4	
Legislation	13.4	17.3	16.2	
Lack of market info	9.6**	15.7	14.0	
Attitudes in plant	8.9**	14.2	12.7	
Lack of partners	5.9**	10.6	9.3	

Note: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample F-tests were used to examine whether the proportion of plants citing these constraints on innovation as important in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Figure 5.1: Profile of Constraints for Product and Process Development in Northern Ireland and the Republic of Ireland



Notes and Sources: See Table 5.1.

Figure 5.1 clarifies the contrasts between those factors seen as important by firms in Northern Ireland and the Republic of Ireland. In particular, Northern Ireland plants tended to place slightly more emphasis on their lack of finance and the low rate of return anticipated from innovation. Republic of Ireland plants on the other hand tended to place more emphasis on resource constraints and their market environment. In general, however, the importance accorded to the various constraints by plants in Northern Ireland and the Republic of Ireland is broadly similar.

An essentially similar feature characterises the innovation constraints perceived by plants in each employment size-band: low rates of return and lack of finance dominate with lack of partners and attitudinal problems within the plant the least common problems (Table 5.2 and Figure 5.2). As we might expect given their limited financial and managerial resources, smaller plants tend to accord each constraint more importance than larger plants. For example, 41 per cent of Northern Ireland plants in the 10-19 employee size-band regarded lack of finance as an important constraint on innovation compared to 26 per cent of plants with 100 or more employees.

Table 5.2: Constraints on Innovation by Size-band

	Size-band			Total
	10-19	20-99	100+	
Northern Ireland				
Low rate of return	35.4	39.1	46.8	40.0
Lack of finance	40.5	33.0	26.3	33.4
Few opportunities	34.8	24.1	28.6	27.6
Risk of innovation	15.0	18.7	33.5	21.2
Lack of technical skills	20.3*	15.3**	16.9	16.7
Legislation	19.3	9.5**	16.6	13.4
Lack of managerial skills	16.1*	13.5**	8.6	13.0
Lack of market info	11.0	9.5**	8.6	9.6
Attitudes in plant	14.9	7.0	7.6**	8.9
Lack of partners	7.5	5.5*	5.3	5.9
Republic of Ireland				
Low rate of return	42.0	35.0	43.5	38.6
Lack of finance	36.0	31.9	25.8	31.3
Few opportunities	30.1	27.5	32.0	29.1
Risk of innovation	32.3	20.5	31.0	25.5
Lack of technical skills	28.5	26.2	20.0	25.3
Lack of managerial skills	24.7	21.5	14.3	20.5
Legislation	20.3	17.5	14.0	17.3
Lack of market info	18.5	17.4	9.1	15.7
Attitudes in plant	19.2	9.8	19.0	14.2
Lack of partners	11.8	10.4	10.2	10.6

