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The impact of e-business on capital productivity

An analysis of the UK telecommunications sector

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Abstract

Purpose – The purpose of this paper is to provide evidence of the influence of different e-business technologies on capital productivity (CP). Productivity measurement is a useful tool to gauge business performance. However, currently there is little empirical evidence to support the impact of e-business technologies on productivity.

Design/methodology/approach – In this paper, an empirical investigation of 132 small and medium enterprises (SMEs) in the UK telecommunication sector was carried out, using a hierarchical regression. In doing so, three different types of technologies that may be associated with e-business (i.e. internet-based applications, groupware applications, and collective systems) were considered.

Findings – The main findings are that any improvement in CP is significantly influenced by groupware applications and collective systems. Therefore, the UK SMEs and other large companies might be over-investing in the development of web sites to support their internet presence, while under-investing in promoting awareness and the use of these services to customers (i.e. groupware applications and collective systems).

Research limitations/implications – Measuring the payoff is more difficult in e-business environments because applications cut across boundaries thereby affecting multiple parties. Hence, alternative metrics to measure payoff from multiple perspectives could be necessary. Productivity measurements were conducted in the SME UK telecommunications sector, and hence findings are valid within this specific context.

Originality/value – The results of this paper provide interesting insights on the performance drivers of companies using e-business technologies. The findings can guide managers in focusing their energies on e-business technologies and represent an approach to determine which e-business technologies are more likely to lead to a boost in productivity.

Keywords Electronic commerce, Capital gains, Communication technologies, Productivity rate, Small- to medium-sized enterprises

Paper type Research paper

1. Introduction

Increasing competition leads organisations to search for more effective business strategies. Many of these organisations have turned to information and communication

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technologies (ICT) as a way to cope with turbulent environments (Sigala, 2003). In fact, utilising technology and managing it effectively is important for a firm and is widely accepted as a means for creating a sustainable competitive advantage (Barney, 1991; Mahoney and Pandian, 1992; Chen and Liaw, 2001). In particular, it is broadly acknowledged that companies are increasingly facing the challenge of e-business, that is, using internet-based tools to support their business processes (Cagliano *et al.*, 2003). e-Business offers buyers and sellers a new form of communication and provides an opportunity to create new marketplaces. e-Business is recognised as an important area for information technology innovation and investment (Sauer, 2000) and is expected to dramatically improve a firm's performance by providing higher levels of process efficiency.

Initially, many forward-thinking enterprises focused their efforts on the development of corporate web sites and establishing an online presence. As web sites can attract customers all over the world, it is necessary tool to compete effectively with companies that already have an online presence. According to Reis (2006), the overall percentage of enterprises in the European Union (EU) with a web site was 61 percent, but this percentage is higher for larger enterprises: 90 percent for large and 79 percent for medium-sized enterprises. In the UK, 70 percent of the businesses had a web site in 2006 (ONS, 2006).

However, the internet and web sites are not enough to conduct e-business (Cagliano *et al.*, 2003). In recent years, there has been an explosion of new ICTs for e-business that are mainly focused on customer collaboration and decision making (e.g. groupware and collective applications). Nevertheless, evidence about the actual implementation and effectiveness of these new tools is still poor (Cagliano *et al.*, 2003), which makes it difficult to identify the potential benefits of these new tools (Falk, 2005). Therefore, since implementing ICT to enable e-business can be difficult, time-consuming and expensive for a company (Mabert *et al.*, 2001), empirical evidence is necessary to obtain knowledge on this issue. To overcome this lack of good data, capital productivity (CP) can be a valuable measure of business performance (Nachum, 1999; Wilson, 1994) because it reflects the efficiency and effectiveness of resource utilisation to create value in the marketplace.

Although e-business has been considered an effective and efficient means of improving the competitiveness of small and medium enterprises (SMEs), few, if any, studies have considered the relationship between each dimension of e-business and CP. Research into SME use of ICT within the UK context has been limited to a few studies, which are now dated (Naylor and William, 1994; Levy *et al.*, 2005; Simpson and Docherty, 2004). Some of these studies found a strong correlation between ICT use and firm size, innovation, product development and R&D in traditional sectors, such as textiles in the UK, implying that while e-commerce has spread rapidly throughout large firms, its growth among SMEs has been much less pervasive (Harindranath *et al.*, 2008; Pool *et al.*, 2006). However, while this body of work has recognised that SMEs are at a disadvantage in terms of ICT use, other literature suggests that SMEs have advanced in their adoption of sophisticated ICT from the situation described as common in the mid-1990s (Webb and Schlemmer, 2008; Gunawan *et al.*, 2008; Hinton and Barnes, 2009; Kim *et al.*, 2008).

A possible explanation of the above ambiguity would be the fact that much of the existing literature still relies on case studies, anecdotes, and conceptual frameworks,

with little empirical research directed to assessing the impact of each dimension of e-business on a firm's performance (Soto-Acosta and Meroño-Cerdán, 2008). This paper analyses the effects of e-business technologies on the CP of a sample of 132 SMEs in the UK telecommunications sector. The UK telecommunications industry is a high-technology industry in which the basic assumption is that "ICT" plays a key role in enabling SMEs to achieve speed and flexibility in the innovation process (Cegarra *et al.*, 2007). We developed a framework to allow SMEs to facilitate further development of ICT to e-business. To build our framework, we initially make use of the concepts of:

- internet;
- groupware; and
- collective systems.

