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## **Enterprise e-commerce; measurement and impact**

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### **1. Introduction**

This article outlines work in ONS to improve measurement and understanding of information and communication technology (ICT), and how its use affects economic activity. It reviews data on technology adoption, and changes in firm behaviour associated with electronic transactions. It also summarises work to identify economic effects of e-commerce, through different survey sources

Survey measurement of e-commerce and internet use is in its third year in the UK. ONS uses a variety of surveys to improve understanding of the role and impact of the information economy. Its current four main survey instruments are:

- ?? an annual enterprise e-commerce survey, on Information and Communication Technology (ICT) use across all firm sizes, and the use of electronic transactions and e-business processes
- ?? quarterly household surveys on internet access and use for various purposes, on attitudes, and expenditure
- ?? a monthly survey of Internet Service Providers which tracks the growth in internet accounts
- ?? quarterly and annual surveys of investment at firm level, including investment in ICT hardware and software.

Much of the international work on economic impact of ICT to date has been based on growth accounting approaches. OECD and the ICT industry have questioned whether the UK reflects in National Accounts the levels of investment in software shown in other major economies. This issue will be reviewed as sources improve and work to assess UK software capital using OECD methodology proceeds. However, recent growth accounting analysis by London Economics, making ICT investment assumptions based on Bank of England work, shows positive effects on productivity correlated with investment in ICT across a range of UK sectors. (Muller 2003)

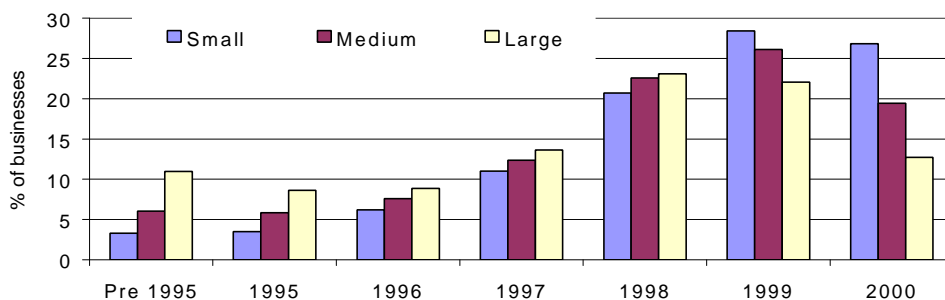
The work outlined in this paper takes a different approach. Instead of focusing on accounting relationships it uses survey micro-data to examine behaviour and performance of individual firms. It seeks evidence for patterns in their adoption of ICT, for changes in firm behaviour and for differences in firm performance resulting from technology. It also looks for evidence on market effects of electronic networks. Its purpose is to provide statistical evidence to support policy makers concerned with productivity and growth. ONS work in this area has been supported by a team of academic economists, and co-ordinated with parallel work in other OECD countries

## 2. Technology adoption

The ONS e-commerce survey launched in 2000 is based on the Eurostat model. Among other items it gathers data on the adoption patterns and use of ICT by UK enterprises. The most recent survey published (Prestwood 2002) shows that among UK businesses with 10 or more employees, only 11% used no form of PCs or workstations in 2001, and only 28% were not connected to the internet. Employment weighted, these figures drop to 2% and 9%, showing that the impact of ICT and e-commerce on the economy and employees is larger than simple 'firm count' data suggests. Data for 2002 will be published shortly.

The initial 2000 survey by ONS contained considerable detail on timing of ICT adoption. 40% of large firms had adopted network technologies by 1997 (Figure 1), with a further 23% adopting in 1998. The peak adoption period for small and medium sized enterprises followed in 1999/2000.

**Figure 1** *Year of adoption of network technologies by sizeband*



Source: e-Commerce Survey 2000

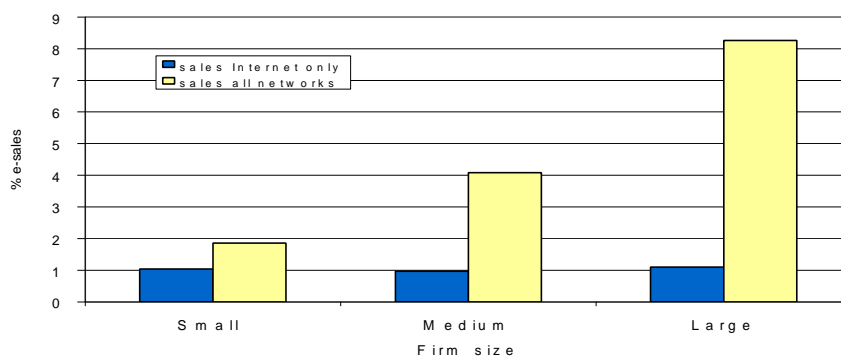
Definitions of network technologies here include internet connection, the earlier, closed, technologies underpinning electronic data interchange (EDI) which have been developed since the 1980s, and intranets within firms. ONS surveys make it clear that although internet connection is the most common 'standalone' application of network technology, it is often used alongside EDI or intranet, particularly in medium and larger firms. This, together with evidence below on firm behaviour, suggests that the internet has not replaced closed networks for electronic interactions between firms. Instead it seems to have broadened the options for firms which were already 'connected' and created opportunities for those which were excluded from closed networks

## 3. e-Commerce behaviour

Usage patterns relating technology adoption to development of e-commerce activity in the UK have been completed for 2000 data, and included in OECD's report on ICT Impact (Pilat 2003). These confirm that established, closed, trading networks still account for much electronic trading; sales over these are almost ten times greater than sales via internet. Figure 2 shows business sales over the internet and via 'all electronic networks', of which EDI is the largest element. In small firms (under 50 employees), the proportion of business sold over the internet is half of all electronic sales, which implies that EDI and internet sales are comparable. For large firms internet sales are only around 10% of total network sales, with EDI and other systems accounting for the

rest. This suggests the internet is used as a point of entry to electronic trading for small firms, giving them access to electronic transactions already available to larger firms.

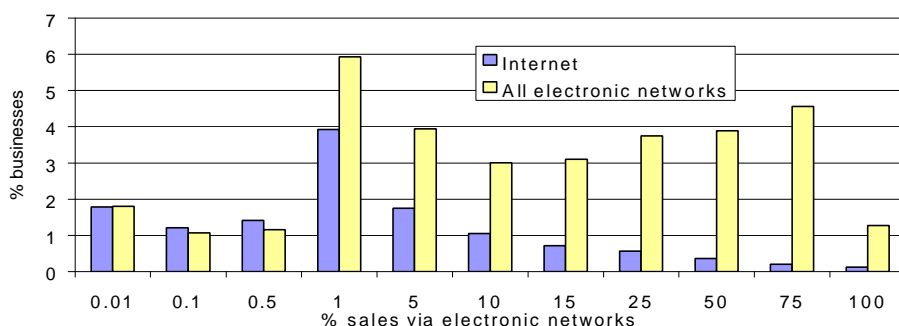
**Figure 2** *e-Commerce sales as % of turnover, by sizeband*



Source; e-Commerce Survey 2000

Analysing the pattern of e-commerce in ONS 2000 and 2001 surveys shows rapid change in activity. In 2000, as the 'dot.com bubble' inflated, a majority of firms reporting e-commerce sales said that it accounted for less than 1% of their turnover. By 2001 this pattern changed significantly, with a greater number of firms for which internet based e-commerce accounts for 1% of sales or more (Figure 3). However, in 2001 most firms for which e-commerce sales make up a majority of business are based on closed networks, not the internet. Activity in these closed electronic systems, such as EDI, seems to have grown in response to internet growth.

**Figure 3** *Business e-commerce sales via internet, and via other networks*



Source; e-Commerce Survey 2001

Within this overall pattern of consolidation and growth of e-commerce, there is considerable firm level turbulence between the 2000 and 2001 surveys. Of firms responding in both surveys, and which did not sell through electronic networks in 2000, 30% said they had adopted some form of electronic selling by 2001. Of firms which were selling electronically in 2000, half increased their proportion of e-business, and 40% had either ceased electronic selling or scaled down their dependence on it (Clayton and Waldron 2003). The data shows a dynamic pattern, with experimentation and exit widespread. This must affect the ease with which we can identify impacts of e-commerce use.

#### 4. International approaches to estimating productivity impact of ICT

The most widely publicised studies of economic gains due to ICT adoption and use are those based on growth accounting studies, at country or sector level. These track relationships between inputs (capital, labour, material, ICT measures) and outputs over time, and attributing part of any overall output increase to ICT. The availability of firm survey data permits an alternative approach.