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

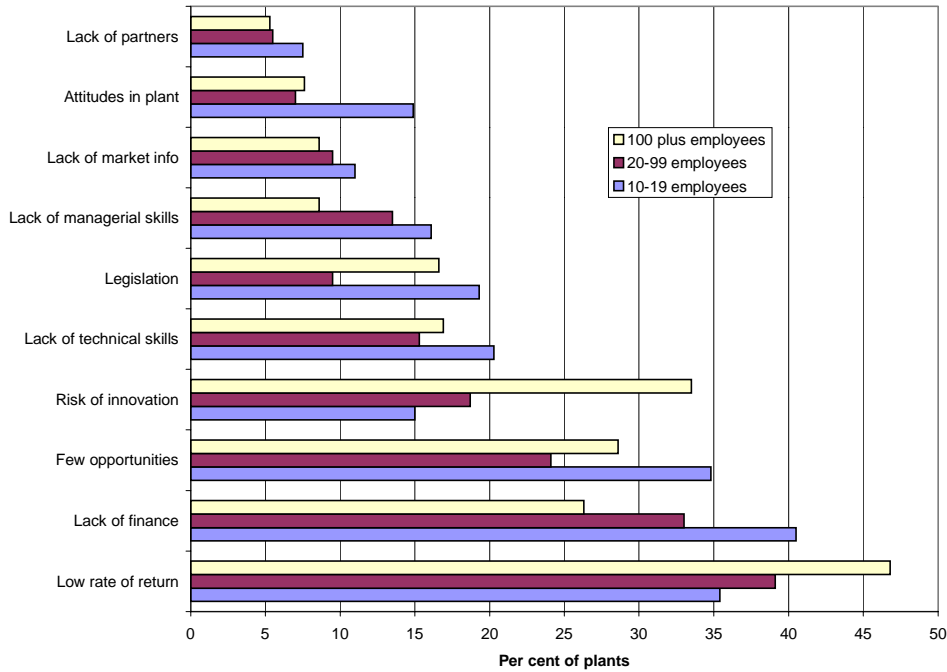
Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 237; 100 plus employees, 90; all plants, 418. Republic of Ireland; 10-19 employees, 125; 20-99 employees, 329; 100 plus employees, 177; all plants, 631.

Sample F-tests were used to examine whether the proportion of plants citing these constraints on innovation as important in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

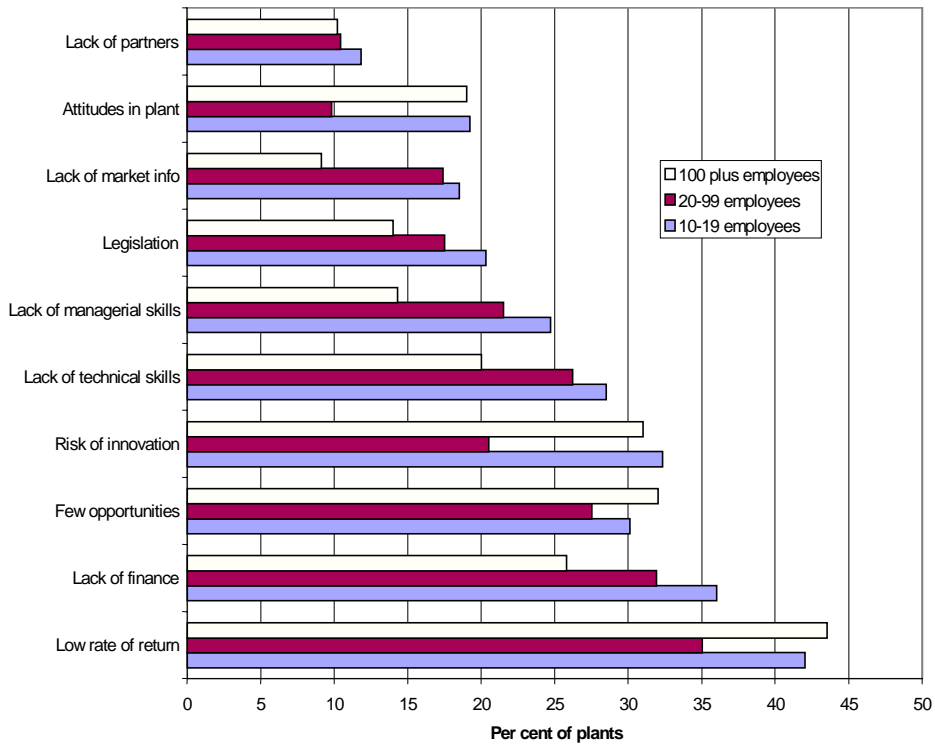
Source: PPDS3

Figure 5.2: Constraints on Innovation Activity in Northern Ireland and the Republic of Ireland: By Plant Size-band

A. Northern Ireland



B. Republic of Ireland



Notes and Sources: See Table 5.2.

