

3 Firm level evidence: uptake of ICTs

This and the next chapter report on the current joint project work examining firm-level data.

This chapter first outlines the data sources being used. It then describes broad trends in the use of ICTs and investigates factors affecting the uptake of ICTs.¹⁸ The analysis of the take up of ICTs in this chapter should be viewed as preliminary. The principal focus of the project to date has been on analysis of the performance effects of computer use as reported in the next chapter.

3.1 Data sources

The main data base available for empirical analysis is the (Australian) Business Longitudinal Survey (BLS) collected for the years 1994-95 to 1997-98. The BLS provides information about firm performance, innovation, business practices, restructuring and reorganisation for each survey year. Whilst not primarily designed for this purpose, the BLS also provides information on business use of computers and the duration of computer use obtained in the 1996-97 collection and, in less detail, in the 1997-98 collection (box 3.1). The 1996-97 information was sufficiently detailed to impute key computer use indicators for matched firms for the earlier survey years 1994-95 and 1995-96, and for 1997-98. The information about firm performance, computer use and other factors provided a basis for the analysis of the characteristics of firms using ICT and the implications of ICT use for productivity over the four year period 1994-95 to 1997-98.

Overall, this data source and investigation period is particularly suited to the current study since:

- the survey covered a substantial number of firms that used ICT as well as firms that did not report the use of ICT;
- there was a continuation of ICT capital deepening at the national level (chapter 2);
- it corresponded to a period of acceleration in national productivity growth (chapter 2);
- it covers a range of industry sectors which, as demonstrated in chapter 2 have shown significant variation in the uptake of ICTs and productivity growth; and
- it provides information enabling the investigation of the influence of lags and firm characteristics, including some that are considered complementary to ICT.

Another data source is the (Australian) Business Use of Information Technology Survey (BUIIT). This survey was first conducted in 1993-94 with 2000-01 being the latest year for which data are available. While this survey does not collect information on business performance or innovational and organisational characteristics of firms, it spans a longer period and thus

¹⁸ This chapter and chapter 4 refer to the broad concept of ICT. In this context, reference is made to computer use, Internet access and Web presence by firms. The growth accounting analysis presented in chapter 2 refers to IT. In that context, reference is made to investments in computers and software as defined in the Australian national accounts. Communications technologies, such as the Internet and the world-wide web and their application, are not within the scope of the IT series.

supports analysis of national trends in the uptake of ICTs to complement data available from the BLS. It also provides topical details on computer use.¹⁹

Industry sectoring in the BLS and the BUIT is based on the Australian and New Zealand Standard Industry Classification (ANZSIC). A concordance to sectoring and the industry classifications adopted in the BLS and the BIUT is provided in appendix A together with a link to the ‘market sector’ industry divisions analysed in chapter 2.

Price and quality adjusted information (particularly relevant to the analyses presented in chapter 4) is not available in unit record level data sets.²⁰ Accordingly, we use current value measures of output and book value measures of capital. In principle, this shorthand approach could result in measurement error in estimates of output, capital and labour inputs and, under certain conditions, may lead to biased results in productivity analyses based on BLS unit record data. Main concerns include:

- the prospect of offsetting pure price and quantity changes leading to the appearance of no change in activity levels where in fact there were changes;
- the decline in ICT (and other capital-good) prices giving the appearance of a decline in capital inputs when in fact there has been an increase; and
- changes in the composition of employment at the firm level leading to a change in ‘real’ labour inputs when unadjusted employment estimates suggest that there has been no change (a problem shared with a wide range of micro and macro analyses).

Baily, Hulten and Campbell (1992) find that estimates of productivity dispersion and evolution amongst firms were not sensitive to the choice of crude book value and theoretical measures of capital inputs. Also, in periods of low product-price inflation as occurred during the 1990s, the predominant reason for relative price increases (or slower declines, in the case of ICT hardware) amongst firms may well be due to quality improvement and as such would be properly reflected in volumetric measures of inputs and outputs (Brynjolfsson and Hitt 2000 and Hempell 2002).

While, in principle, unit record data sets have limitations for productivity analyses, practical considerations suggest that they should be useful for productivity analyses.

¹⁹ To complement the analysis based on the BLS, the ABS is linking at a unit record level, business use of ICT information from the BUIT with business performance data from the ABS Economic Activity Survey (EAS) or where necessary a Business Income Tax data set provided to the ABS by the Australian Taxation Office (ATO). The reference year for the linked data set is 1999-00. As mentioned in chapter 1, the intention is to present analyses from this new data set in later reports from this project.

²⁰ For productivity measurement, outputs and inputs should be measured in volumetric terms. For traditional productivity analyses at the national and sectoral level, such volumetric measures are typically estimated by the application of ‘quality adjusted’ price indexes to observed current-value

estimates of outputs and inputs, that is: $Y_t = \frac{P_{Y,t-1}}{P_{Y,t}} Y_t^{\$}$ and $K_t = \frac{P_{K,t-1}}{P_{K,t}} K_t^{\$}$ for output and capital

inputs, respectively (see also chapter 2). Labour inputs are also required in volumetric units. For national and sectoral analyses in Australia, hours worked is preferred to persons employed as a measure of labour inputs.

Box 3.1 **Background of Australian Business Longitudinal Survey as it relates to the analysis of ICT, productivity and growth at the firm level**

The BLS was conducted by the ABS to establish a data set for the analysis of the growth and performance of small to medium-size enterprises in Australia. A primary aim of the BLS was to gather detailed firm-level information on growing businesses with an innovation and export focus. The BLS was conducted over the financial years 1994-95 to 1997-98. In the 1994-95 phase of the survey, around 9000 live responses were collected. In later phases and after further stratification of firms, between 5000 and 6000 live responses were collected. A panel of over 4000 firms operated for all four years of the survey.

Although not part of the original design, questions on ICT use were introduced in the 1996-97 phase of the survey in recognition of the growing importance of ICT use to firm operation and performance.

The BLS:

- survey period — 1994-95 to 1997-98 — coincides with a period of substantial take-up of ICT and productivity growth in the Australian economy;
- provides information obtained in the 1996-97 collection on the duration of computer usage (in terms of years of use), business use of computers in selected functions (eg electronic stock monitoring, purchasing and selling) and the intensity of use (in terms of the number of employees using computers per week). It also provides information on Internet use for the reference years 1996-97 and 1997-98;
- provides a comprehensive range of information across all survey years on firm performance, involvement in exporting, product innovation, business practices, business restructuring and reorganisation and training;
- provides information on employment in firms, industrial relations and manager qualifications;
- provides information on total business capital (although separate details on the components of capital (including ICT software and hardware) were not collected);
- provides information on firm entry and exit; and
- covers firms in 11 industry sectors. In addition, the manufacturing industry sector is disaggregated into 9 industry subdivisions. Analysis using BLS data in this study has focused on 8 of the 11 industry sectors (appendix A).

