

e-Commerce adoption and business impact: a progress report

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Summary

In June 2002, a first article 'e-Commerce and business change' (Clayton and Criscuolo 2002) outlined the programme of microdata work within ONS to examine effects of e-commerce adoption on business behaviour and performance. During the second half of 2002 significant progress has been made, and the programme has developed three main lines of analysis:

- examination of technology use and e-business adoption over time;
- investigating the influence of electronic networks, and e-business use, on innovation and its contribution to business growth;
- linking data on electronic network use by firms to information on productivity, building on frameworks developed by CeRiBA¹ and on approaches developed in other countries.

This article reports progress on the first line of work and briefly reviews research under way on the second and third. The innovation and productivity studies will be reported fully in later articles.

Background

A substantial body of work has already been completed, under the Evidence Based Policy Fund programme, to examine business performance at firm level. This uses microdata collected as part of normal statistical surveys to examine the effects of specific inputs on firm performance.

Early in 2002 ONS started to assess how survey data on e-commerce activity could be used in this type of analysis. There is strong policy interest in identifying the economic impact of 'new economy' inputs, and evidence on whether – and how – the use of Information and Communication Technology (ICT) affects firm behaviour and performance.

The work programme ONS has adopted is based on reporting unit data collected using the following enterprise surveys:

- the Annual Business Inquiry, including employment, gross output and value added;
- the Community Innovation Survey, which gathers data on R&D, innovation output and innovation processes;
- the e-Commerce Inquiry to Business, which asks for information on ICT use and electronic transactions at reporting unit level.

In addition, capital expenditure surveys that include ICT investment will be used. The article 'e-Commerce and business change' (Clayton and Criscuolo 2002) reported on the feasibility of linking these surveys, and summarised preliminary evidence that:

- business level innovation and e-commerce activity by firms are related;
- firms that are e-commerce users are more likely to assess their innovations as having high positive impact on firm performance than those that are not;
- there are strong skill/educational requirements related to e-business adoption.

Focus of work in 2002

ONS has conducted its second e-commerce survey for 2001, published in stages during August – November 2002 (Prestwood 2002). Further analysis of the ONS 2000 e-commerce survey has explored in detail the adoption behaviour by business, and shows that patterns of e-commerce use vary widely across UK industry. Initial work to link 2000 to 2001 e-commerce data has revealed a high level of experimentation and change under way, which will be important to recognise when we come to look at impact on performance.

At the same time, parallel statistical work in other OECD countries², and case studies conducted for the Department of Trade and Industry (DTI) and DG Enterprise, have demonstrated some common patterns of e-commerce adoption and shared factors in the ability of businesses to capitalise on ICT benefits. Statistical evidence on these patterns is of interest to policymakers, and has helped to shape work in ONS.

Input from other studies has helped focus our analytical approach on three strands:

- tabulation of the 2000 and 2001 e-commerce surveys, to understand the relationships between technology use and adoption of electronic transactions;
- analysis of R&D, innovation and output growth, to test whether use of electronic networks can improve the return from investment in innovation;
- modelling enterprise productivity levels and changes, taking into account the use of computer networks and electronic transactions, an extension of work already carried out in the US Bureau of Census (Atrostic and Nguyen 2002).

Computer networks and e-commerce adoption

Multiple technologies

The ONS e-commerce survey was launched in 2000 and is based closely on the Eurostat model survey. It gathers data on the adoption patterns and use of ICT by UK enterprises. The 2000 survey showed that the majority of UK firms had invested in some form of 'connected' technology, and that many were using more than one technology.

Figure 1 shows the pattern of technology in use for connected firms and the relationships between older technologies, such as Intranet (internal networks within firms) and electronic data interchange (EDI, which links firms over closed transaction networks) and the more recent web technology.