5.3 Support for Innovation Activity

One way in which plants may be encouraged to increase their level of innovation activity is through grants or other public support. Grants or other support for R&D or innovation, for example, can reduce the cost of undertaking any innovation and reduce the implicit risk. Other forms of support for appropriate training, exporting or investments in capital equipment may also contribute to innovative activity and/or plants' adoption of best practice. Table 5.3 summarises the proportion of plants in Northern Ireland and the Republic of Ireland which received government support for different aspects of their operations over the 1996-99 period. Around a quarter of all plants, for example, received support for their product development activities with around 1 in 8 firms obtaining public support for process development. Smaller proportions of plants in both Northern Ireland and the Republic of Ireland received public help with non-specific R&D and adopting best practice.

Overall, the proportion of plants receiving support for each activity was broadly similar in Northern Ireland and the Republic of Ireland. Public support in Northern Ireland, however, is significantly more strongly biased towards capital investment than that in the Republic of Ireland: lower proportions of Northern Ireland plants received support for product and process development and R&D with a larger proportion of plants (37 per cent) receiving support for capital investment than that in the Republic of Ireland (27 per cent). Marked differences also exist between the proportions of plants in each size-band receiving public support. Notably the proportion of plants in the 10-19 size-band receiving support for each activity with the exception of exporting was higher in the Republic of Ireland than in Northern Ireland. For example, the 32 per cent of plants in the 10-19 size-band who received support for product development in the Republic of Ireland was significantly above the 8 per cent who received such support in Northern Ireland.

Table 5.3: Percentage of Plants Receiving Government Assistance: By Plant Size-band 1996-1999

	Plant Size-band			All Plants
	10-19 employees	20-99 employees	100 plus employees	
A. Northern Ireland				
Product Development	8.1**	26.3	34.8	23.8
Process Development	4.1	15.7	31.5	16.5
Non-specific R&D	3.8**	8.5	19.9	9.9
Manufacturing License	0.5	1.6	0.8	1.2
New Plant or Machinery	8.5	34.4*	71.0**	36.6
Exporting	19.8	25.1**	27.5	24.4
Best Practice	1.5	9.0	12.5*	8.0
B. Republic of Ireland				
Product Development	32.0	24.3	40.5	29.6
Process Development	8.5	15.6	31.1	17.4
Non-specific R&D	15.2	10.3	15.8	12.6
Manufacturing License	4.4	2.2	1.9	2.6
New Plant or Machinery	16.9	26.9	35.0	26.5
Exporting	14.6	15.8	19.3	16.3
Best Practice	5.1	9.8	6.8	8.1

Notes: Table relates to manufacturing plants with 10 or more employees. Survey responses were weighted to give representative results (Appendix 1).

Sample sizes are as follows for: Northern Ireland; 10-19 employees, 91; 20-99 employees, 237; 100 plus employees, 90; all plants, 418. Republic of Ireland; 10-19 employees, 125; 20-99 employees, 329; 100 plus employees, 177; all plants, 631.

Sample F-tests were used to examine whether the proportion of plants receiving government assistance in the underlying Northern Ireland and Republic of Ireland populations was the same. ** denotes rejection of this hypothesis at the 5 per cent level, * denotes rejection at the 10 per cent level. Tests were conducted on the unweighted sample.

Source: PPDS3

Appendix 1: Survey Data and Methods

A1.1 Introduction

This appendix provides details of the survey procedures adopted during the third Product and Process Development Survey (PPDS3) conducted between October 1999 and February 2000. Survey procedures followed broadly the same pattern as the 1996 PPDS described in Roper and Hewitt-Dundas, 1998, pp. 63-71.

The PPDS3 survey was a postal survey the primary aim of which was to provide representative indicators of innovation and the adoption of best practice techniques by manufacturing firms in the Republic of Ireland and Northern Ireland. A secondary aim of the survey was to contribute to the creation of a longitudinal database of innovation in Irish companies. The PPDS3 survey is a plant level (rather than company) survey with the sample being structured to minimise the burden on firms while maintaining statistical robustness. In particular, sample structure and response rates were monitored both by plant size-band and broad sectoral group to enable a representative analysis.