The use of micro-level data to study the relationship between ICT and firm performance is now being undertaken in a number of countries. These studies draw on both official and private data sources and use different methodologies. Recent examples of some of the different approaches adopted are listed below:

- ?? inclusion of ICT capital stock at firm level as a separately identified capital input in labour productivity or total factor productivity (TFP) analysis (e.g. Brynjolfsson & Hitt, 2003; Hempell, 2002)
- ?? inclusion of ICT capital alongside other measures of ICT use, such as internet use or number of employees using ICT (Maliranta & Rouvinen, 2003)
- ?? inclusion of ICT capital stock together with measures on innovation and / or organisational change (van Leeuwen & van der Wiel; Brynjolfsson & Hitt, 2003)
- ?? including measures of computer network use (behaviour) as an additional determinant of labour productivity or TFP in a productivity regression equation (e.g. Atrostic and Nguyen, 2002).

Atrostic and Nguyen use the US 1999 manufacturing census combined with the US Computer Network Use Survey (CNUS), a large scale supplementary survey on computer network use. The CNUS asks firms about use of networks both inside and outside their operations and was completed by more than 38,000 firms. The information consists mainly of tick box measures of how computer networks are used for transactions, logistics, operations, and other steps in the business' value chain. Of the firms reporting use of computer networks, only half were using them to buy or sell.

Using this data-set, Atrostic and Nguyen use regression analysis to test whether the presence of computer networks in 1999 was associated with increased total factor productivity (TFP). They conclude that the use of computer networks increased TFP by about 5%, and that this result is robust to different model specifications and to selection. Superior performance by electronically networked firms could be due to:

- ?? use of networks inside firms facilitating more effective process control and resource use
- ?? use of networks between firms reducing transaction costs and improving coordination
- ?? reduction in search costs changing the way in which markets operate

## 5. UK data on e-commerce use and business performance

In the UK, survey data to compile firm level ICT capital estimates is still under development. Our analytical approach has therefore been based on firm behaviour, using methodology similar to that for the US. Initial attempts to link detailed data from the first round enterprise e-commerce survey to productivity data from the UK Annual Business Inquiry (ABI) did not deliver sufficiently large samples for productivity analysis. Therefore an alternative source was needed.

For the UK the largest source of information comparable to that available in the US is provided by qualitative questions added to the ABI from 2000 onwards (Figure 4). These ask firms to indicate whether they use electronic networks to place orders for goods and services, or to receive orders. This covers Internet transactions, or buying and selling over closed networks, and is, in line with the OECD's 'broad definition' of e-commerce use.

**Figure 4** *ABI questions on e-commerce*

<b>E-COMMERCE</b>			
If you use the Internet, Electronic Data Interchange or any other electronic network to:-			
Place orders for goods or services, please <b>enter '1'</b> in the box provided. If not, please <b>enter '2'</b>			<input type="checkbox"/>
Receive orders for goods or services, please <b>enter '1'</b> in the box provided. If not, please <b>enter '2'</b>			<input type="checkbox"/>

Responses to these questions are available for over 6,000 manufacturing reporting units in 2000 and 5,500 in 2001, and for each of these we have employment and output data which permits productivity to be calculated. This compares to an overlap of 650 manufacturing firms between the ARD and the e-Commerce Survey in 2000 and around 1,600 in 2001.

## 6. What the data shows

Unlike US data, the ABI survey does not identify reporting units that use computer networks generally, but only those which use them for buying and selling. This means our study is different from Atrostic and Nguyen, but this limitation has been used to advantage. There is interest in looking at the effect of e-commerce as a means of procurement or of supply chain management separately from other applications. So far this has been led by evidence from case studies. Adoption of electronic procurement systems by firms is claimed to improve efficiency by cutting internal administration costs and speeding up purchasing processes, by improving price transparency, and by reducing search costs. Anecdotal evidence from industry providers of e-commerce systems, and cases from the EU's e-business w@tch programme, suggest we should expect e-procurement to have a positive effect on productivity.

Figure 5 below shows that firm level data supports this hypothesis. Value added per employee is shown for over 7,000 UK firms, under four headings:

?? firms which do not use e-commerce at all (none)

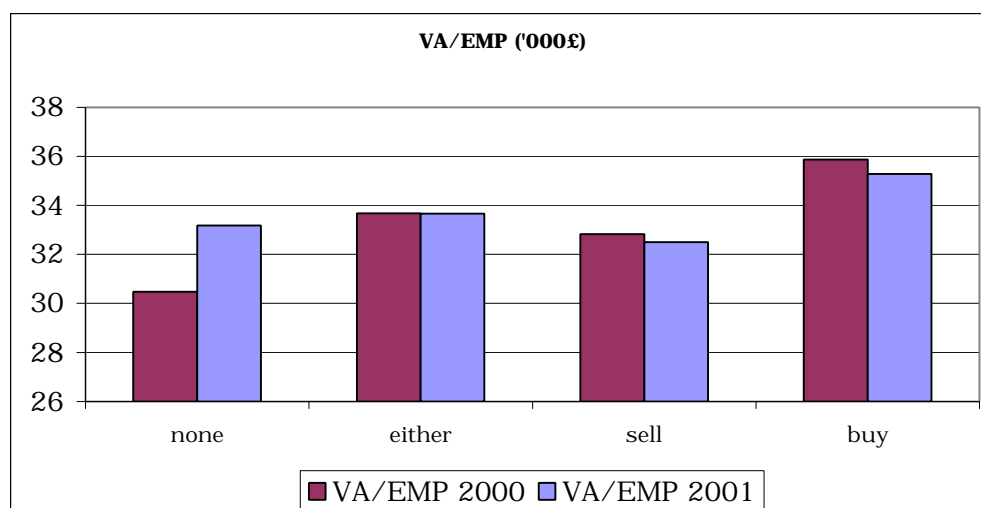
?? firms which use it for either buying or selling (either)

?? firms only using e-commerce for selling (sell)

?? firms using e-commerce only for buying (buy)

Data for 2000 is taken from the final ABI, that for 2001 from provisional results.

**Figure 5 Productivity in UK manufacturing firms**



Source: ABI 2000/2001

The group with the highest value added per employee - in both 2000 and 2001 - is of firms which only use e-commerce for buying. The lowest is of firms which use e-commerce only for selling. This may suggest efficiency effects associated with e-procurement, but also price effects. Differences may be driven by other effects. As the descriptive data in Tables 1 and 2 shows, reporting units that carry out e-buying and e-selling are larger and more capital intensive than reporting units which do not, besides having higher labour productivity.

**Table 1 Characteristics for 2000**

2000	none	either	sell	buy	Sell no buy	Buy no Sell	Buy and Sell
OBS	3365	1771	2310	2812	1269	502	1041
EMP	184 (414)	350 (852)	349 (776)	378 (992)	302 (533)	354 (1138)	387 (928)
GO/EMP	97.34 (128.86)	108.91 (160.41)	108.69 (168.43)	117.64 (188.44)	94.06 (93.63)	109.95 (116.74)	120.69 (210.12)
VA/EMP	30.47 (34.60)	33.68 (34.32)	32.82 (31.93)	35.87 (38.92)	29.95 (24.17)	37.61 (43.49)	35.18 (36.95)
K/EMP	55.28 (85.32)	55.79 (73.74)	55.20 (74.66)	57.86 (79.73)	52.28 (62.12)	58.53 (69.37)	57.60 (83.49)

**Table 2 Characteristics for 2001**

2001	none	either	sell	buy	Sell no buy	Buy no Sell	Buy and Sell
OBS	2622	1978	2398	2964	1412	566	986
EMP	192 (467)	337 (729)	350 (772)	359 (809)	292 (529)	282 (502)	390 (902)
GO/EMP	109.18 (200.77)	111.50 (121.87)	108.21 (117.38)	118.19 (136.47)	98.07 (83.80)	125.42 (138.52)	115.29 (135.59)
VA/EMP	33.17 (53.79)	33.66 (32.08)	32.50 (28.23)	35.28 (34.72)	30.43 (25.69)	38.61 (44.56)	33.94 (29.79)
K/EMP	57.92 (99.56)	60.16 (73.69)	58.20 (70.56)	62.99 (79.95)	54.48 (58.80)	68.49 (85.26)	60.79 (77.64)

Note: Figures reported are unweighted averages. Standard deviations in parentheses.  
Source authors' own calculation using ARD 2000 and 2001.