Only web access shows up as a 'standalone' technology in use by a significant number of firms on its own although half of firms accessing

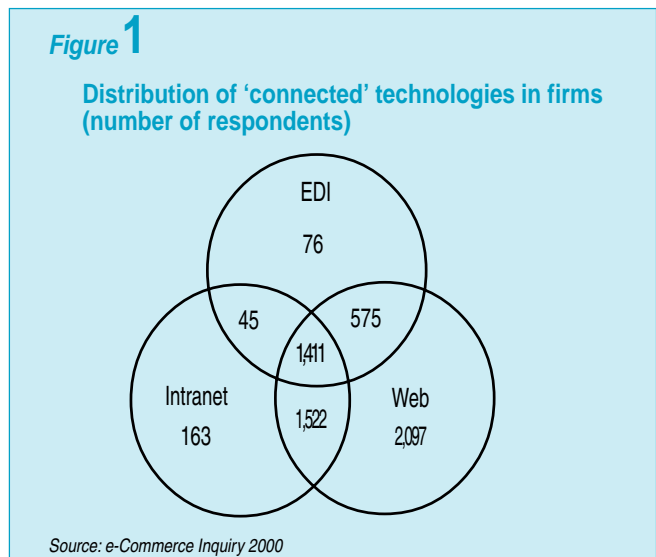
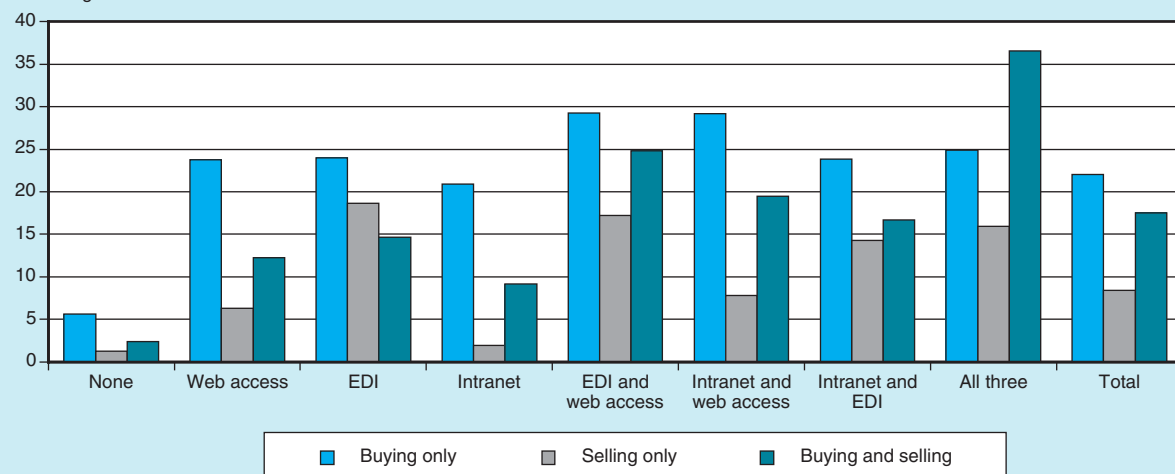


Figure 2

Technology combinations and e-commerce activity

Percentage of businesses



the web were also using intranet or EDI: 20 per cent of survey respondents, 1,411 in total, were using all three – web access, Intranet and closed links with business partners via EDI. A similar number, 1,385 or 19 per cent of respondents, had no connection at all.

Figure 2 shows that use of multiple 'connected' technologies is positively related to penetration of use of e-commerce. There are a small number of reporting businesses without any of these technologies that may engage in e-commerce via third party web sites but, for the rest, more than one channel for e-business often means a higher proportion able to undertake electronic sales. In addition, ownership of an Intranet, connecting internal processes within a firm, increases the likelihood that it will be able to buy and sell electronically.