Section A1.2 summarises the main characteristics of the sampling frames obtained for the PPDS3 and the characteristics of the final sample. Section A1.3 focuses on survey response and Section A1.4 describes patterns of non-response and discusses the possibility of non-response bias. Section A1.5 describes the construction of weights designed to give representative results.

A1.2 Sampling Frames

Separate sampling frames were obtained from official sources in Northern Ireland and the Republic of Ireland. In Northern Ireland the sampling frame used was provided by DED Statistics Branch and was drawn from the Inter-departmental Business Register (IDBR) maintained by the Business Statistics Office, Newport. Sampling was in two stages. First, a random sample was drawn from the IDBR using guidelines provided by NIERC. Sampling fractions were: 50 per cent for plants with 10-19 employees, 75 per cent for plants with 20-100 employees and 100 per cent for all larger plants. Secondly, to maximise the longitudinal coverage of the survey, the IDBR sample was augmented by those respondents to the 1996 PPDS that were excluded from the

random sample. Details of the number of plants in the population and final augmented random sample are given in Table A1.1.

An essentially similar sampling approach was adopted in the Republic of Ireland. A population listing of manufacturing firms was kindly provided by Forfás and a random sample was constructed from this population. As in Northern Ireland, sampling fractions were: 50 per cent for plants with 10-19 employees, 75 per cent for plants with 20-100 employees and 100 per cent for all larger plants. This random sample was then augmented by those respondents to the PPDS that were excluded from the random sample. Details of the number of plants in the population and the final augmented random sample for the Republic of Ireland are given in Table A1.2.

A1.3 Survey Methodology and Response

The questionnaire used in the PPDS3 was very similar to that used successfully in the PPDS (see Roper and Hewitt-Dundas, 1998). Changes to the previous questionnaire were restricted to changes of dates, some structural changes and the inclusion for the first time of a set of questions relating to E-commerce. A copy of the survey questionnaire is included as Appendix 2. Because the questionnaire had been tested in previous surveys no pilot survey was undertaken.

The main PPDS3 postal survey was conducted between October 1999 and January 2000 with each plant being sent an initial form and two postal reminders. All non-respondents in the sample were then also contacted by fax during February 2000. In addition, plants which had responded to the PPDS in 1996-97 were also contacted by telephone. From the original sample of 3578 a total of 1043 usable responses was obtained with 134 additional responses or contacts with plants which had closed, were not involved in manufacturing or were out of scope (Table A1.4). Adjusting the overall sample by these proportions suggests an overall survey response rate of 32.8 per cent (1043 responses). A significant difference was evident, however, between the response rate of 41 per cent (419 responses) in Northern Ireland and 29.4 per cent (624 responses) in the Republic of Ireland. Expressing the respondent plants as a proportion of the population suggests that the sample covers 32.7 per cent of all manufacturing plants in NI and 22.4 per cent of plants in the Republic of Ireland.

A1.4 Non-Response

One potentially significant issue in innovation surveys is the possibility that survey respondents are more likely to be innovators than non-respondents. To check the representativeness of the group of respondents, a random sample of non-respondents

in Northern Ireland and the Republic of Ireland was contacted by telephone. Plants were asked about the nature of any R&D they undertook and whether they had made any product and process changes since 1996. Table A1.5 summarises the responses from the PPDS3 survey in weighted and unweighted form and the results of the non-response survey. Overall, little difference is evident between the innovative behaviour of respondents and non-respondents suggesting that the PPDS3 may be regarded as representative.