The effects of e-commerce appear to be consistent between the two years, but possibly more pronounced in proportional terms for value added than for gross output. In both years the 'e-buy only' group appears to have a higher capital / labour (K/EMP) ratio; this is consistent with accounts from industry sources that firms with e-procurement systems are likely to be more sophisticated. To control for the role of other factors (size, capital intensity, or industry) regression analysis similar to that by Attrostic and Nguyen has been completed.

## 7. Regression analysis

Our analysis using UK ABI data has set out to take account of all the factors in the US work, plus multinational effects which earlier studies have shown to be important (Criscuolo and Martin 2003). It covers only the manufacturing sector, because firm level capital stock data is not yet available for services.

The regression model is a Cobb-Douglas production function of the form:

$$Q = AK^\alpha L^\beta M^\gamma$$

where K, L and M are capital, labour and materials inputs (all available from the ABI). A is a technology change term which shifts the production function, and is a function of the use of computer / electronic networks for buying or selling, of the form:

$$A = \exp(\alpha_0 + \alpha_1 eActivity)$$

and where *eActivity* has the value 1 if e reporting unit uses an electronic network for buying or selling, as appropriate, and zero if it does not. The equation on which regression is based is therefore:

$$\ln \frac{Q}{L} = \alpha_0 + \alpha_1 eActivity + \alpha \ln \frac{K}{L} + \beta \ln \frac{M}{L} + \gamma \ln L + u$$

The *eActivity* term in the analysis is split into a number of dimensions for different specifications of the model, to show separately the effects for:

- ??firms using computer networks for selling
- ??firms using computer networks for buying
- ??firms using networks for either buying or selling
- ??firms using networks for both buying and selling

The reason for investigating selling and buying separately is to distinguish between ‘market effects’ and internal effects. Market effects from e-selling could be positive for a firm due to increased market size and ability to grow or negative due to tougher competition. Market effects from e-procurement could be due to access to more supply sources, to better collaborative working, or to better pricing conditions. Expected effects of e-commerce on internal efficiency may be due to reduced transaction costs, and to better information and process flows within the firm.

The analysis controls for:

- ?? reporting unit size, as represented by number of employees
- ?? industry sector and region
- ?? ownership (both multinationality which has major influence and foreign ownership)
- ?? age of reporting unit
- ?? macroeconomic shocks as measured by year dummies

Results have been developed using labour productivity as measured by gross (sales) and net (value added) measures of total factor productivity, and for value added per employee. All show positive statistically significant effects of e-procurement on productivity. As shown in columns 2 and 8, negative correlation exists in the value added specifications between the use of computer networks for selling and labour productivity, and for TFP.

**Table 3 Regression results**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Labour productivity			Total factor productivity			Total factor productivity		
	Dependent variable: value added			Dependent variable: gross output			Dependent variable: value added		
e-buy or sell	0.020 (0.013)			0.001 (0.007)			0.009 (0.012)		
e-sell		-0.045 (0.015)***			-0.012 (0.008)			-0.048 (0.014)***	
e-buy		0.078 (0.015)***			0.023 (0.008)***			0.070 (0.014)***	
e-sell, no buy			-0.036 (0.018)*			-0.021 (0.009)**			-0.046 (0.017)***
e-buy, no sell			0.093 (0.022)***			0.008 (0.014)			0.074 (0.021)***
e-buy & sell			0.031 (0.016)*			0.014 (0.008)*			0.021 (0.015)
Observations	11497			11656			11433		

Note: Robust standard errors in parentheses. Unreported regressors are: for columns 1-3: ln employment; columns 4-6: ln employment, ln (capital/employment), ln (materials/employment); columns 7-9: ln employment, ln (capital/employment). All regressions also control for age of firm, ownership (multinational, foreign dummies), industry, region and year.

In unreported results we take account of possible endogeneity problems with the *Eactivity* variable. We assume, as Atrostic and Nguyen do, that high productivity firms are more likely to carry out e-commerce. Using a two-stage estimation procedure, with computer related expenditure

in prior periods as an instrumental variable, we conclude that the UK result is robust, and comparable to those achieved in the US.

## **8 Interpreting the regression results**

### *Buying vs. Selling*

The regression results show an overall positive effect on firm productivity - on all the three measures listed above - associated with use of computer networks for trading. However, a comparison of the gross output result with the value added results shows that pricing effects play large part in the differences. Gross output results show a 2.3% gain in output associated with e-procurement. However, the value-added results show gains associated with e-procurement between 7% and 9%, and a loss of value added associated with e-selling of between 2 and 5%. The most likely explanation for the loss to sellers appears to be due to pricing effects.

Industry sources suggest that at least part of the gain from investment in electronic procurement by firms comes from the ability to use better price transparency to secure more competitive deals. Part of this comes from efficiency gain, but part is likely to be at the expense of suppliers. A well documented example of case evidence was provided by Siemens to the DG Info e-business w@tch workshop in November 2002, emphasising that procurement savings to the company came from both internal and external sources.

### *Larger vs. smaller firms*

A hypothesis advanced from case evidence is that the 'price effect' which may benefit firms through e-procurement is partly due to large firms using electronic markets to strengthen their position at the expense of smaller ones. For example, if a large multinational firm has a procurement system which enables it to put all its purchasing requirements out to international tender, and buy in a global market, while smaller suppliers tend to be local, unable to access wider markets, then smaller firms could be disadvantaged. Smaller buyers may find it difficult to buy electronically in international markets, and therefore to secure gains available to larger firms.

To test this possibility, the productivity analysis for 2000 and 2001 has been split between:

- ?? reporting units which are smaller than the median reporting unit in their four digit sector, as measured by employment (and likely to include firms with low market share).
- ?? reporting units which are larger than or equal to the median reporting unit in their four digit sector, as measured by employment (and likely to include firms with high market share).

Unreported results show that the productivity effects associated with e-buying and with e-selling are almost equally strong in large and small firms. Both show value added productivity loss associated with e-selling, and coefficients are larger for large firms than for small. Both groups of firms show value added productivity advantages associated with e-procurement, with coefficients for the large firms only marginally bigger than for the small.

### *Integration*

Policy makers have put forward the hypothesis that firms which both buy and sell are likely to be more 'integrated' in terms of their network use, and therefore show greater efficiency gains from ICT use. This is tested in the 'e-buy and sell' results above, and does not seem to be strongly supported. Units which both buy and sell, appear to have additional productivity advantage in only two of the six specifications of the regression model tested (columns 3 and 6, table 3), the one for labour productivity.

### *Regression conclusions*

Comparison of UK results with Atrostic and Nguyen's for the US suggests that they are consistent, but with e-procurement, as opposed to computer networks, having a measurable positive

impact on firm level productivity. However, it seems possible that both approaches may understate the productivity impact of ICT at firm level:

?? our analysis because it takes no account of e-business processes which are unrelated to buying or selling and which Atrostic and Nguyen found to be an important part of overall network use; in our analysis, firms using networks in this way are categorised as 'non users'.

?? Atrostic and Nguyen because their data does not distinguish e-commerce between buying and selling, and the analysis may therefore be unable to separate out the partly offsetting 'market effects' on both sides of transactions.

To overcome these and other analytical difficulties, the 'ideal' data-set for analysing computer network use effects should have a longitudinal dimension, to permit analysis of usage and effects over time, and would include:

?? distinction between network use for buying and selling

?? records of network use for other purposes (as included in the latest UK e-commerce survey)

It would also include firm level data on ICT capital, so that we could distinguish between the investments firms make in technology and the use they make of it.

## **9 Economic effects of e-commerce on prices**

Literature on the price effects of digital markets (reviewed in Smith, Bailey and Brynjolfsson) covers a complex set of possible effects, which depend on the types of transactions covered.

For simple products which can be specified in relatively few dimensions, electronic markets may increase price transparency and commoditisation, raising the importance of price in buying decisions which may tend to push prices down. For more complex products, where differentiation is possible there may be added scope, through the one to one relationship between buyer and seller permitted by e-commerce, for price discrimination based on specific buyer circumstances, increasing both price dispersion and level.