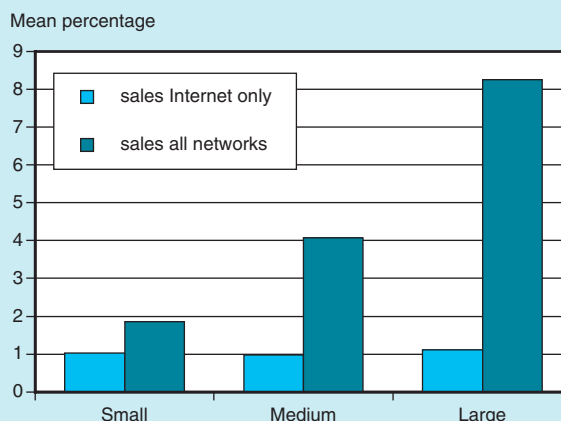
Adoption by large versus small firms

EDI predates the Internet by 20 years, but its role as a vehicle for e-commerce is still important. Almost all large firms in the 2000 e-commerce survey used some form of connected technology, often EDI, and 40 per cent of large firms were already doing so by 1997 (see Figure 3). The Internet boom of 1999/2000 drew in many more firms, but more of the 'late joiners' were small and medium-sized enterprises, under 250 employees.

As many larger firms that were ICT-enabled since the mid 1990s used electronic exchange of orders or of information over closed systems, EDI dominates measures of value of e-commerce in both 2000 and 2001. Figure 4 shows, for the year 2000, business done over the Internet and via 'all electronic networks', of which EDI is the largest element. In small firms, the proportion of business sold over the Internet is half of all electronic sales, which implies that EDI and Internet sales are roughly comparable. For large firms, Internet sales are only around 12 per

Figure 4

e-Commerce sales as percentage of turnover, by size of firm



Source: e-Commerce Inquiry 2000

cent of total network sales, with EDI and other systems accounting for the rest. This difference suggests the Internet is a point of entry to electronic trading for small firms, giving them access to e-business transactions already available to others for longer.

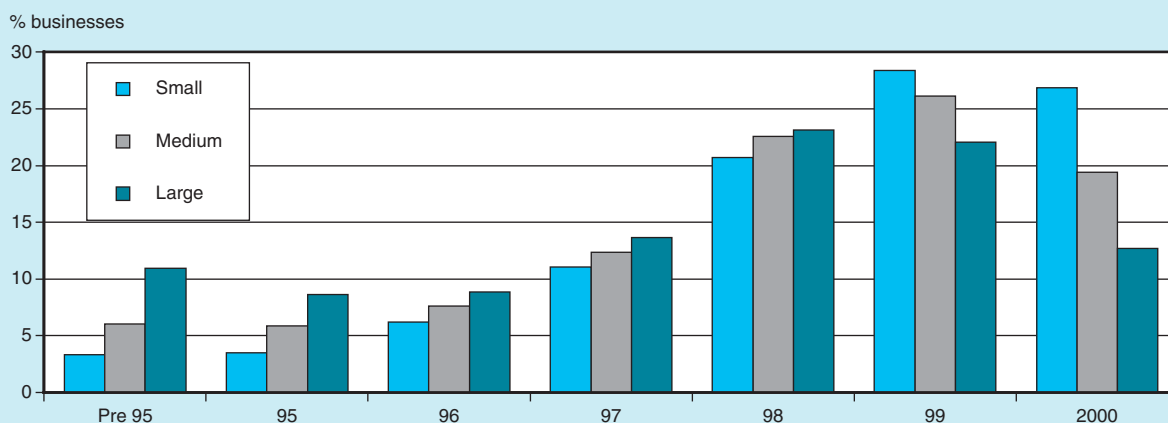
Analysis of the pattern of electronic transactions as a percentage of enterprise turnover (Figure 5) shows a similar effect. The majority of businesses for which e-commerce constitutes over 10 per cent of sales value use non-internet networks.

The 'marginal' e-traders

It is clear from the analysis in Figure 5 that a high proportion of businesses undertaking e-commerce sales in 2000 were very 'marginal', e-traders. For well over half the businesses undertaking electronic sales, this activity accounted for 1 per cent or less of their

Figure 3

Year of network technology adoption, by size of firm



Source: e-Commerce Inquiry 2000

Figure 5

Business percentage of e-commerce sales via Internet and over all electronic networks in 2000