A1.5 Sample Weights

The PPDS3 survey was based on a structured sample with different sampling proportions for different plant size-bands. Obtaining representative results therefore requires that sample observations be weighted. Weights were specified separately for plant size-bands (i.e. 10-19, 20-99 and 100 plus employees) and for ten industrial categories. The industrial categories were combinations of 2-digit groupings from SIC92: Food, Drink and Tobacco, 15, 16; Textiles and Clothing, 17, 18, 19; Wood and Wood Products, 20; Paper and Printing, 21, 22; Chemicals, 24; Metals and Fabrication, 27, 28; Mechanical Engineering, 29; Electrical & Optical Equipment, 30, 31, 32, 33; Transport Equipment, 34, 35; Other Manufacturing, 25, 26, 36, 37. Plants were excluded from the survey if they were in Nuclear, Coal, Coke etc, 23.

Table A1.1: Northern Ireland Sample Structure – Number of Plants

	Plant Size-band			Total
	10-19	20-99	100+	
Food, Drink and Tobacco	40	113	47	200
Textiles, Clothing	29	73	66	168
Wood Products	22	38	3	63
Paper and Printing	29	40	16	85
Chemicals	8	9	11	28
Metals and Fabrication	35	72	9	116
Mechanical Eng.	27	40	13	80
Electrical and Optical Equip.	15	31	24	70
Transport Equip.	9	22	14	45
Other Manufacturing	62	108	31	201
Not Assigned	15	17	2	34
Total	291	563	236	1090
<i>Memo Items:</i>				
<i>Population</i>	582	750	236	1568
<i>Sampling Proportion (%)</i>	50	75	100	70

Source: PPDS3

Table A1.2: Republic of Ireland Sample Structure – Number of Plants

	Plant Size-band			Total
	10-19	20-99	100+	
Food, Drink and Tobacco	96	258	135	489
Textiles, Clothing	41	127	37	205
Wood Products	25	45	13	83
Paper and Printing	38	108	33	179
Chemicals	24	90	62	176
Metals and Fabrication	97	183	35	315
Mechanical Eng.	54	66	33	153
Electrical and Optical Equip.	61	167	130	358
Transport Equip.	16	45	24	85
Other Manufacturing	109	272	57	438
Not Assigned	1	4	2	7
Total	562	1365	561	2488
<i>Memo Items:</i>				
<i>Population</i>	<i>1124</i>	<i>1820</i>	<i>561</i>	<i>3505</i>
<i>Sampling Proportion (%)</i>	<i>50</i>	<i>75</i>	<i>100</i>	<i>71</i>

Source: PPDS3

Table A1.3: Decomposition of Samples By Previous Response Status

	Plant Size-band			Total	
	10-19 No.	20-99 No.	100+ No.	No.	%
A. Northern Ireland					
PPDS Respondent Only	55	56	21	132	12.1
Random Sample Only	214	419	166	799	73.3
Random Sample and PPDS Respondent	22	88	49	159	14.6
All Plants	291	563	236	1090	100.0
B. Republic of Ireland					
PPDS Respondent Only	29	100	48	177	7.1
Random Sample Only	515	1126	402	2043	82.1
Random Sample and PPDS Respondent	18	139	111	268	10.8
All Plants	562	1365	561	2488	100.0

Source: PPDS3

Table A1.4: Survey Response Rates

	Northern Ireland	Republic of Ireland	Total
Sample (no. of plants)	1090	2488	3578
Response	446	731	1177
Of which:			0
Out of Scope/Closed (no. of plants)	27	107	134
Usable Responses (no. of plants)	419	624	1043
Response Rate (%)	40.9	29.4	32.9
Population Proportion (%)	32.7	22.4	25.4

Source: PPDS3

Table A1.5: Non-Response Analysis of Main Technological Indicators

	Northern Ireland			Republic of Ireland		
	PPDS3 Weighted	PPDS3 Unweighted	Non- Response Check	PPDS3 Weighted	PPDS3 Unweighted	Non- Response Check
N	418	418	104	631	631	94
Undertaking R&D in plant (%)	45.3	45.6	38.8	52.4	54.0	46.7
R&D Dept in plant (%)	19.4	18.6	19.2	24.4	26.7	25.5
Product Changes Since 1993 (%)	58.2	59.7	63.1	65.2	66.4	69.1
Process Changes Since 1993 (%)	57.6	58.0	67.0	65.6	66.4	67.7
Links to Others Firms (%)	40.4	40.9	42.1	50.0	50.5	40.7