Electronic transactions may affect market boundaries in opposite ways. Lower search costs for buyers may enable them to seek more suppliers, tipping the balance of supply and demand in their favour and edging prices down. On the other hand, the investment required by suppliers in some EDI type closed electronic purchasing systems may limit entry, reducing scope for competition; but once made such investment may act as a barrier to exit, so that competition in supply increases over time.

Interviews with firms which provide the infrastructure and databases on which electronic transaction systems are based have confirmed that gains through the management of backward supply chains are among the most important ex-ante justifications for investment for firms. The sources of cost saving for them are both internal and external, reducing the search and administrative costs associated with buying, and reducing purchase prices through access to a broader and better specified set of suppliers.

One system supplier specialist interviewed qualified the experience of price effects by commenting that in their experience the effect of electronic buying and selling depends on the relative numbers of buyers and sellers, as well on the nature of the transactions. In markets where there are a large number of sellers making sales propositions to fewer buyers, the most likely outcome is downward pressure on prices, but where a larger number of buyers faces a small number of sellers the effect of electronic networks is to exert upward pressure on prices. These considerations were said to affect the design of buying / selling networks.

E-commerce can also change the nature of transactions. Adoption of systematised e-procurement models by firms often changes relationships with suppliers from a negotiation process towards long term agreement into a series of auctions and bids for specific, shorter term, contracts

which are likely to be more intensely competitive. Against this, use of electronic networks for purposes in addition to the purchase decision can facilitate the delivery of value added services as part of a more intimate partnership between suppliers and customers in the value chain.

The most dramatic effects of e-commerce can arise when suppliers use it to sell direct to their end users, cutting out a stage in the distribution chain; the best known example of this is Dell computers, selling direct to consumers and by-passing PC retailers

One further difference between electronic sales and traditional marketing approaches is that the ability of suppliers to change prices quickly and cheaply using web-based price lists is greater. For example, traditional catalogue selling organisations were restricted to changing prices, via catalogues, two or three times a year to avoid unacceptably high costs; with web based selling they can change prices from day to day, and target offers at selected customers whose buying patterns are known. Greater price flexibility and speed of response to shocks may be expected.

Many of these effects have been identified, but not often quantified, in the OECD E-Business Impact Programme (EBIP) which brings together e-commerce experiences from a number of countries (see [www.oecd.org/sti/information-economy](http://www.oecd.org/sti/information-economy)). The quantified evidence quoted by Smith Bailey and Brynjolfsson tends to come from consumer internet markets (which still account for a small minority of e-commerce in the UK) rather than from digital business to business markets. This evidence seems to suggest that consumer prices are as likely to have risen as to have fallen over the internet, and that price dispersion has, on the whole, been unaffected.

## **10 UK survey data on producer prices, linked to e-commerce**

Based on our results from section 6 above, using ABI data to identify large numbers of manufacturing businesses which do, and do not, use electronic networks for selling, we are able to test the behaviour of prices in UK firms as a function of their use of e-commerce, mainly in business to business markets. So far we have conducted only a limited test covering firms identified for the year 2000, but it suggests that results are statistically significant and worth further investigation as additional years' data become available.

To undertake this analysis, the following indirect data linking exercise has been undertaken. From the ABI responses to the e-commerce questions shown in Figure 4, the use / non use of electronic networks for selling has been identified for firms in 40 SIC sectors and sub-sectors where e-commerce is known to be significant. Through identifiers from the UK business register (IDBR) the firms have been matched with those that respond to the monthly UK producer price inquiry (PPI). This inquiry asks a large number of firms for monthly quotes for specific, detailed, products on a consistent and confidential basis.

PPI results are summarised in a database which captures monthly movements for the prices returned, corrected for any changes in quality specification which occur. Based on January 1995 = 100, the 'price relatives' for each specified product show its movement since the base date. These are weighted together according to value of output from each respondent to develop the UK Producer Price Index data-set.

For this analysis we are only able to identify firms that sell electronically in the year 2000, not the specific products they sell over electronic networks, or the year in which they might have started selling over electronic networks. To test for possible differences, the first approach has been to separate the PPI sets for firms which do, and do not, sell electronically within each SIC, taking the firm identifier as the definition of industrial classification (which may not be the same classification as the products quoted).

We have then weighted the price relatives equally within each of the two sets (e-sellers and non e-sellers), because we are concerned to identify possible differences between trends in the two sets of data than to reproduce the Producer Price Indices. Only in about 30% of cases do the two data-sets (PPI and ABI) overlap, so price data is only available for a partial set of the firms on which our productivity evidence is based

Results show a very mixed pattern reflecting the range of economic forces at work, and summarised in section 9 above. Figures 6.1 to 6.5 at the end of the paper show specific sectors as examples. Each graph shows the evolution of average price relative data for e-sellers and for non e-sellers month by month over the period January 1997 to December 2000. Each individual price relative series is based on January 1995 = 100, and the individual series are equally weighted to produce the average. They appear to show different effects in different markets, and we have grouped them into five main patterns of price behaviour over time.

*i) sectors where prices diverge in the period, and e-sellers' prices fall relative to non e-sellers.*

This group (Figure 6.1) includes pharmaceutical manufacture (177 firms observed), where e-commerce systems have been adopted by major pharmaceutical wholesalers over the period as part of the process of increasing competition in a regulated market. It also includes mechanical engineering (32 firms observed), which is a relatively heterogeneous sector subject to increasing international competition over the period.

*ii) sectors where e-sellers' non e-sellers' prices diverged between 1995 and 1997, and where e-sellers prices remained lower through to 2000.*

This group (Figure 6.2) includes food products in both meat processing (125 observations) and bakery production (67 observations) which sell a large part of their output to supermarkets, all of whom have used electronic procurement systems based on closed (EDI) systems for some time.

*iii) sectors where e-sellers prices had fallen relative to non e-sellers prior to 1997, and appear to re-converge by 2000*

This group (Figure 6.3) includes basic organic chemicals (191 observations) and pesticides and agrochemical products (41 observations). In both these sectors there are effectively global markets, and there has been substantial international consolidation of supply during the later 1990s. These sectors are also subject to input price shocks from the oil market, to which they adjust with varying degrees of speed.

*iv) sectors where prices for the two groups are indistinguishable*

This group (Figure 6.4) includes electronic components (137 observations) and newspaper publishing (118 observations), both areas related to sectors where e-commerce is well established, and has influenced markets for considerable time. In such markets it is possible that competition has ensured that prices have stayed aligned. It is worth noting that in productivity analysis by sector (not reported here) publishing and computer manufacture were the two sectors in which value added / employee productivity measures for e-sellers were higher than for e-buyers.

*v) sectors where e-sellers' prices are higher than non e-sellers'*

This group (Figure 6.5) includes manufacture of parts for motor vehicles (148 observations) and manufacture of soap and detergents (58 observations). These are both sectors where intermediate demand includes both major brand owners who purchase for inclusion into branded consumer products, and 'spot' demand for other applications. It may be that differences in service levels or specification account for the differences.

## **11 Initial conclusions on price effects of e-commerce**

UK price evidence from this limited set supports the view from the literature that a range of forces are at work to affect prices in electronic markets. Across all the 21 groups examined, the sectors in which e-sellers' prices are lower (groups i to iii above) outnumber those where there is no difference, or where e-sellers' prices are higher. Overall therefore, it seems that the effects of reduced search costs, price transparency and rapid supplier reaction associated with electronic marketing and sale of goods is likely to have a negative impact on prices - but there is a great deal of variation depending on market conditions.

This conclusion is supported by regression analysis for 2400 reported price series across forty four digit sectors in manufacturing for which we have data, each series monthly over four years. The results suggest that the electronic receipt of orders has a negative impact on relative prices which is statistically significant at the ten per cent level, after taking sector and size effects into account. The sample contains all firm level observations of relative prices for the selected sectors between January 1997 and December 2000 where real responses are available. Monthly price trends, and sector effects have been controlled for using monthly and industry dummies, the latter using four digit SIC codes.

Next steps in this work are to generalise it across all sectors for which PPI data is available, and to test whether the conclusions on price effects and competition due to e-commerce are robust. The comparison of these results with our productivity conclusions for manufacturing suggest that they should be, in most areas.