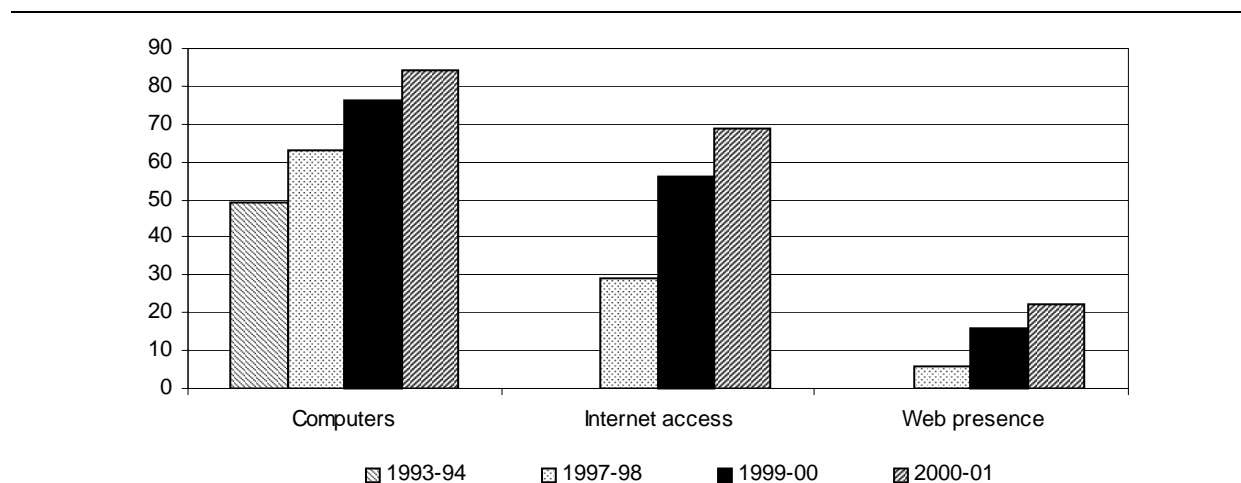
Details of information provided in the BLS are published in ABS, *Business Longitudinal Survey: Confidentialised Unit Record File 1994-95 to 1997-98* (Cat. no. 8141.0.30.001), ABS, Canberra released in June 2000. A detailed description of features of the BLS is provided in Will and Wilson (2001).

3.2 Take up of ICTs

Time series data from the BUIT survey indicate rapid diffusion of the use of ICT technologies among businesses during the 1990s. The uptake of ICTs covered the majority of businesses by the financial year 2000-01 when over 80 per cent of Australian businesses used computers, up from about one half only seven years before (figure 3.1). Whilst computer use to date has been more widespread than Internet access and a Web presence, take-up of these computer-based communications technologies has been rapid and is catching up with computer use.

Figure 3.1 Australian businesses using ICT^{a,b,c}

Per cent



^a All employing businesses in Australia except businesses in Agriculture, forestry & fishing and general government and like activities. ^b Information technology refers to services and technologies which enable information to be accessed, stored, processed, transformed, manipulated and disseminated. ^c Data on Internet access and Web presence were not collected in 1993-94.

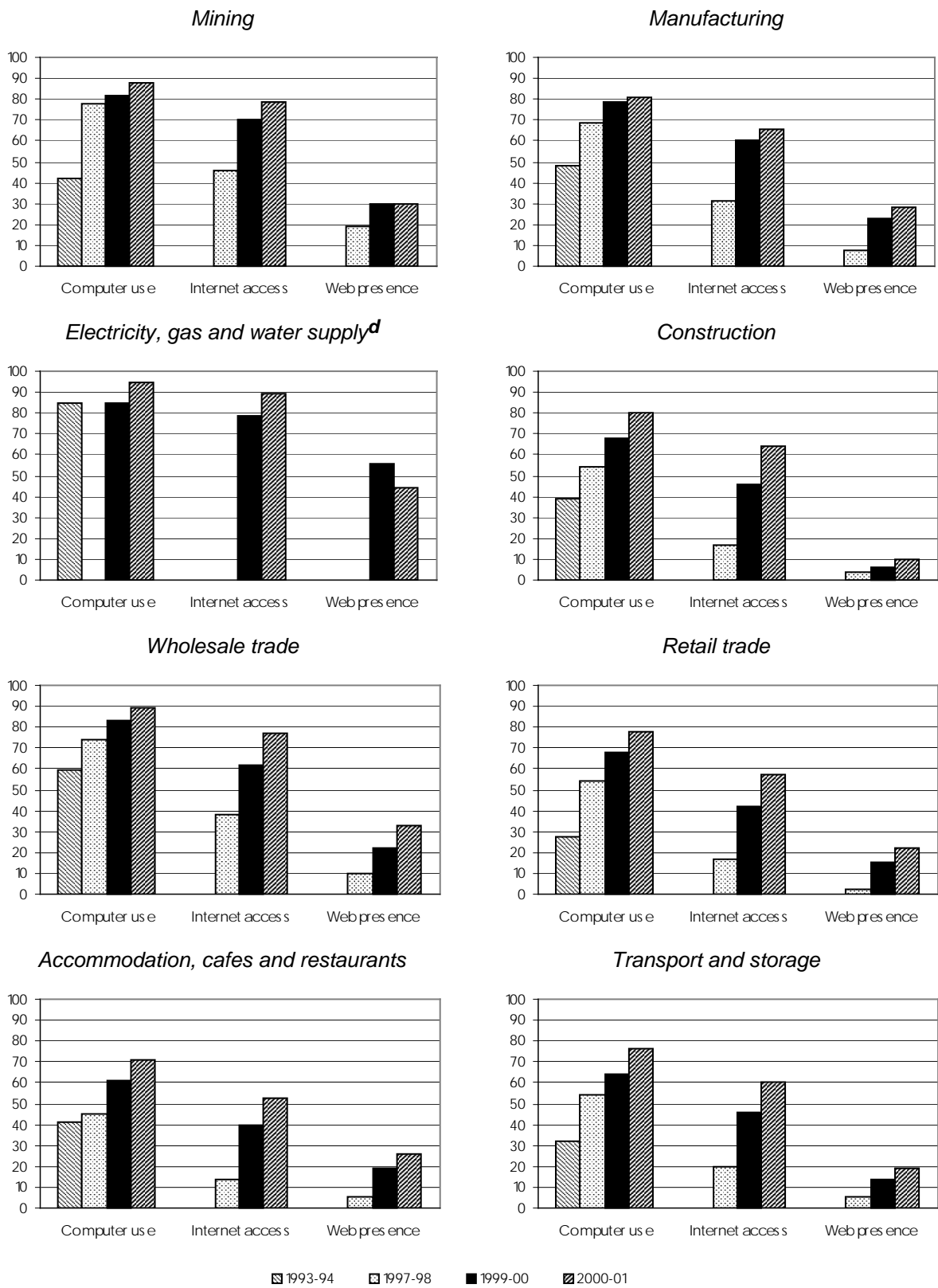
Source: ABS (Business Use of Information Technology, Australia, 2000-01, Cat. no. 8129.0).

More than two thirds of firms in all BUIT industry sectors were using computers by 2000-01 (figure 3.2). For a number of sectors, there was a substantial increase in computer use over the four-year period 1993-94 to 1997-98 and further increases to 2000-01. For example, around 30 per cent of firms in Retail trade reported using computers in 1993-94. By 1997-98 this proportion had risen to over 50 per cent of firms and by 2000-01 it had risen again to nearly 80 per cent of retail businesses. For other industries, the majority of firms reported using computers by 1993-94. For example, over 70 per cent of firms in the Property & business services and Finance & insurance sectors reported using computers by 1993-94 with this proportion rising to 90 per cent or more by 2000-01.

Firms reporting that they had Internet access increased dramatically for all sectors over the last few years so that by 2000-01 the majority of businesses in each sector reported having access to the Internet. Between 20 and 30 per cent of firms in most sectors also reported having a Web presence by 2000-01. For most sectors, BUIT data suggest that the incidence of firms with a Web presence is on the increase, particularly if take up follows trends established for the spread of computer use and Internet access. However, BUIT data also suggest that this is not the case for all sectors. For example, in Mining the proportion of firms with a Web presence remained around the same level between 1999-00 and 2000-01 while for the Electricity, gas & water supply sectors the proportion of firms with a Web presence was estimated to have declined.