Source: PPDS3, Non-Response Survey

Appendix 2: Survey Questionnaire

PRODUCT AND PROCESS DEVELOPMENT INITIATIVE - PHASE THREE

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Please complete your company details:

Label Here
Northern Ireland
Companies

1. Background

Please indicate whether this plant is: *(Please tick relevant box)*

A single-plant company	
A parent or group HQ	
A subsidiary plant in a group	
Other	

If this plant is a subsidiary, in which country is your group's headquarters located?

Location of Group HQ:

In what year did your plant start production?

Year

Please indicate approximately what proportion of your sales (by value) were outside the UK and Ireland in 1998

% of sales

Indicate the main type of production undertaken in your plant: *(tick relevant box)*

One-offs	
Small batches	
Large Batches	
Continuous Production	

Please indicate the percentage growth of this plant since 1996:

	Percentage Growth Since 1996
Employment Growth	%
Sales Growth	%

Please indicate *approximately* what proportion of the people who work in your plant have as their highest qualification:

	% of Workforce
A degree or equivalent qualification	%
A technician level qualification	%
A relevant apprenticeship level qualification:	%
Some relevant vocational qualification	%
No post-school vocational qualification	%

(Note: percentages should sum to 100%)

For the 1998 business year please estimate:

Average employment	
The value of your sales turnover	£
The value of materials and fuels purchased	£
Total gross expenditure on wages and salary payments	£
Investment spending on plant, machinery and fixed assets	£
Investment spending on buildings	£

2. Research and Development

(Please tick as appropriate)

- Was any R&D undertaken in your plant in 1998?
 Is there a formal R&D department in your plant?
 Is R&D relevant to your plant done elsewhere in the group?

Yes	No

Please *estimate* how many man-years were spent on R&D in your plant during 1998

Man-years:

Approximately what was total R&D expenditure in your plant in 1998 (£000s)?

£000s:

3. Product Developments

Have you introduced ANY new or improved products at this plant since 1996?

	Yes	No
Product Changes since 1996		

IF NO SKIP TO SECTION 4

How many new or improved products have you introduced since 1996?

Number of new/improved products:

Please *estimate* the proportion of your current sales (by value) that consist of:

(Note: percentages should add to 100%)

	% of Sales
New products introduced to the market <i>for the first time</i> since 1996 by this plant	%
New products introduced by this plant since 1996 but <i>previously made elsewhere</i>	%
<i>Technically improved</i> products which were being made by this plant in 1996	%
<i>Aesthetically improved</i> products which were being made by this plant in 1996	%
Products which have remained <i>unchanged</i> since 1996	%

How important were these sources of technology for your product development?

	Not Important		3	Very Important	
	1	2		4	5
In-house R&D or development work					
Technology transferred from other group companies					
Collaboration with other company					
Purchase of new machinery					
Purchase of manufacturing licence					
Copying competitors or other firms					
Trade shows, fairs etc					
Collaboration with government/agencies					
Collaboration with higher education/research institutes					

How important was product development since 1996 in enabling you to:

	Not Important		3	Very Important	
	1	2		4	5
Replace out-dated products					
Extend your product range					
Increase or maintain your market share					
Enter new markets					
Reduce production costs					
Produce environmentally friendly products					
Improve product quality					
Match developments by competitors					

4. Process Developments

Have you introduced ANY new or improved production processes at this plant since 1996?

	Yes	No
Process Changes since 1996		

IF NO SKIP TO SECTION 5

Have changes in production techniques/processes since 1996 led to *significant* changes in the organisation of production?