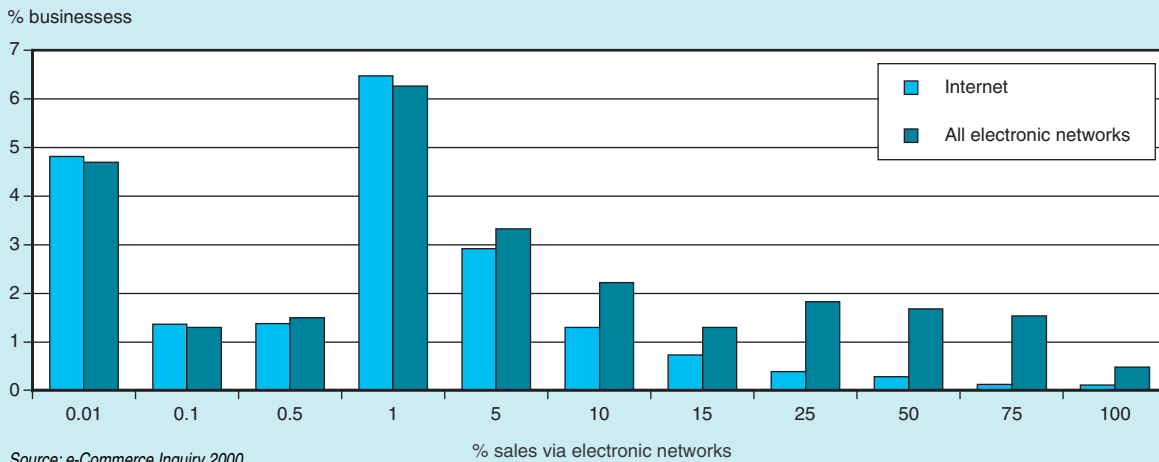
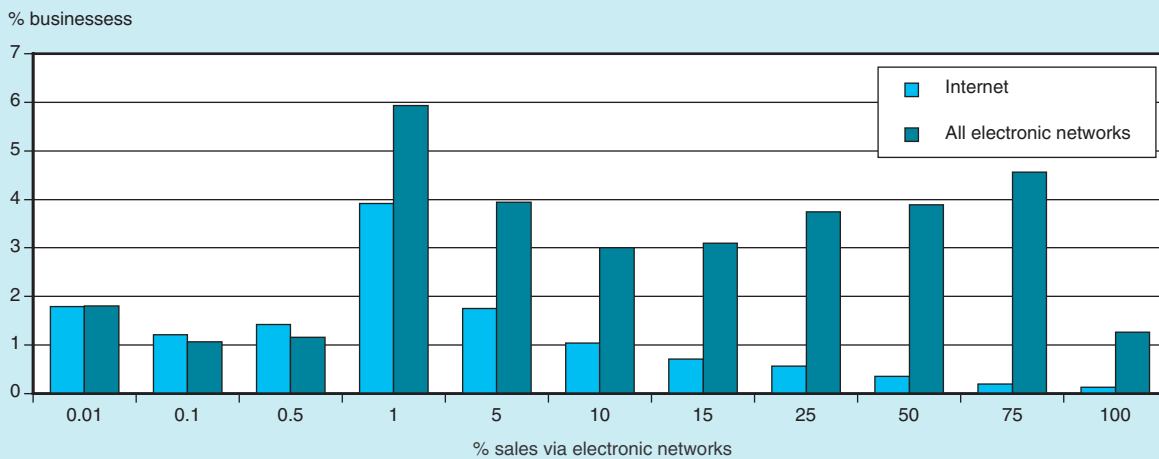


Figure 6

Business percentage of e-commerce sales via Internet and over all electronic networks in 2001



turnover. UK survey data for 2001 shows that this pattern has changed significantly. By 2001 there is a significantly higher proportion of e-traders in the 'over 1 per cent of sales' bands, and a definite reduction in the proportion of very marginal users (see Figure 6). A large part of the increase among the more intensive e-commerce businesses appears to be among users of non-Internet technologies.

Within this overall pattern of consolidation of e-commerce, and the decline in the number of 'marginal' e-sellers, there is considerable change shown by comparison of the 2000 and 2001 surveys. Of firms responding in both surveys, and that did not sell through electronic networks in 2000, 30 per cent said they had adopted some form of electronic selling by 2001. Of firms selling electronically in 2000, half had increased their proportion of e-business, and 40 per cent had either ceased electronic selling or scaled down their

dependence on it. The data shows a dynamic pattern, with experimentation and exit still widespread. This will affect the ease with which we can identify costs and benefits of e-commerce use.