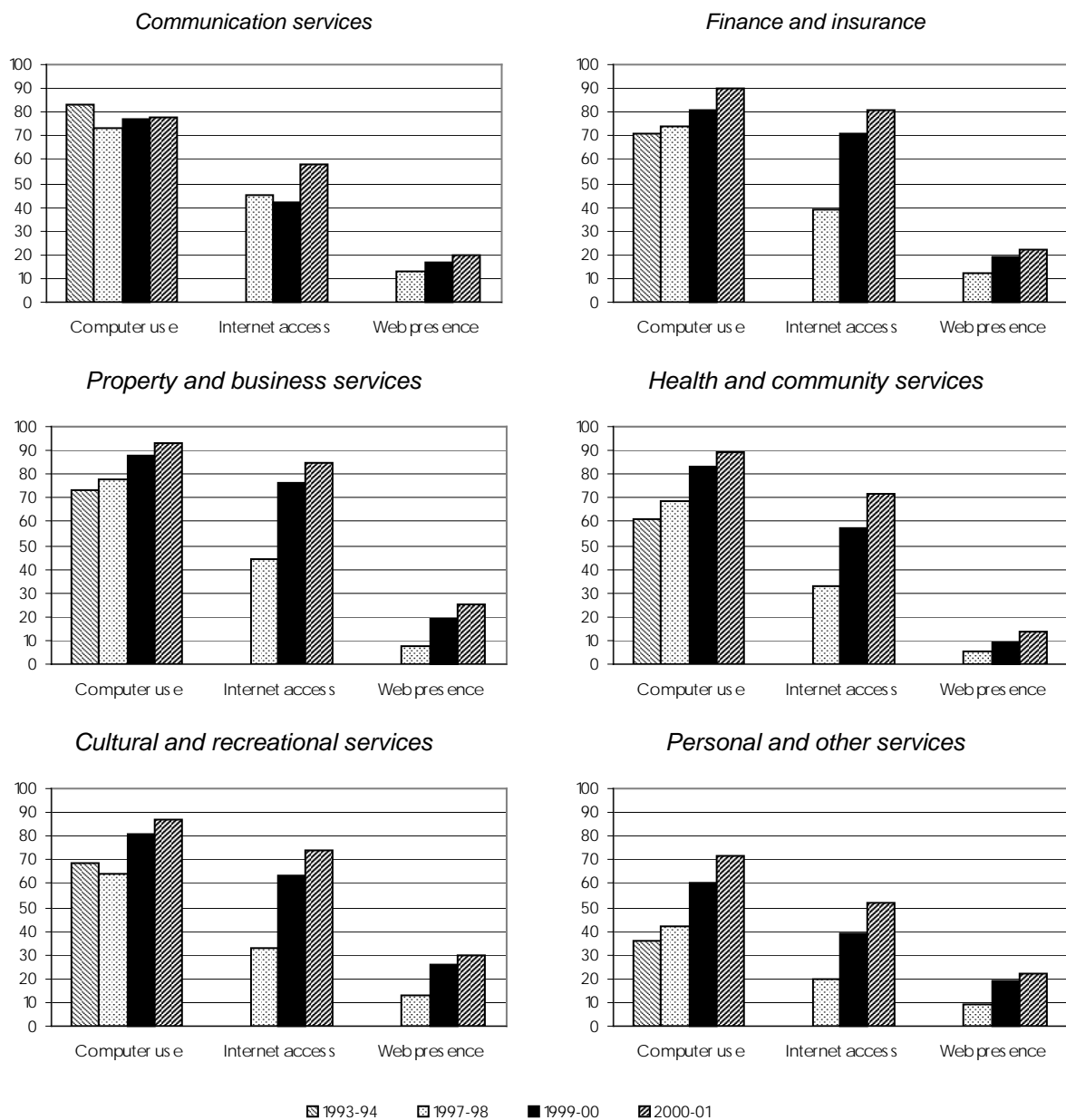
In summary, use of computers is now widespread in all industries. At this stage, Internet access and the establishment of a Web presence is not as widespread and more variation across industries is evident.

Figure 3.2 Australian businesses using ICT by industry^{a,b,c}
Per cent



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Figure 3.2 (continued)



a,b,c For footnotes, see table 3.1. d Data not published for 1997-98.

Source: ABS (Business Use of Information Technology, Australia, 2000-01, Cat. no. 8129.0).

3.3 General characteristics of firms using ICTs

Cross sectional information from the 1996-97 BLS collection is used in this section to outline key characteristics of firms using ICTs in 10 industry sectors (appendix A). The year 1996-97, when around 60 per cent of firms used computers, lies in the middle of the take-up period considered above.

Studies from a number of countries suggest that the take up of advanced technologies such as ICTs increases with firm size. While there is an issue concerning the direction of causality, that is, whether large firms have more to gain from advanced technologies or whether adoption of advanced technologies enable firms to grow in size, Australian data appear to confirm the broad

relation that advanced technologies in the form of ICT are more prevalent and were adopted earlier amongst large firms (figures 3.3 and 3.4).

BLS data suggest that by 1996-97 nearly all medium to large firms (ie firms employing 50 persons or more) used computers (figure 3.3). However, the use of computers by 'smaller' firms in terms of employment (ie with employment of up to 50 persons) varied substantially across sectors. For example, over 70 per cent of small firms in the Wholesale trade, Finance & insurance, Property & business services and Cultural & recreational services were computer users by this time. On the other hand, only around 40 per cent of small firms in the Retail, Accommodation etc and Transport & storage sectors were computer users.

There was substantial variation across firms of different sizes in terms of Internet access and a Web presence. While the average rate of connection was around one third for Internet access and less than 10 per cent for a Web presence in the mid-1990s, BLS data suggest that more than half of the larger firms had Internet access with a somewhat lower proportion with a Web presence. There was a marked tailing off in the take up of these facilities with decline in firm size.