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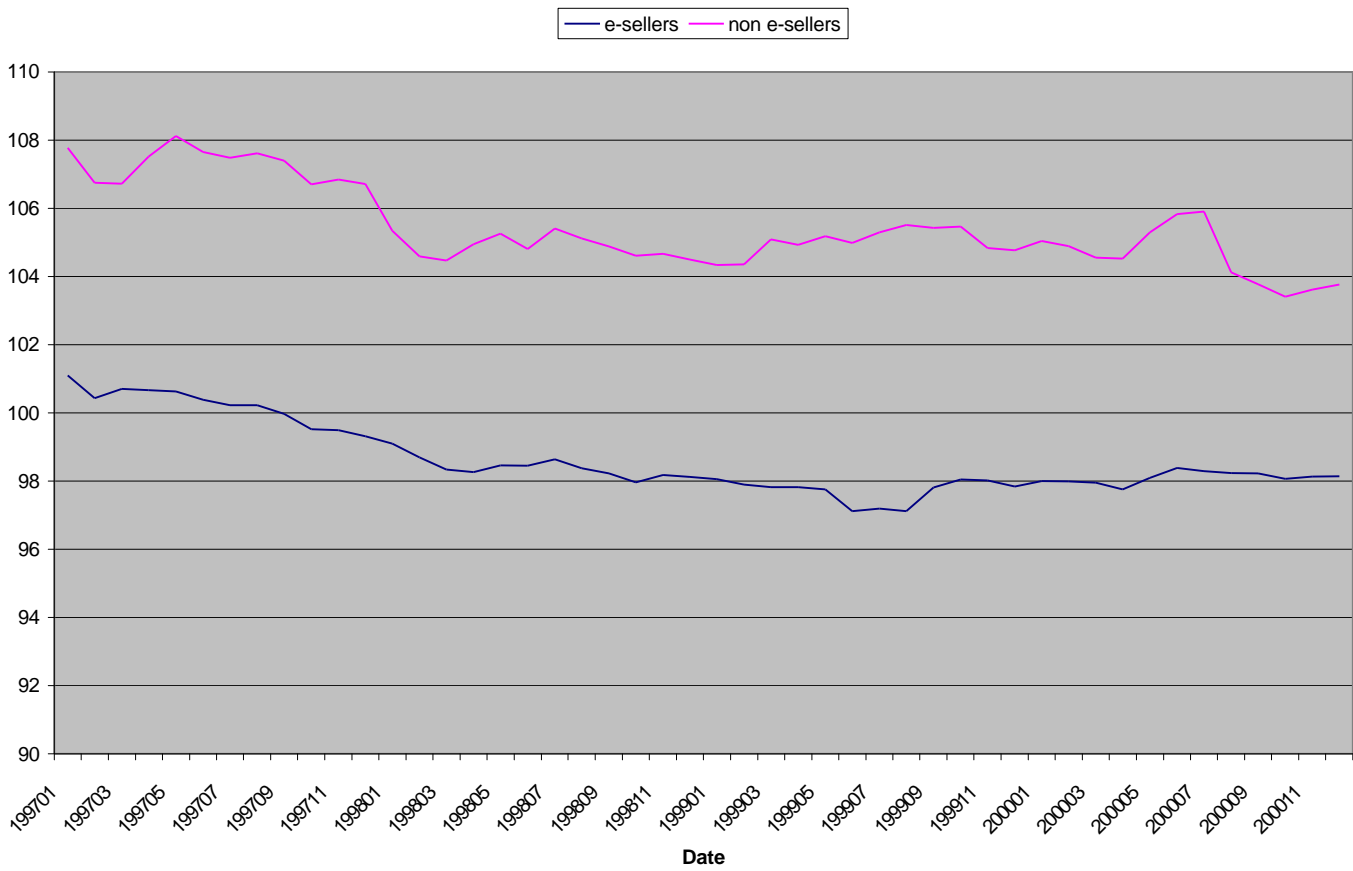
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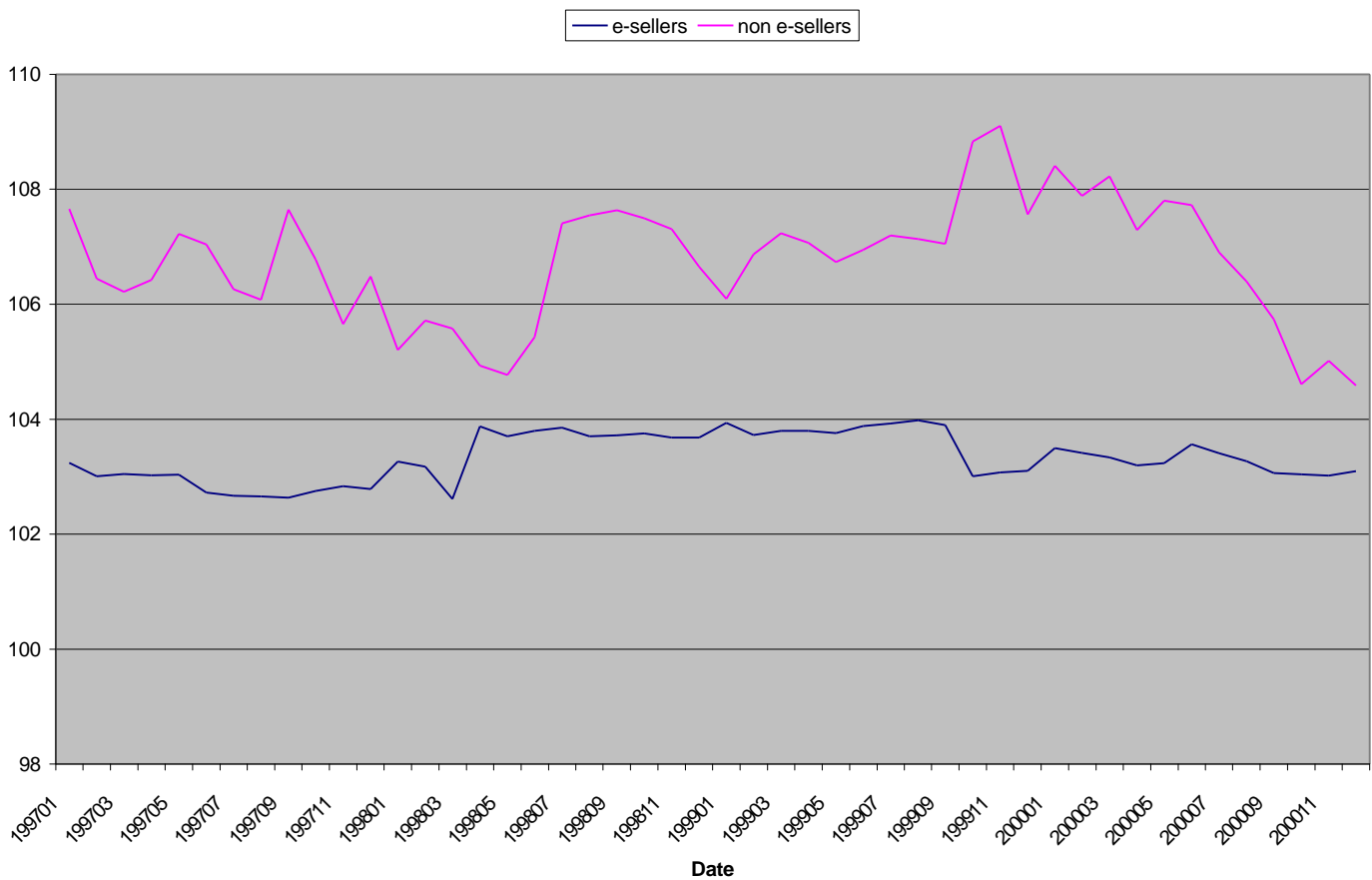
E-business Impact Programme (EBIP) at [www.oecd.org/sti/information-economy](http://www.oecd.org/sti/information-economy)