	Yes	No
Organisational Changes since 1996		

How important have the following sources of technology been for your process development?

	Not Important		3	Very Important	
	1	2		4	5
In-house R&D or development work					
Technology transferred from other group companies					
Collaboration with other company					
Purchase of new equipment					
Purchase of manufacturing licence					
Copying competitors or other firms					
Trade shows, fairs etc					
Recruiting skilled employees					
Collaboration with government/agencies					
Collaboration with higher education/research institutes					

5. Information Technology

Does your company have or use
(Please tick relevant boxes)

	Yes	No
Internal E-mail facilities		
External E-mail facilities		
A Local Area Network (LAN)		
A Wide Area Network (WAN)		
Your Own Locally Run Web Site		
Access to a Group Run Web Site		
Electronic Data Interchange with customers		
Electronic Data Interchange with suppliers		

Does your company have Internet access?

	Yes	No
Internet Access		

IF NO SKIP TO SECTION 6

Do you use the internet for:

	Yes	No
Gathering information		
Purchasing		
Sharing information in-house		
Raising your company profile		
Advertising/marketing		
Selling products on-line		

6. Manufacturing Techniques

Please indicate if you now use any of the following production techniques. Also, please indicate the date when they were first introduced:

	Use Now	First Introduced:		
		Before 1994	During 1994-96	Since 1996
Numerically Controlled (NC) or CNC Machinery				
Robotic Equipment				
Automated Materials Handling				
Computer Aided Design (CAD)				
Computer Aided Production Management				
Computer Integrated Manufacturing				
Quality Certification (e.g. ISO 9000)				
Total Quality Management				
Quality Circles				
Just in time				
Investors in People				

In terms of replacement value, what proportion of your current production equipment consists of Numerically Controlled (NC) or Computer Numerically Controlled (CNC) equipment?

%

7. Links to Other Firms and Organisations

Since 1996 did you have links with any other companies or organisations as part of your product or process development?

	Yes	No
Links with other companies or organisations		

IF NO SKIP TO SECTION 8

Please indicate the types of companies or organisations that contributed to your product or process development and the way in which you involved them:

	Links with	Type of involvement		
		Collaboration	Sub-contract	Other
Other group companies				
Clients/customers				
Suppliers				
Competitors				
Joint ventures				
Consultants				
Government research labs				
Universities/higher education				
Industry operated labs				
Private research institutes				

How important were these external links in each of the following:

	Not Important			Very Important	
	1	2	3	4	5
Making developments more cost-effective					
Sharing development costs					
Reducing development risk					
Accessing specialist equipment or technology					
Accessing specialist expertise					
Speeding up development					
Meeting legislative/regulatory requirements					
Accessing additional finance					

8. Government and EU Assistance

Please indicate whether you have received government support for any of the following since 1996. Tick as applicable but omit support of less than £5,000

	Yes	No
Product development		
Process development		
R&D not related to any specific product or process development		
Purchase of licences to manufacture		
New Plant/Machinery		
Exporting		
Management training in relation to product/process development		
Training for product development techniques		
Training for process development techniques		
Best Practice or Benchmarking		

9. Constraints on Product/Process Development

Please indicate if any of the following factors have reduced or hindered product or process development in your plant: (Please tick relevant boxes)

	Not Important			Very Important	
	1	2	3	4	5
Riskiness of product/process development					
Low rate of return					
Attitudinal barriers in this plant					
Lack of necessary finance					
Few market opportunities					
Lack of information about technologies					
Legislative or regulatory requirements					
Lack of partners					
Lack of technical expertise in this plant					
Lack of managerial expertise in this plant					

Thank You for your help

Please send your completed form in the FREEPOST envelope provided to Julie Anderson, Northern Ireland Economic Research Centre, 46-48 University Road, Belfast, BT7 1NJ Tel: 01232-261808/261811; Fax: 01232-439435

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