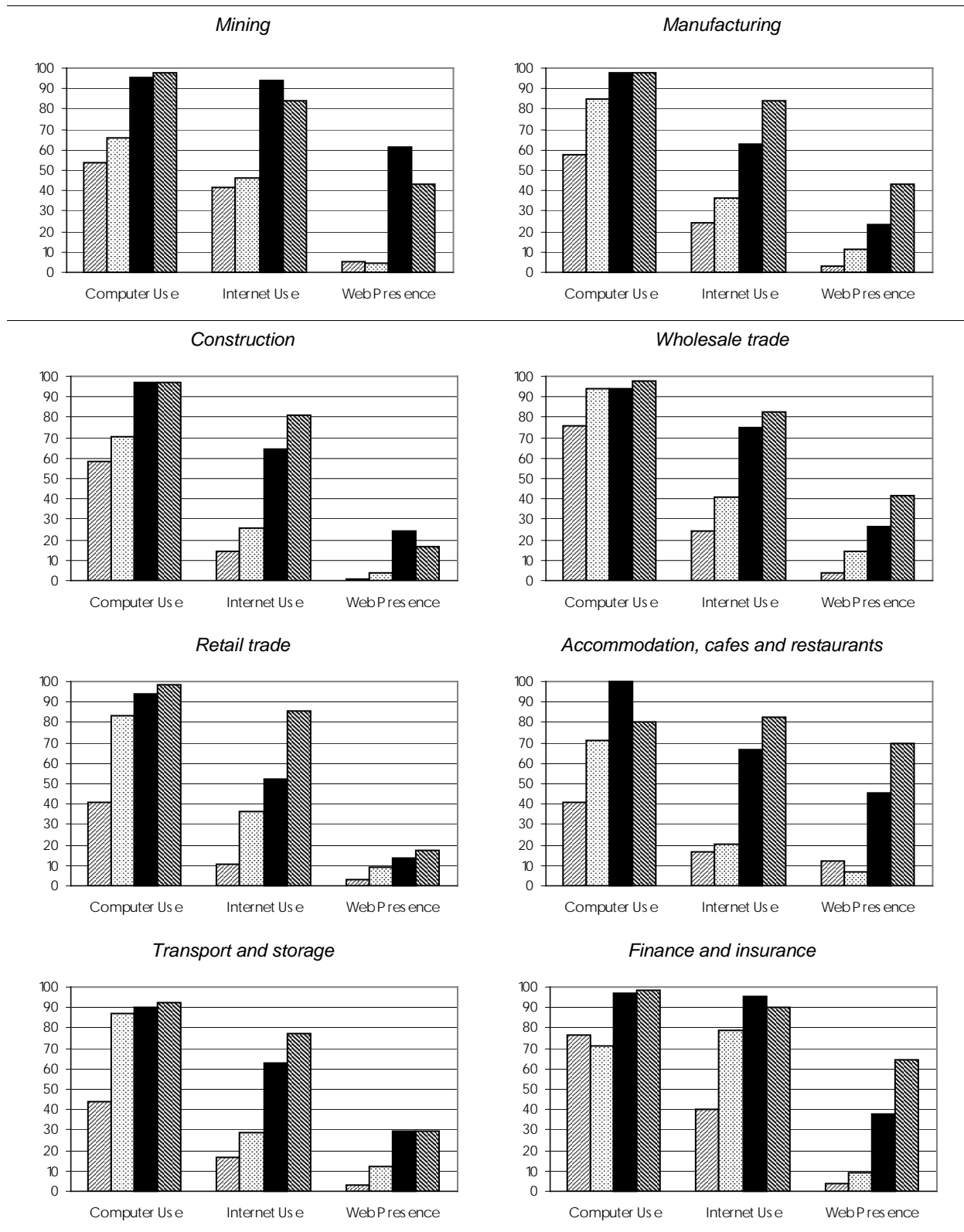
When the data about computer use are cross classified by firm size and duration of use of computers, it is also evident that larger firms tended to adopt computers earlier than smaller firms (figure 3.4).

Another basic firm characteristic is firm age. On the one hand, it may be suggested that more experienced older firms are more able to recognise and take up new technological opportunities while younger firms may face credit and other constraints that inhibit adoption of new business practices. On the other hand, new firms may bring new and more technologically advanced ways of working to an industry which would have favoured the early and more intensive adoption of ICT.

Information for 1996-97 has been used to divide firms into three age groups — less than 5 years old, 5 to 20 years and 20 or more years. This information suggests that at a broad level there was not a lot of difference in computer use between firms of different ages (figure 3.5). That said, there is a tendency for computer use to have been more widespread amongst 'younger' firms in the Mining, Construction, Retail trade and Property & business service sectors but to have been more widespread amongst older firms in Manufacturing, Transport & storage, Finance & insurance and Cultural & recreational services sectors. Also, younger firms appear to have moved towards Internet access and establishing a web presence in the Construction, Retail and Property & business services ahead of other firms.

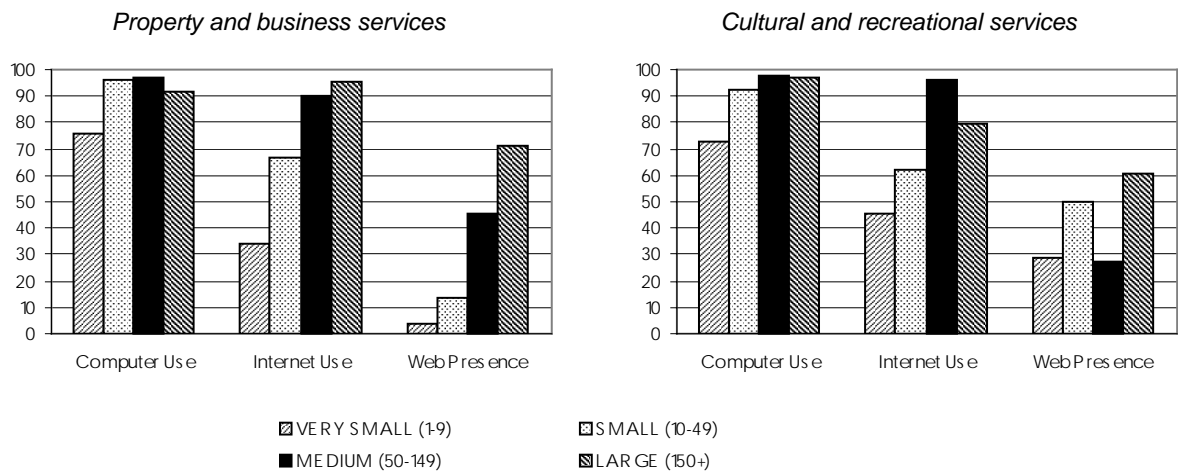
Figure 3.3 Take up of ICT by firm employment size, 1996-97

Per cent



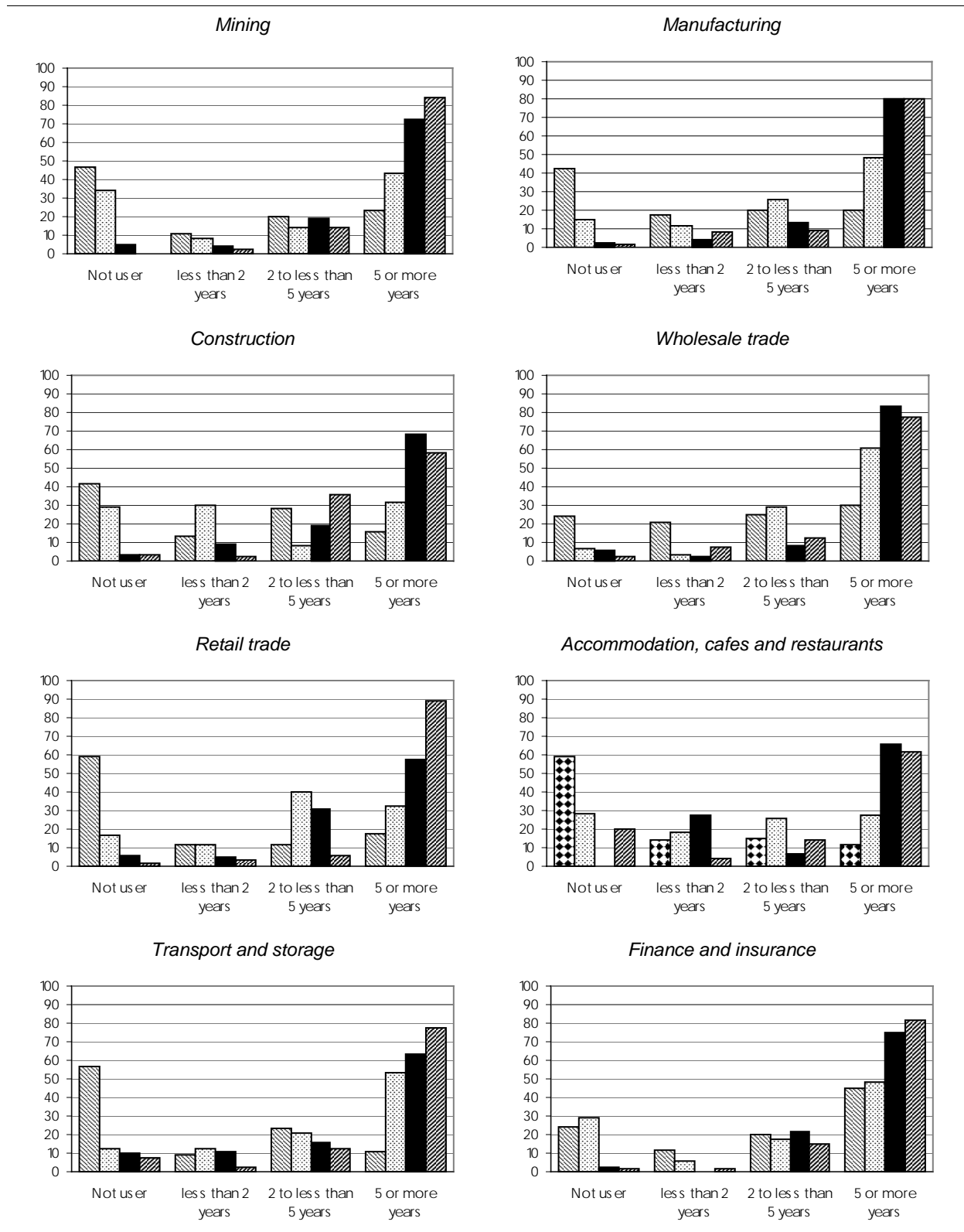
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Figure 3.3 (continued)