**Figure 6.1**

1513 Production of meat & poultry products

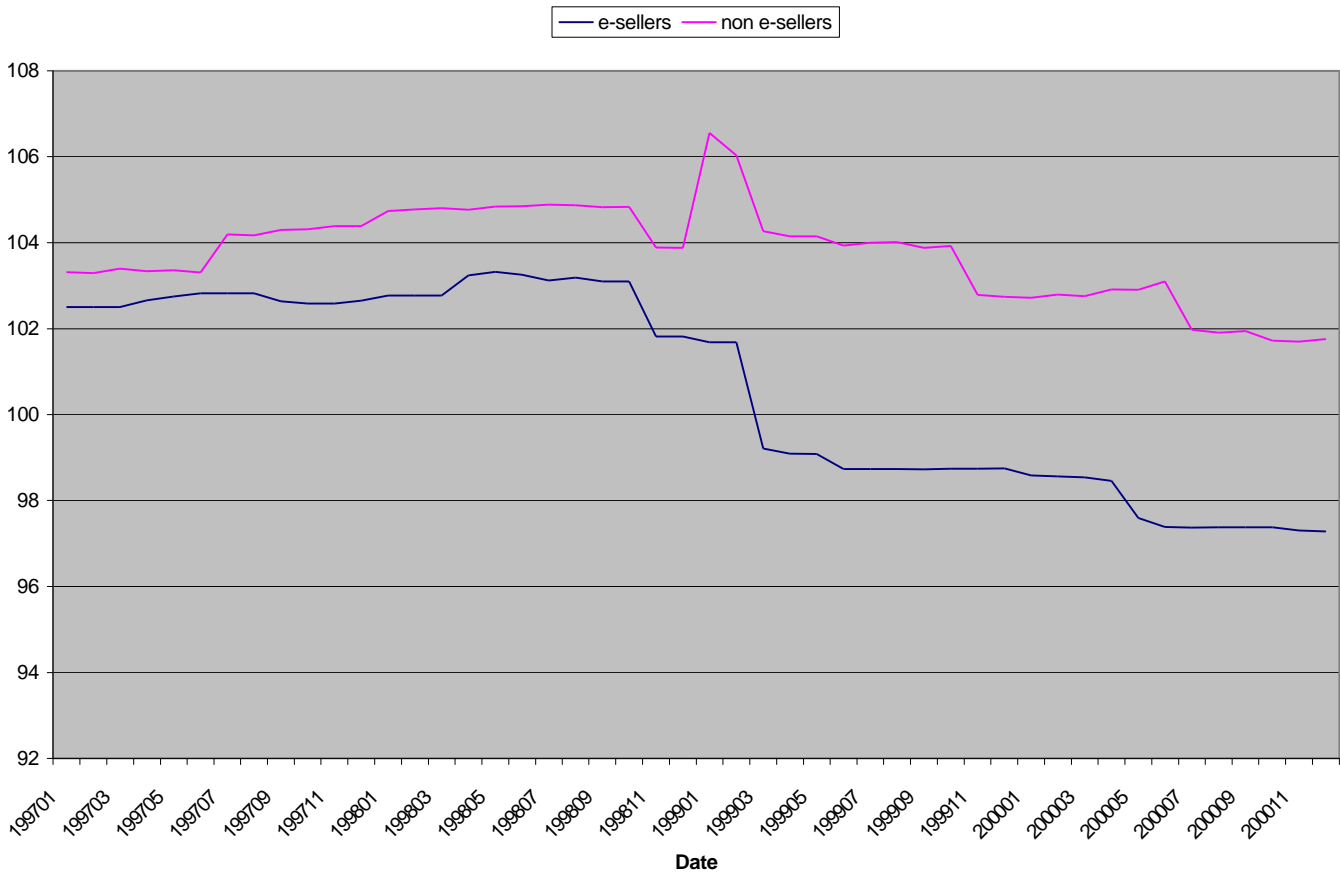


1581 Manufacture of bread; manufacture of fresh pastry goods and cakes

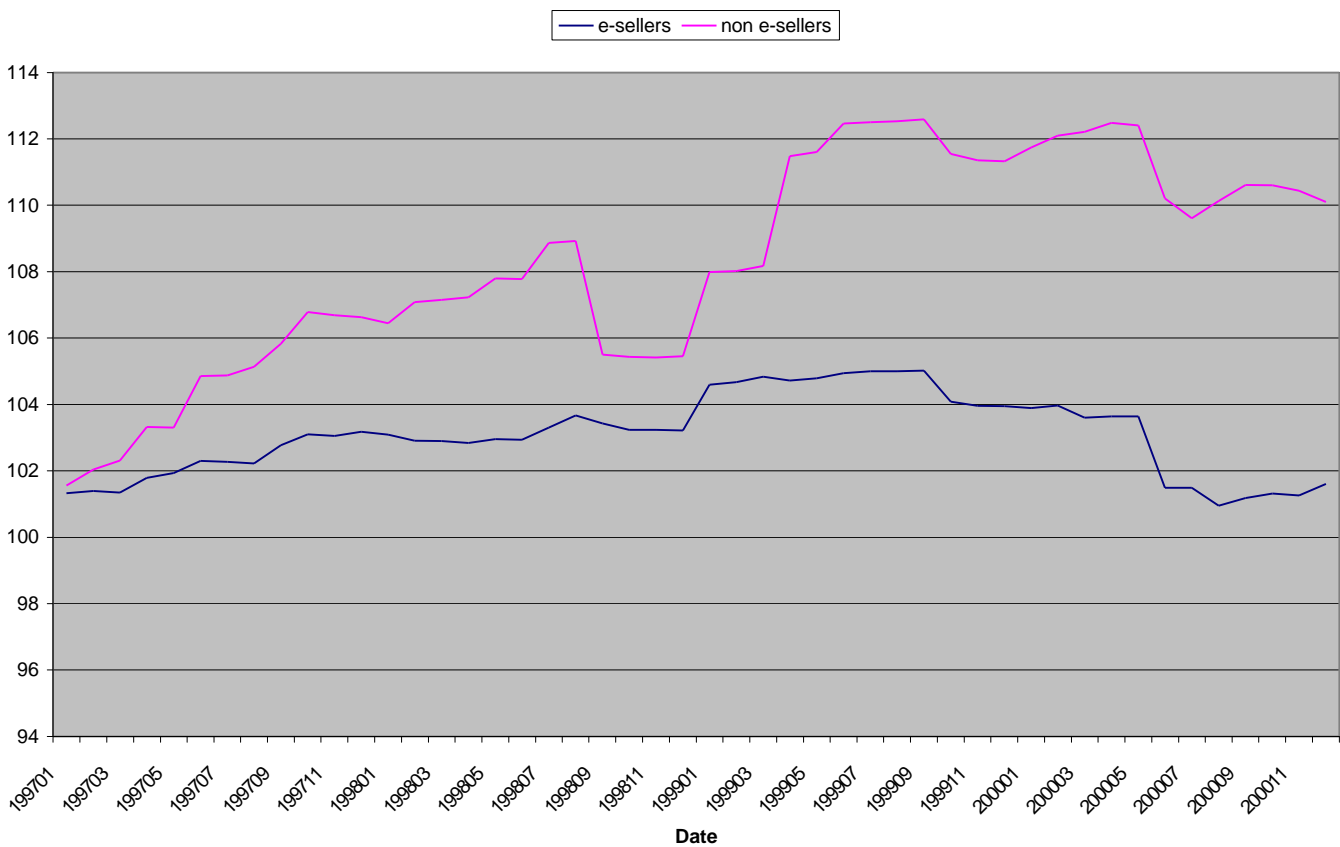


**Figure 6.2**

2852 General Mechanical Engineering

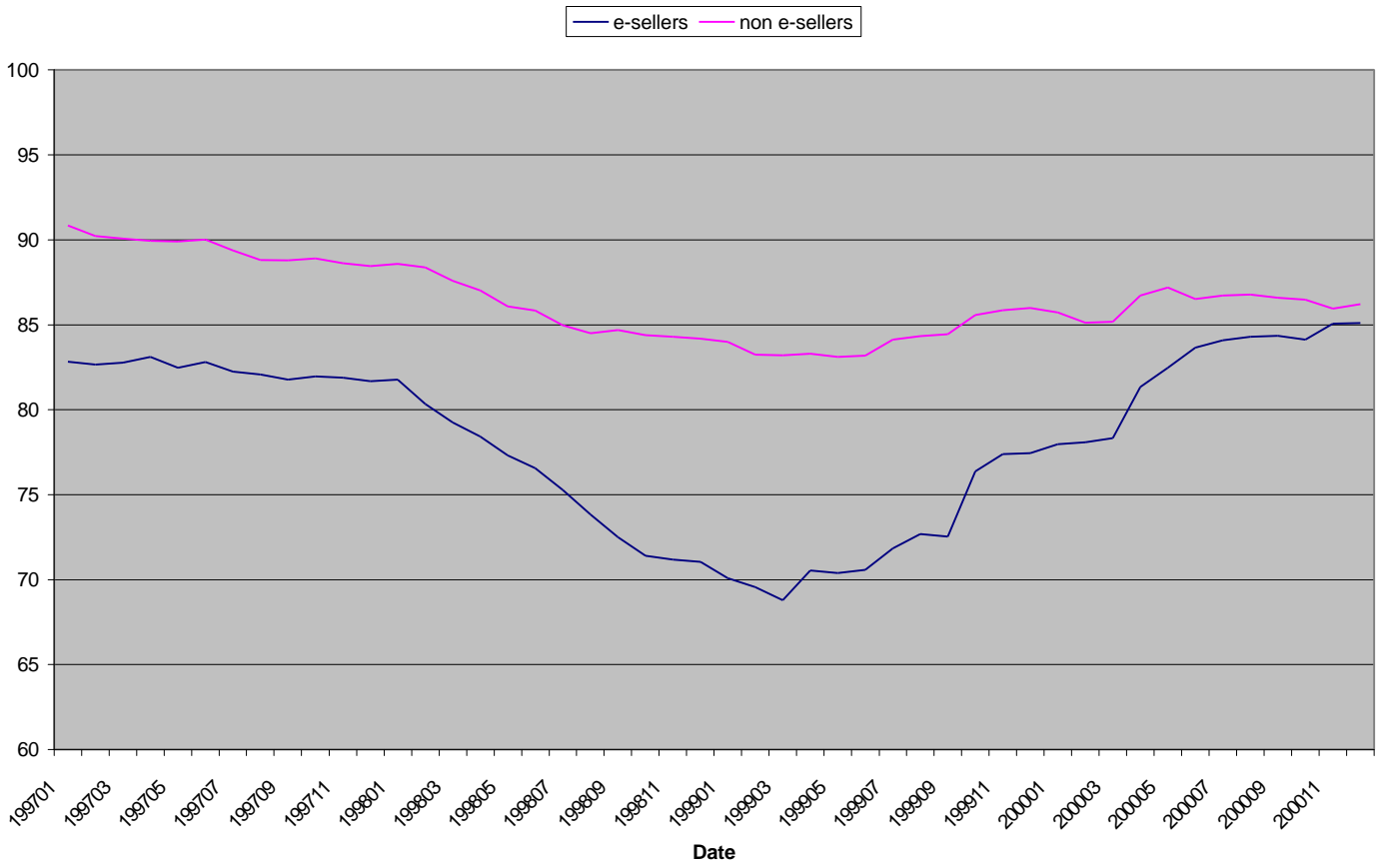