Sector balance of e-purchasers and e-sellers

The sector pattern of e-commerce sales has been published in value terms in ONS releases (Prestwood 2002). It shows significant differences across sectors for values of electronic sales as a percentage of total sales, by broad SIC category. An alternative approach is to look at selling and buying behaviour, focusing on the proportion of businesses for whom e-commerce represents more than 1 per cent of sales, and the proportion for whom it represents more than 1 per cent of purchases. This gives a pointer to how e-commerce is used by sector. Table 1 shows that:

- the food, drink and tobacco sector has by far the greatest proportion of 'non-marginal' e-traders, over 40 per cent. Sales from this sector via EDI to supermarkets and wholesalers have been an established business practice for several years.
- the wholesale/retail sector has among the highest proportion of electronic purchasers (22 per cent), along with financial services (23 per cent), business services (20 per cent) and electrical / optical machinery (21 per cent).

The pattern in Table 1 seems to suggest that e-commerce involves a significant proportion of firms in sectors where the number of suppliers and/or buyers is low. This model of e-commerce is likely to be a closed system of EDI. Where customers are more fragmented and the market structure suited to the Internet, penetration appears to be slower.

This 'buyer/seller' analysis confirms that, for the majority of sectors, the proportion of 'non-marginal e-purchasers' is greater than that of 'non-marginal e-sellers'.

Benefits of e-commerce

Responses to survey questions on the benefits associated with e-commerce use show business objectives for electronic trading have changed over time. Those firms that began using computer networks or the Internet prior to 1997 are more likely to have reported their reasons for doing so in terms of very specific business benefits (see Figure 7). They report benefits including cost reduction for the firm, service quality improvement for customers, increased speed of operation and simplification of business processes. These are benefits which usually

Table 1 e-Purchasers versus e-Sellers

Selected industry sectors	Percentage of firms with more than 1 per cent e-purchases	Percentage of firms with more than 1 per cent e-sales
Higher user sectors:		
Food / drink / tobacco	12	45
<i>Paper etc</i>	16	12
Chemicals	17	19
<i>Rubber / plastic</i>	19	14
<i>Equipment / machinery</i>	18	10
<i>Electrical / optical machinery</i>	21	12
<i>Transport equipment</i>	16	12
<i>Utilities</i>	21	10
<i>Wholesale / retail</i>	22	14
<i>Hotels / catering</i>	13	11
<i>Real estate / business services</i>	20	6
<i>Transport</i>	18	12
<i>Financial services</i>	23	17
Lower user sectors		
Textiles	7	11
Leather	8	7
Non-metallic products	6	8
Metal products	10	11
<i>Manufacturing nes</i>	8	6

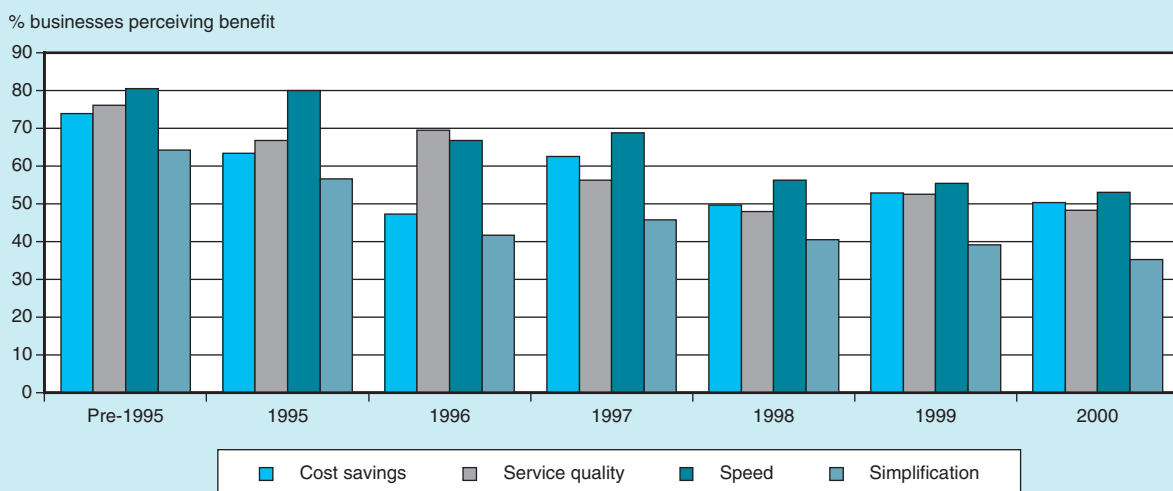
Source: e-Commerce Survey 2000
Sectors shown in italics have fewer >1 per cent e-sellers than >1 per cent e-purchasers