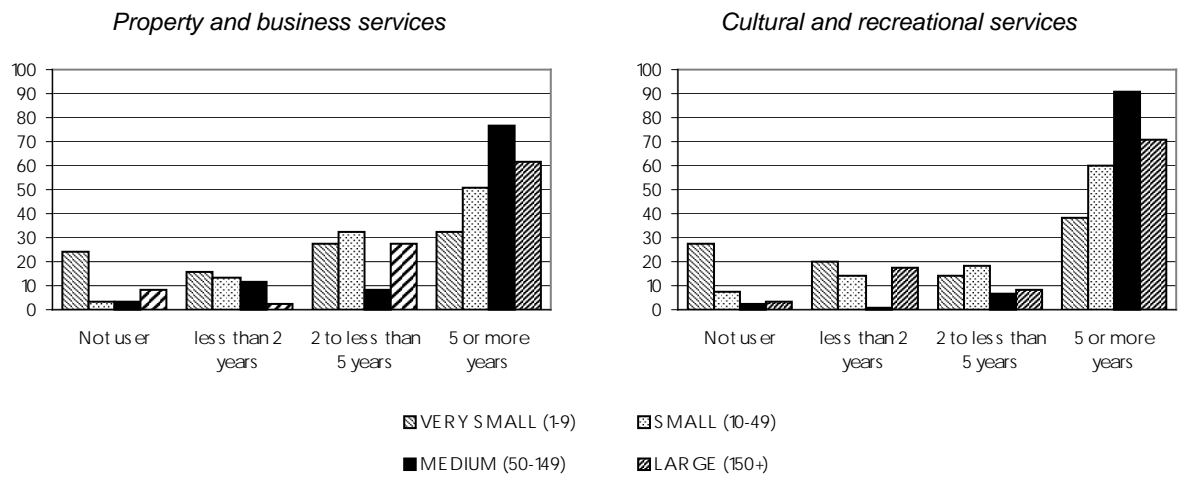
Source: ABS (*Business Longitudinal Survey, 1994-95 to 1997-98* Cat. no. 8141.0.30.001; special tabulations by the ABS based on the Main Unit Record File (MURF)).

Figure 3.4 Duration of computer use by firm employment size, 1996-97
Per cent



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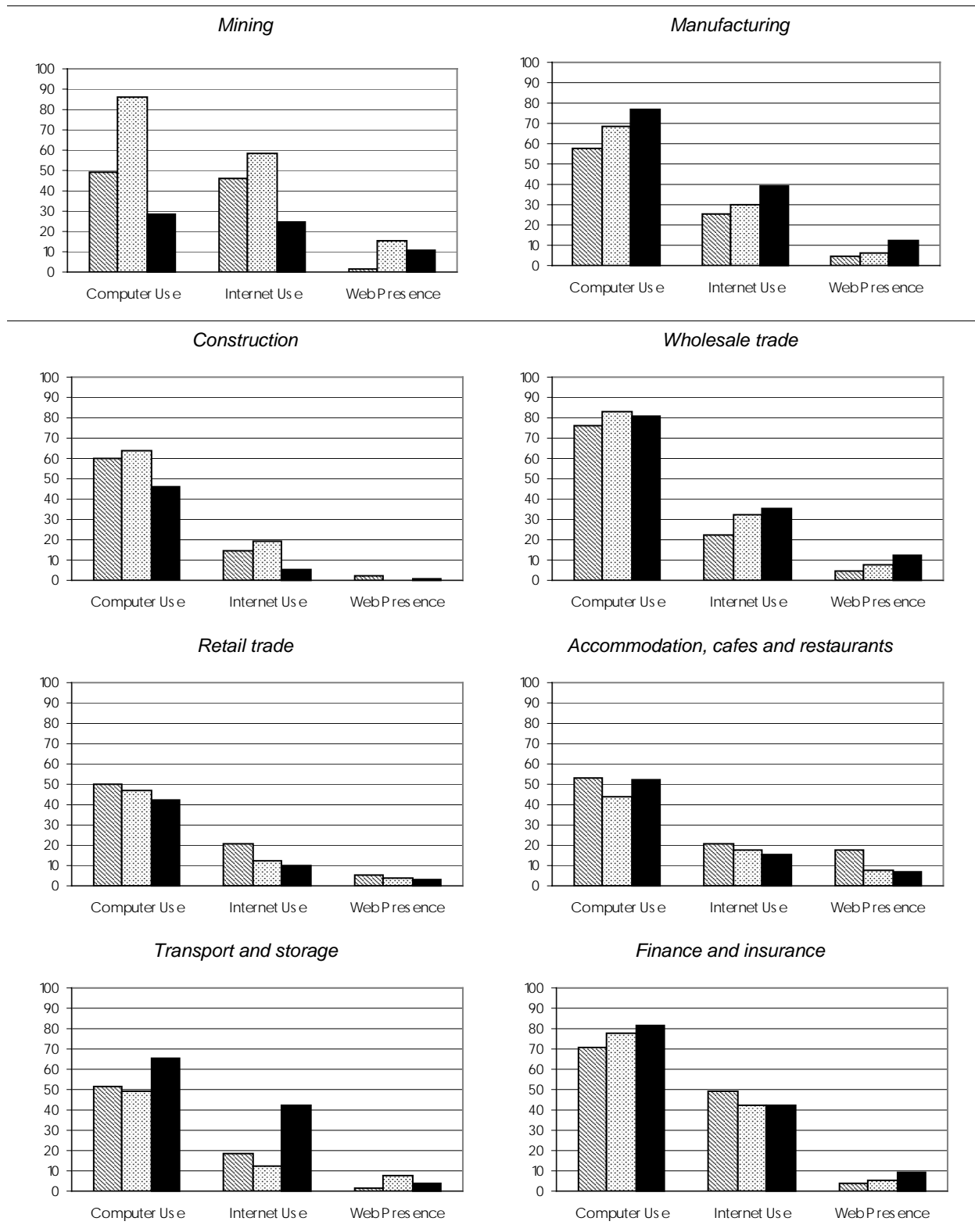
Figure 3.4 (continued)



Source: ABS (*Business Longitudinal Survey, 1994-95 to 1997-98* Cat. no. 8141.0.30.001; special tabulations by the ABS based on the Main Unit Record File (MURF)).