2442 Manufacture of pharmaceutical preparations

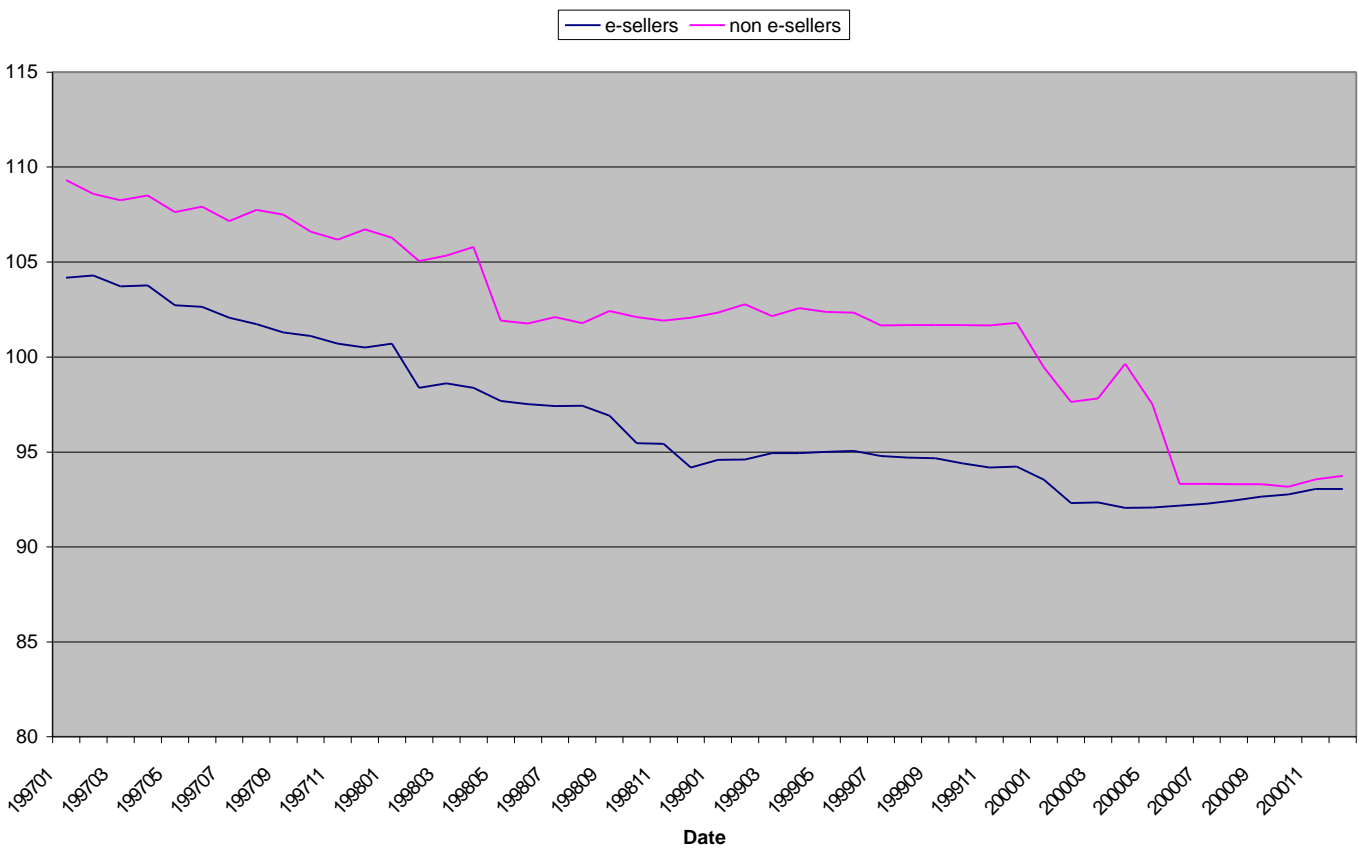


**Figure 6.3**

2414 Manufacture of other inorganic chemicals

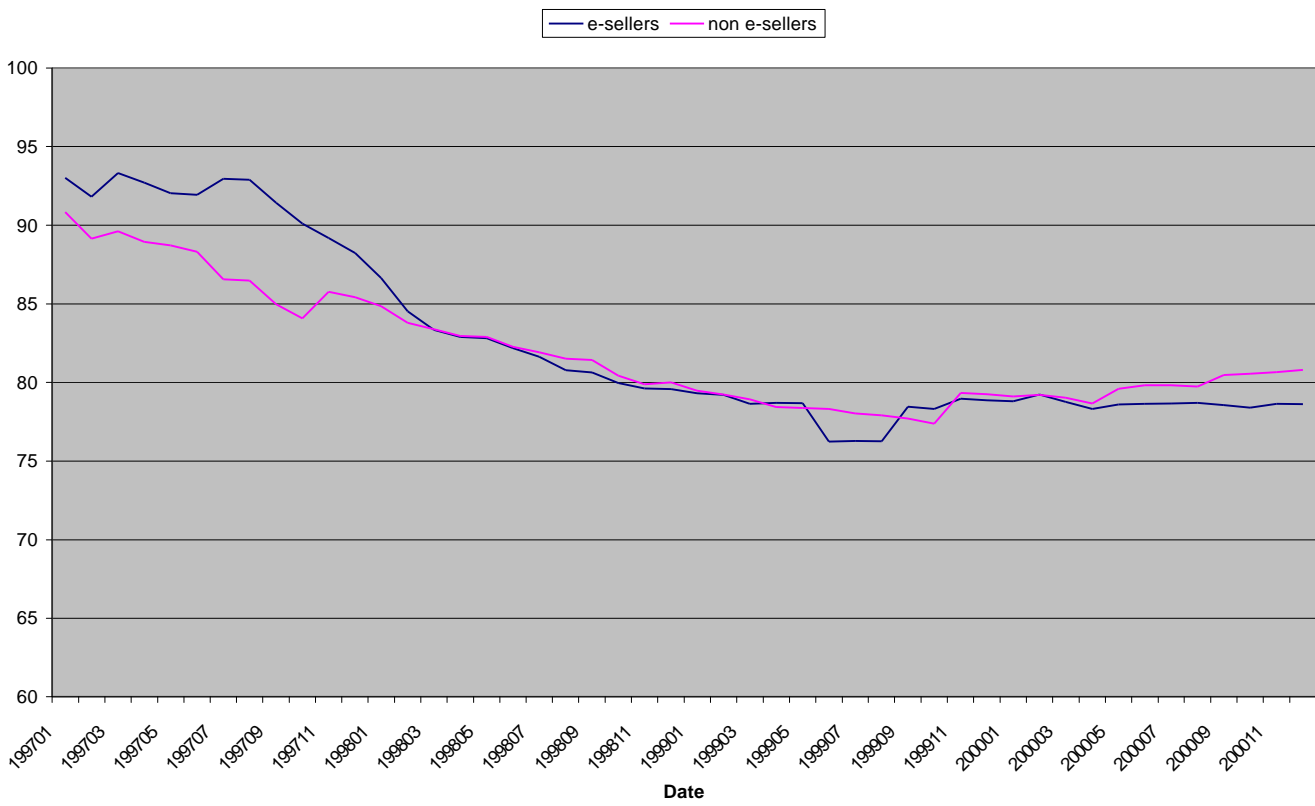


2420 Manufacture of pesticides and other agro-chemical products

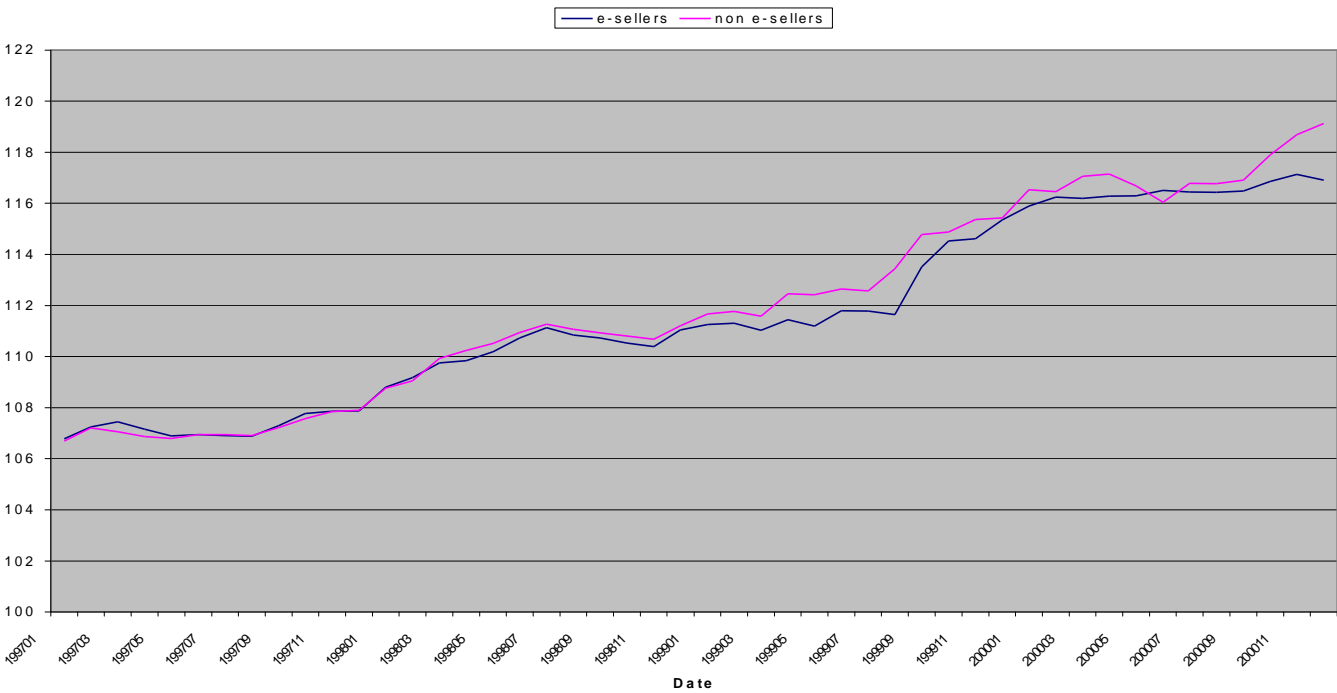