require electronic processes to be 'engineered in' to firms, affecting methods of work, or the way firms interact with customers.

Figure 8 shows, by way of contrast, that benefits reported by later adopters seem more related to marketing goals. The majority of these

Figure 7

Specific benefits versus first year selling over electronic networks

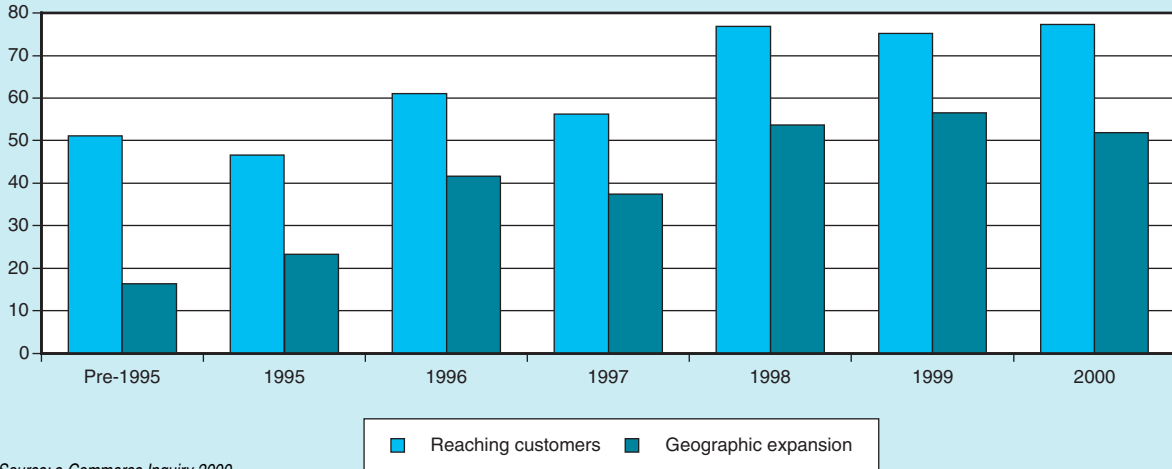


Source: e-Commerce Inquiry 2000

Figure 8

Marketing benefits versus first year selling over electronic networks

% businesses perceiving benefit



Source: e-Commerce Inquiry 2000

report their main objectives as geographic expansion or reaching customers. Often these objectives are less specific, and require less investment in business processes than cost savings, service quality, speed or process simplification. Further analysis may show whether businesses with primarily 'market reach' priorities are among the 'marginal' businesses in Figure 5 (see page 36).

Adoption rate

Most important for identifying the impact of ICT and e-commerce use for business performance is an understanding of lags involved in the adoption process. From survey responses (see Figure 9) it is possible to identify how long firms are likely to take to move from initial investment in 'connected' ICT to trading online, either as a