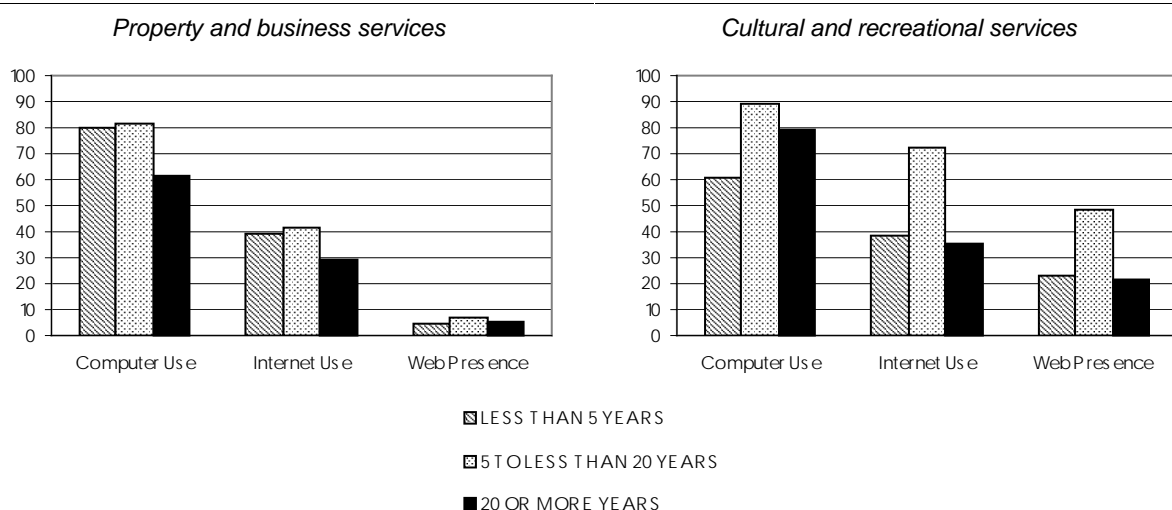
Figure 3.5 Take up of ICT by firm age, 1996-97

Per cent



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Figure 3.5 (continued)



Source: ABS (*Business Longitudinal Survey, 1994-95 to 1997-98* Cat. no. 8141.0.30.001; special tabulations by the ABS based on the Main Unit Record File (MURF)).

3.4 Analysis of factors influencing the use of ICTs

Overview of methodology

This section formally examines the characteristics of firms:

- using computers against firms not using computers; and
- with Internet access against firms without Internet access.

To do this, binary choice (ie logit and probit) models were used in which the dependent variable is an index indicating whether a firm used ICT or not. The data for the analysis of computer use were drawn from all of the four BLS years in pooled regressions. Data for the analysis of Internet access were drawn from pooled data for the two BLS years 1996-97 and 1997-98. The pooled regressions enabled the inclusion of time-related effects on the spread of ICT technologies across firms in addition to cross section information on firm-specific factors drawn from the BLS.^{21,22}

²¹ The pooled regression analysis is based on two important assumptions. First, it was assumed that the use of ICTs in each year was an independent decision unrelated to their behaviour in other years. Second, it was assumed that any unobserved firm-specific effects were uncorrelated with the error of estimates.

²² Consideration was given to the use of logit and probit panel data techniques. However, they were not taken up for this study as they appeared to provide unlikely results (in the case of probit random effects models) or did not reliably reach a solution (in the case of logit fixed effect models). A possible reason for such outcomes was attributed to the likely high level of correlation between observed firm-specific characteristics across time. By assuming that variability is primarily between firms and that errors are independent of unobserved firm-specific effects the pooled cross-sectional estimator did not encounter such problems.

The independent, or explanatory variables, upon which ICT use was considered to be conditional include firm size and firm age examined above, and a range of other firm-specific characteristics. The approach adopted has been to include, as far as practicable, characteristics suggested by the literature as increasing the likelihood of firms adopting and using ICTs early and using them more intensively than other firms.²³ Groupings of characteristics and a rationale for their inclusion in the analysis are outlined in table 3.1 while a detailed list of BLS variables under each category is provided in appendix B.

The regression analysis on the characteristics of firms using ICTs in this chapter and on the productivity implications of ICTs on chapter 4 cover BLS eight industry sectors: Manufacturing; Construction; Wholesale trade; Retail trade; Accommodation, cafes & restaurants; Transport & storage; Property & business services; and Cultural & recreational services. It does not cover the Mining sector of the Finance & insurance sector because of the lumpiness of changes in a small number of large firms comprising Mining and the lack of information to define firm value added in Finance & insurance.

²³ The approach adopted allows computer use to be reversible. Another approach would be to treat the uptake of ICTs as a one way process in which take up is seldom reversed. For example, Hollenstein (2002) based his analysis of the adoption of ICT on the assumption that "... potential users of new technology differ from each other in important dimensions so that some firms obtain a greater return from new technology than others do. The larger the net advantage resulting from the technology adoption, the stronger the tendency to adopt early and intensively".

Table 3.1 Firm-characteristic groups

<i>Group</i>	<i>Rational</i>
Balance panel indicator	A flag to identify which firms operated in each year for which the BLS was conducted for inclusion in regression analysis
Time dummies	Allow for the diffusion of ICTs over time on account of declining relative prices, information spillovers and network externalities between firms (Geroski 2000)
Absorptive capacity	Allow for potential economies of scale and scope arising from size, multiple locations and type of legal organisation, and the impact of experience through firm age (Karkenas and Stoneman 1995) vs the lower adjustment costs for young firms (Dunne 1994)
Financial conditions	Allow for the possibility of liquidity constraints to the take up and use of ICTs (Hollenstein 2002)
Human capital	Allow for firms ability to assess technological opportunities and put new technologies into practice (Cohen and Levinthal 1989, Hollenstein 2000), and learning effects from the adoption of new technology (Colombo and Mosconi 1995, McWilliams and Zilberman 1996 and Arvanitis and Hollenstein 2001)
Information and knowledge	Allow for the effects of advanced business practices — formal business planning, budget forecasting, regular reporting, firm comparisons, export marketing — on the propensity to recognise and take up new technologies
Organisational and management conditions	Allow institutional conditions (such as union membership) to be linked to use of new technologies
Organisational change and processing efficiency	Allow for links between the implementation of organisational change and the use of new general purpose/productivity improving technologies (Ichniowski et al. 1997 and Black and Lynch 2001)
Product innovation	Allow for the possibility that innovative firms are more successful and are likely to use new technologies as inputs to the innovation process, ahead of general market supply functions (Loundes 2002)
Openness	Allow for the possibility that openness, as measured by export intensity, increases market competition and motivates firms to rapid technological adoption (eg Majumdar and Venkataraman 1993)
Sample bias	Allow for the possibility that the BLS sample design unintentionally was biased either toward or away from firms using ICT, after controlling for other factors

Computer use

The first regression analysis investigated the characteristics of firms using computers using pooled-cross section data for the years 1994-95 to 1997-98. Results are presented in table 3.2 for eight market sector industries.

A key finding is that for each sector, the time dummy variables were positive and significant reflecting the influence of the declining relative prices of ICTs (chapter 2) and spillovers between firms. In addition, the analysis indicates that there were a number of firm-specific factors positively and significantly associated with the use of computers.