**Figure 6.4**

3210 Manufacture of electronic valves and tubes and other electronic components

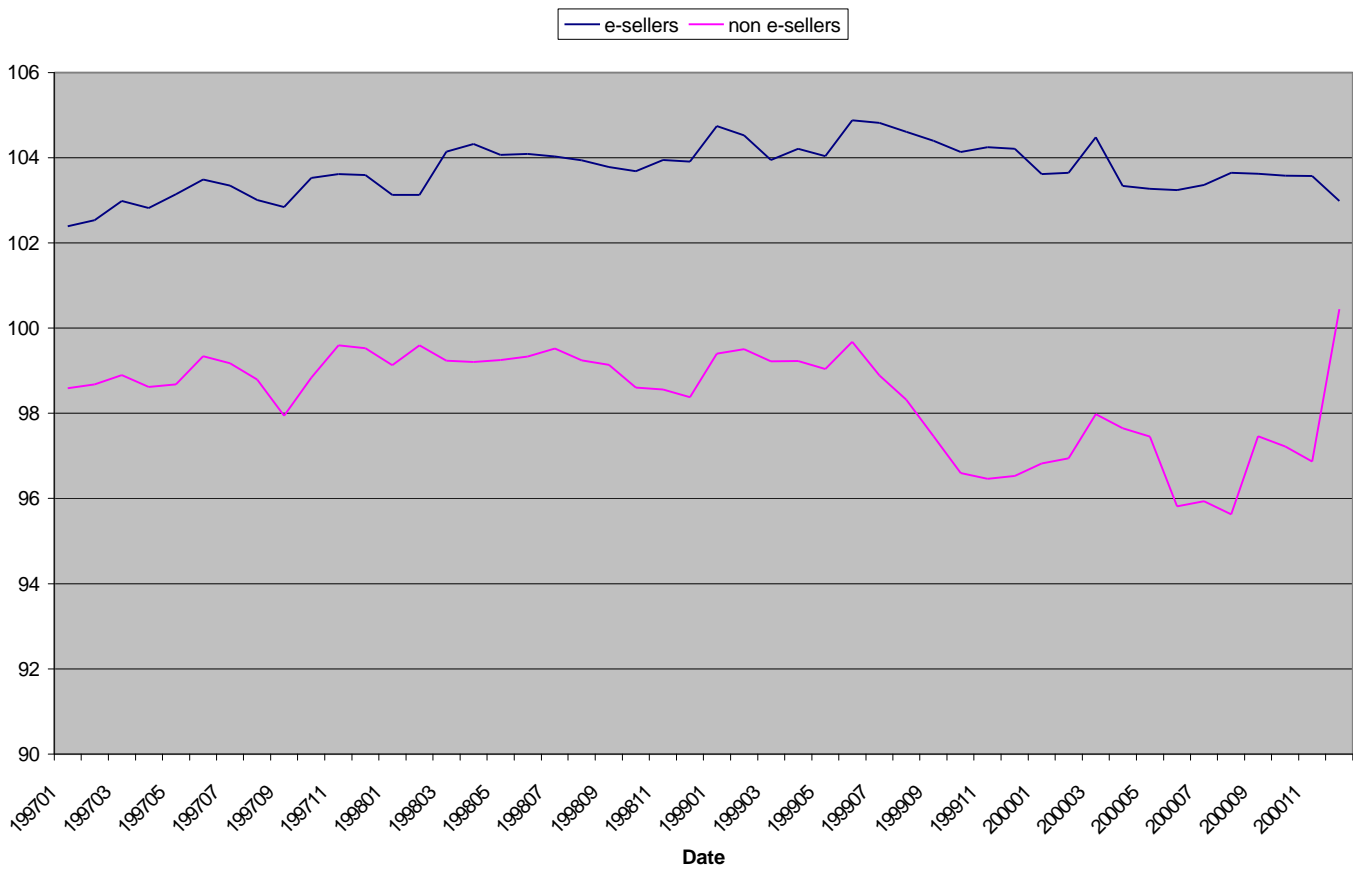


2212 Publishing of newspapers



**Figure 6.5**

24511 Manufacture of soap and detergents



3430 Manufacture of parts and accessories for motor vehicles and their engines