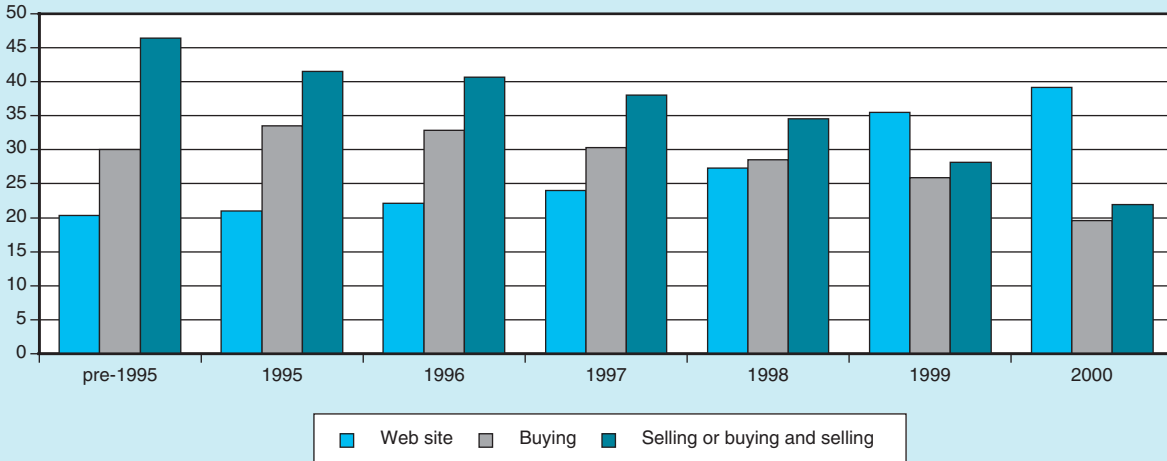
buyer or as a seller. For example those investing in the technology pre-1995 had a 46 per cent probability by 2000 of selling via e-commerce and possibly buying as well. Those investing in 2000 only had a 21 per cent probability of trading, and were nearly twice as likely to have only a marketing web site. The sharpest increase in probability of trading takes place in the first two years of adoption, which suggests a learning period for many firms to move from technology to business operations.

This result may be related to the responses on benefits to e-trading reported in Figure 7 (see page 6). The time taken to embed electronic processes to enable effective trading and secure benefits is probably measured in years rather than months. We will need to recognise this in looking for 'impact' benefits of technology.

Figure 9

e-Activity versus time with network technology

% businesses



Source: e-Commerce Inquiry 2000

ICT and e-commerce impact on business performance

Limited progress has been made on analysis of business performance. However, the research approach has been developed, and some initial results are shown here.

ICT, e-business and product innovation

Work with the Community Innovation Survey (CIS) collected in 1996 and 2000 has confirmed that innovation is related to business performance. Microdata from CIS 2000 shows that:

- businesses with higher levels of R&D spending relative to turnover in each sector also deliver more new and improved product sales relative to turnover;
- businesses maintaining higher levels of new and improved product sales relative to turnover in each sector achieve above sector average rates of sales growth, i.e. they increase market share.

The first of these relationships is similar to results derived in new research on CIS 1996 (Criscuolo and Haskel 2002).

The second is shown by our comparison below, which separates businesses surveyed in CIS 2000 into three groups:

- those reporting no new or improved products at all;
- firms which innovate, but whose proportion of new or improved output is less than the mean (excluding non-innovators) in their two-digit SIC category;
- innovators whose new or improved output equals or exceeds the mean for businesses in their SIC category (again excluding non-innovators).

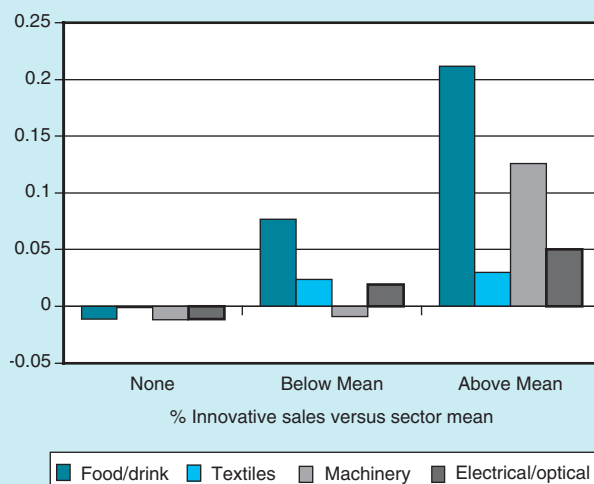
For each group we have looked at the percentage growth performance of businesses relative to the mean growth of their two-digit category – effectively relating relative innovation activity to the change in the business' share of its sector. The results are shown below, for selected broad sector groups.