- Firm size (*_totfte*) indicated by employment levels (measured as a full time equivalent) is positively related to the use of computers for all sectors. This finding reinforces the descriptive analysis above centred on figure 3.3 and suggests that significant economies arise from the use of computer technologies by large firms, once account has been taken of firm-specific financial and skill characteristics included separately.
- The level of educational qualification of the major decision maker (*educatn*) is positively and significantly related to computer use for six of the eight sectors, the exceptions being Wholesale trade and Property & business services. This suggests that higher levels of human capital of lead managers is individually important to the adoption of technologies.
- The average wage of employees (*wagerate*), a measure of the human capital across all workers in a sector is also positively and significantly related to computer use in six sectors. Notably, it is relevant for the Wholesale and Property & business services sectors, suggesting that human capital within the workforce of these sectors may, on balance, be a more important variable than the skill level of management alone. By contrast, variability in the skill levels of managers appears more important for the Retail and Construction sectors. For Manufacturing and Cultural & recreational services (the remaining two sectors) human capital of the managers and workforce are both identified as important.
- The intensity with which advanced business practices (*_buspract*) such as business planning, budget forecasting and inter-firm comparisons (see appendix B) are used by firms is positively and significantly related to the use of computers in each sector. This result can be interpreted in different ways. On one hand, it could point to the importance of how businesses are managed as a factor determining the uptake and use of new technologies. It could also point to the possibility that ICTs introduce to firms information handling capabilities that enable them to use a wider range of advanced business practices than otherwise.
- Being an incorporated company is positively and significantly related to the use of computers for 5 sectors. This suggests that the additional complexity and statutory reporting requirements associated with incorporation is individually important in decisions to use computers. The sectors in which variability of other factors is dominant are Construction, Accommodation etc and Cultural & recreational services.
- At least one of the variables representing firm reorganisation (*_busrest* and *restd1*) is positively and significantly related to computer use in all sectors, except Cultural & recreational services. Of the two variables, the strength of restructuring (*_busrest*) based on an index of 11 within period possibilities (such as changes in range of products and services, advertising, technical and on the job training, and business structure, see appendix B) is significant in seven industries. The flag (*restd1*) indicating whether firms restructured in any one of the four survey years is significant in four cases. These results provide support for the view that the take up of new technologies is led by firms with a capacity for restructuring — with the greater the capacity for change increasing the probability of computer use. Two

directions of causality in relation to ICT use may be considered. First, a propensity to restructure leads to computer use to support change or alternatively the adoption of ICT involves other organisational changes.

For some other variables noted in the literature, a mixed relation with computer use was indicated by the regression analysis.

- After controlling for firm age and size, the number of business locations (*_buslocs*) is positively related to computer use for a number of sectors but negatively related for Transport & storage. A possible explanation for this result is that transport networks adopting computer technology as a means of coordination are recognised in statistics as ‘single locations’ even though their operations may span a wide geographic area.
- After controlling for other factors, whether firms undertook product innovation (involving new or substantially changed goods and services) in any year (*innod1*) and the frequency of innovation during the four-year period (*innofreq*) has a mixed relation with computer use. This result is somewhat at odds with the view that there is an important and widespread positive link between the use of ICT and the ability of a firm to ‘innovate’. It may signify the possibility: that the takeup and use of advanced technologies may be more directly associated with ‘input’ (or process) innovation such as adoption of new business strategies, business processes and organisational structures (covered by other explanatory variables); or that the link between ICT use and product innovation specified in the current model is only part of the story. It may also indicate lagged relationships between computer use or product innovation, or data considerations, that are not fully reflected in the model specification.

It should also be noted that the sample weight is significant and negative in five of the eight cases. These results suggest that firms with a low probability of sample selection (ie firms with the highest sample weights) were biased towards non-computer users and this bias was stronger in some sectors than others. For Cultural & recreational services the bias appears to have gone in the opposite direction. Noting that firm employment was a BLS stratification variable, the results may indicate a non-linear relationship between firm size and computer use not picked up in the linear form of firm size (*_totfte*).

Overall, large firms with more skilled managers and workforce, a greater propensity to use advanced business practices and implement organisational change were the firms most likely to have been early computer users during the uptake period of the mid-1990s. As time progressed, computer use spread fairly quickly so that by the early 2000s it was uncommon to encounter firms not using computers (figures 3.1 and 3.2).

Internet access

The second regression analysis investigated the characteristics of firms with Internet access using pooled-cross section data for firms with computers for the years 1996-97 to 1997-98. There was not sufficient information on Internet access in the BLS to include data for 1994-95 and 1995-96 in the analysis. Results are presented in table 3.3 for eight industry sectors.²⁴

²⁴ In contrast to computer use, there was a substantial mix of firms with and without Internet access during the survey period (figures 3.1 and 3.2). This additional variability provides some basis for testing the accuracy of the statistical models in distinguishing between firms that have Internet access and those that do not. The diagnostics at the foot of table 3.6 indicate that on average, the model correctly predicted the Internet access status of organisations with computers in around 3 out of every 4 observations. This level of accuracy is well above the chance of randomly selecting an Internet user which ranged from 14 per cent for Accommodation etc services to around 60 per cent for Property &

Restricting the analysis to firms already using computers presupposes that establishing Internet access was conditional on a firm already having taken up computer technologies and can be modelled as being independent of the decision to use computers in the business. It therefore does not address possible simultaneous relationships whereby a firm acquires computers to establish Internet access. However, the specification of the analysis would be consistent with the view that the use of computers leads to 'input innovation' which in this case is the communication services provided by Internet access.

Again a key finding is that for each sector (except Accommodation etc.), the progression of time, after controlling for other influences, was important for the spread of business communication via the Internet. This is indicated by the positive and significant coefficient on the time dummy (*tdum98*). Spillovers occurring between firms are likely to be a contributing factor to the take-up of Internet communications, in this context.

Concerning other factors considered, Internet access is positively and significantly related to:

- human capital of firms represented by the education of the main decision maker (*educatn*) and average wages (*wagerate*);
- information and knowledge of the firm as represented by use of advance business practices (*_busprac*);
- measures to improve firm organisation and processing efficiency represented by the intensity of restructuring (*_busrest*) and the presence of restructuring in a survey year (*restd1*); and
- the degree of openness indicated by the intensity of exporting (*_expint*). This result would indicate that the Internet has significant advantages over traditional media for communications, searches and perhaps transactions over long distances and between countries. The result contrasts with mixed results concerning the relation between computer use and export intensity which suggest that computer use alone is not important to exporting.

Overall, as with computer usage, BLS data suggest that larger firms with more skilled managers and workforce, a greater propensity to used advanced business practices and implement organisational change were the firms most likely to have been found to adopt Internet communications earlier than other firms. Openness to international trade was also important.

These results taken from experience in the mid to late 1990s have some commonality with other research findings that have recently come to light. For example, Loundes (2002) reported evidence from a *Melbourne Institute Business Survey* of 281 top Australian enterprises (in terms of revenue) from a range of industries including Manufacturing, Electricity, gas & water supply, Wholesale and Retail trade, and Transport & storage. The survey showed that:

- there was little benefit to firms from the Internet unless its use was incorporated into an overall strategy;
- manufacturing firms were more likely to use the Internet for coordination of delivery arrangements whereas firms in services were more likely to use the Internet to forge closer links with customers;
- organisations that were strong in at least one nominated competitive strategy (ie 'operational excellence', 'customer intimacy' and 'product leadership') were more likely to use the Internet than other firms;
- management style made a difference with 'bold' organisations (eg firms that favoured higher risk projects and taking a more aggressive attitude towards change by new products or

business services. The models, although not based on an integrated theory relating to the take up of new technologies, appear to be a relevant method for identifying the characteristics of firms using ICTs.

research and development) were more likely to make extensive use of Internet features than other firms; and

- process and product innovative organisations were more likely to extensively use Internet features than others.

These results reinforce the findings of this study which emphasise adoption of advanced business practices and organisational change as important factors influencing the likelihood of firms having access to the Internet. They also reinforce the link between openness and Internet access for some sectors. The emphasis in Loundes on the link between process and product innovation and Internet access is also evident in the current study. Although as noted above, the link between product innovation and Internet access is evident for some sectors but not others in the current study.