For most production and service sectors, these results show that firms with no innovation grow slowest – usually slower than the sector mean. Firms with moderate innovation do better (although not in every case), and firms with the highest innovation levels increase their sales significantly faster than the sector mean. The effect is present in both manufacturing and service sectors.

Figure 10

Relative growth versus relative innovation: production

Firm growth versus sector

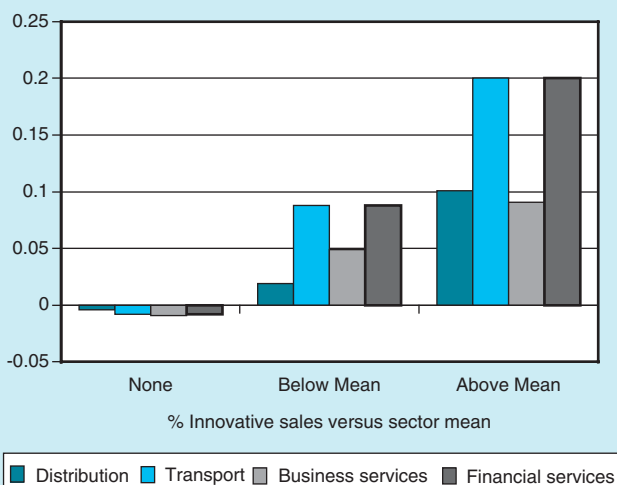


Source: Community Innovation Survey 2000

Figure 11

Relative growth versus relative innovation: services

Firm growth versus sector



Source: Community Innovation Survey 2000

These relationships provide a base from which it is possible to assess the case-based and anecdotal evidence that electronic interactions increase the benefits firms reap from innovation. Next steps are to test whether:

- e-enabled networks help to increase the speed or the amount of innovation derived for a given level of R&D spending, through more effective interaction;
- ICT and electronic transactions help to speed up or increase the sales growth effect associated with innovation, through faster access to a wider spread of markets, or through more effective targeting of customers.

If there is evidence to show either of these effects, either in general or in specific market situations, part of the value of e-commerce in promoting business growth could be quantified.

ICT, e-business and productivity

An important strand of the Criscuolo and Haskel article shows the importance of process innovation in promoting productivity gain, using data from the CIS 1996. It can be argued that the effect of introducing e-business processes into firms is a special case of process innovation, bringing changes in methods of working, cutting out unnecessary process steps and facilitating automatic control of processes.

Atrostic and Nguyen (2002) have shown using the US 1999 manufacturing census, combined with a computer network use supplementary survey, that there is a significant positive effect on productivity associated with the use of computer networks, after allowing for management and other effects. Initial work on 2000 ABI data for the UK (Criscuolo and Waldron 2003) suggests similar overall effects, but with most of the benefit of e-commerce adoption accruing to businesses that use it for procurement. These results will be presented in a subsequent paper, and extended to other years.

Future work

In 2003 the focus of this continuing work will be on identifying performance effects of ICT and e-commerce use. In addition to the sources of data already accessed, it is planned to use:

- data on ICT investment, developed from investment surveys, to help distinguish between the effects of installed ICT capital and e-commerce use;
- data on the linkage of e-business processes to purchasing and order receipt systems, which was included in the ONS e-commerce survey for the first time in 2002.

In parallel with this work, DTI and the Office of the e-Envoy will be commissioning further business case studies. The intention is to link these streams of work, using the case studies to develop models that can be tested using firm level statistics.

Acknowledgement

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Notes

- 1 Centre for Research into Business Activity (CeRiBa) led by Professor Jonathan Haskel, working on microdata analysis and business data linking at ONS, supported by the Evidence Based Policy Fund with input from HM Treasury and DTI.
- 2 The OECD is co-ordinating a program of work in this topic under its DSTI SWIC committee, in which Australia, Canada, Denmark, Germany, Italy, Japan, Netherlands, USA, UK, Sweden and Switzerland have already contributed, leading to a report to Ministers in spring 2003.