Table 3.2 **Characteristics of firms using computers, 1994-95 to 1997-98a**

Pooled cross-section regression, unweighted estimates

Characteristic	Mnemonic	Expected sign	Manufacturing	Construction	Wholesale trade	Retail trade	Accom., rest's	Transport & storage	Property & bus. services	Cultural & rec. services	Sector summary	
											No. of positives	No. of negatives
Dummy 1996	TDUM96	+	+***	+***	+***	+***	+	+**	+**	+*	8	
Dummy 1997	TDUM97	+	+***	+***	+***	+***	+	+**	+*	+*	8	
Dummy 1998	TDUM98	+	+***	+***	+***	+***	+	+**	+***	+***	8	
Absorptive capacity												
Employment	_TOTFTE	+	+***	+***	+***	+***	+	+***	+***	+**	8	
Business locations	_BUSLOCS	+			+	+	+	+**	+*		3	1
Older firm flag	DAGE2	+		-***	+**		-***	+**	-***	+*	3	3
Financial conditions												
Low profitability flag	DEBIT1	-		-#	+*		+***	+***	-*	+*	4	2
Human capital												
Education of decision maker	EDUCATN	+	+*		+**		+**	+**	+*	+*	6	
Tertiary qual. of decision maker	TERTQUA	+			-#		-**	-**	-#	-#	1	3
Average wage	WAGERATE	+	+***		+**		+***	+***	+*	+*	6	
Information and knowledge												
Use of advanced bus. practices	_BUSPRAC	+	+***	+*	+***	+***	+***	+***	+***	+*	8	
Organizational and management conditions												
Union membership	_UNIONME	-/+					+*				1	2
Type of legal organization	TOLO	+	+***		+**	+***	+**	+**	+*	+*	5	
Organizational and processing efficiency												
Intensity of restructuring	_BUSREST	+	+***	+***	+***	+***	+***	+**	+**	+**	7	
Restructuring flag	RESTD1	+	+***	+***	+***	+***	+**	+**	+**	+**	4	

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Table 3.2 (continued)

Characteristic	Mnemonic	Expected sign	Manufacturing	Construction	Wholesale trade	Retail trade	Accom., cafes & rest's	Transport & storage	Property & bus. services	Cultural & rec. services	Sector summary		
											No. of positives	No. of negatives	
Product innovation													
Innovation flag	INNOD1	+		-#	+#	+#	+#	+**	+**			5	1
Frequency of innovation	INNOFREQ	+	+**	+**	-#	+#	-**	-***		+#		3	3
Openness													
Export intensity	_EXPINT	+			+#	-#	-#	+#	+#			3	2
Sample bias													
Sample weight	_WGHT_F	-			-***	-***	-***	-***	-#	+#		1	5
Diagnostics													
Period	1994-95 to 1997-98												
Model	Unweighted, Logit												
Observations	No.		5340	936	2419	1164	595	596	2388	384			
Firms using computers	%		89%	71%	95%	78%	56%	75%	88%	86%		79%	
Correct predictions	%		90%	75%	95%	83%	80%	79%	89%	87%		84%	

*** coefficient significant at the 1 per cent level, ** at the 5 per cent level or * at the 10 per cent level. # coefficient relevant as indicated by a t-statistic > 1. a Firms in the BLS only in 1994-95 and firm-records with incomplete data are not included in the regression. Typically each firm is observed four times.

Source: Regression analysis based on the BLS Confidentialised Unit Record File (CURF). See ABS (Business Longitudinal Survey, 1994-95 to 1997-98, Cat. no. 8141.0.30.001).

Table 3.3 Characteristics of firms with Internet access, 1996-97 and 1997-98a

Pooled regression, unweighted estimates

Characteristic	Mnemonic	Expected sign	Manufacturing	Construction	Wholesale trade	Retail trade	Accom., cafes & rest's	Transport & storage	Property & bus. services	Cultural & rec. services	Sector summary	
											No. of positives	No. of negatives
Time												
Dummy 1998	TDUM98	+	+***	+#	**	+#		+#	**	+#	7	
Absorptive capacity												
Employment	_TOTFTE	+	+***	+**	+***	+***			+***	+***	6	
Business locations	_BUSLOCS	+	+**		-#			+#			2	1
Older firm flag	DAGE2	+	+#			+#	+#				3	
Financial conditions												
Low profitability flag	DEBIT1	-	+**		+#					+#	3	
Human capital												
Education of decision maker	EDUCATN	+	+***	+#	**		+#	+#		+#	6	
Tertiary qual. of decision maker	TERTQUA	+	-#									1
Average wage	WAGERATE	+			+#	+***			+***	**	4	
Information and knowledge												
Use of advanced bus. practices	_BUSPRAC	+	+***	+***	+***	+***	+**	+***	+***		7	
Organizational and management conditions												
Union membership	_UNIONME	-/+	-**		-#			+#	-***	-**	4	1
Type of legal organization	TOLO	+				+#	-#				1	1
Organizational and processing efficiency												
Intensity of restructuring	_BUSREST	+	+***		+#	+#	+#				4	
Restructuring flag	RESTD1	+	+#								1	

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Table 3.3 (continued)

Characteristic	Sector summary									
	Manu- factur- ing	Cons- truction	Whole- sale trade	Retail trade	Accom., cafes & rest's	Trans- port & storage	Property & bus. services	Cultural & rec. services	No. of posives	No. of neg- atives
Product innovation										
Innovation flag						+	+	+	2	
Frequency of innovation									2	1
Openness										
Export intensity									6	
Sample bias										
Sample weight									2	5
Diagnostics										
Period	1996-97 & 1997-98									
Model	Logit									
Observations	No.	2481	349	1188	668	178	233	1058	170	
Firms with internet access	%	49%	31%	56%	32%	24%	35%	66%	58%	44%
Correct predictions	%	68%	77%	67%	75%	81%	75%	73%	79%	74%
<p>*** coefficient significant at the 1 per cent level, ** at the 5 per cent level or * at the 10 per cent level. # coefficient relevant as indicated by a t-statistic > 1. ^a Firms in the BLS with incomplete data are not included in the regression. Typically each firm is observed twice.</p> <p>Source: Regression analysis based on the BLS Confidentialised Unit Record File (CURF). See ABS (<i>Business Longitudinal Survey, 1994-95 to 1997-98</i>, Cat. no. 8141.0.30.001).</p>										

Other issues

A number of other issues have been raised in the context of the ICT and firm performance study. Particular interest has been given to factors that effect higher intensity of computer use, the early adoption of ICT technologies and reasons advanced by firms for not using ICTs. Where practicable, it is intended to extend our investigations into these areas of interest in later work by reference to BLS and BUIT unit record data.

3.5 Main findings

- There was rapid diffusion of computers during the 1990s. By 2000-01 over 80 per cent of firms used computers in some way while 70 per cent had Internet access.
- In the mid-1990s, the pattern of uptake was broadly similar between sectors, with larger firms tending to have computers for the longest and non-users being concentrated amongst the smaller firms.
- The substantial growth in computer use since the mid-1990s suggests that the use of computers by smaller firms has deepened while larger firms have continued to extend their application of ICTs including through gaining Internet access and establishing a Web presence.

Information from the key mid-1990s period indicates:

- Firms that took up ICT earliest and made most intensive use of ICT tended to be the larger firms with skilled managers and workforce, a greater propensity to use advanced business practices and a record for implementing organisational change.
- There was also an important link between openness to international trade and use of technological innovations that improve communication (such as the Internet).

Lower prices, spillovers between firms and learning by doing are likely to have been important in the deepening of computer use and computer-based applications (including Internet access).