We then suggest that the development of these three ICTs in practice can help SMEs to convert information related to e-business services into CP. The next section provides a literature review on how these three ICTs affect productivity. Based on the review, we propose a research approach analysing which e-business technologies are more likely to lead to a boost in productivity, and derive a set of hypotheses. This is followed by a description of the empirical study and a presentation of the analysis and test results of the hypotheses. Finally, we conclude with a discussion and conclusions.

2. Theoretical background

Performance measurement plays a critical role in understanding how a business is operating and helps to identify where improvements might be made. Ultimately, performance measurement informs the strategic planning process (Gunawan *et al.*, 2008). In the literature on management, numerous concepts and variables to measure performance are recognised. For example, drawing upon a reading of March and Sutton (1997) and Ittner *et al.* (1997), Koellinger (2008) mentions profits, sales, market share, productivity, debt ratios, and stock prices as performance measures. Koellinger (2008) differentiates between financial and non-financial measures of performance and suggests that many of these different measures are correlated and the choice of the performance measure is often limited by the availability of data. In this study, organisational performance is measured in terms of productivity (Craig and Harris, 1973; Sumanth, 1984). Regarding this, there are some well-known models for productivity measurements in the literature, e.g. labor productivity, CP and total factor productivity. However, there is a misconception that productivity metrics cannot capture the full impacts of ICT (Sigala, 2003). It is suggested that financial metrics encapsulate both tangible and intangible productivity gains because only when tangibles and intangibles are at correct levels will customer levels, income and costs be controlled in such a way that profit is produced at the required rate in relation to the capital employed (Gummersson, 1998). Hence, in this study we use CP to measure the effects of e-business systems on a firm's performance.

e-Business can be defined as the use of systems that open communication channels for information exchange, commercial transactions and knowledge sharing between organisations (Croom, 2005). e-Business involves web-based technologies to support company operations (Cagliano *et al.*, 2003). The study of e-business technologies is different from the broader meaning of information technologies (Sanders, 2007), which

can be defined as technological capability used to acquire, process and transmit information for more effective decision making relative to competitive standards (Grover and Malhotra, 1997). Hence, e-business can be considered a subsection of ICT. Investments in e-business are nevertheless distinct from traditional ICT investments because both the risks and the rewards are greater. Kohli *et al.* (2003) give the two main characteristics of the e-business environment. First, e-business environments have generally been more volatile and therefore prone to greater risks. Hence, ICT investment should be the result of a well-planned strategy. It needs to be closely monitored, even more so than other investments. Likewise, they offer extraordinary opportunities that, when managed appropriately, can yield significant gains as well as long-term competitive advantage. Second, by their very nature, e-business applications are cross-functional and span traditional departmental boundaries. Thus, greater numbers of applications within a firm can receive and provide information to e-business applications.

As noted above, e-business is not limited to internal applications and generally extends to suppliers and customers across the value chain. As Falk (2005) points out, e-business is a broad term that encompasses not only e-commerce, but also any electronic business process. Whereas e-commerce focuses only on commercial transactions, the scope of e-business includes information exchange, commercial transactions and knowledge sharing between organisations (Cullen and Webster, 2007). Simple examples of typical business processes that may be carried out in the electronic form include customer support and education, marketing, advertising and public relations, strategic and tactical planning, distributed inventory control functions, payroll, and benefits management (Falk, 2005). There is a significant amount of research in the area of e-business classification, development and implementation. Timmers (1998), for instance, classifies e-business based on the vertical or horizontal integration of various companies and industries, and looks at e-shops, e-procurement, e-auctions, e-malls, and marketplaces. Rayport and Jaworski (2001) suggest two main criteria to classify e-business:

(1) the sources of content organisation (which may refer to products, services, and information); and

(2) the focus on e-commerce business strategy, which can be on the supply side (e.g. supply chain movement) or on the demand side (e.g. better customer experience).

Following the suggestions of Cegarra *et al.* (2007), we considered three different types of technologies that may be associated with e-business processes:

(1) Internet-based applications, which enables customers and employees to have access to instantly available information about products and services across time and distance (Tetteh and Burn, 2001; Porter, 2001). These are the most frequent technologies employed in e-business and we consider them as basic internet resources. They focus on the promotion of the firm, its products and services, including brochureware, online catalogues, and other types of internet uses (i.e. intranets and extranets) and web sites designed to share information with customers and employees (Raymond and Bergeron, 2008). The flow of information can be boosted with other tools such as search engines or banners in other sites.

(2) Groupware applications that provide collaborative groups formed by employees, managers and sometimes customers with the ability to make the relationship between individuals or institutions easier as well as to link large amounts of information in a dynamic manner (Rodgers and Thorson, 2000; Brown, 2002; Meroño-Cerdán, 2008). Groupware systems are typically off-the-shelf products deployed across organisations and include e-mail, electronic bulletin boards, and group support systems (Artail, 2006) as well as discussion forums, repositories or yellow page (Meroño-Cerdán, 2008).

(3) Collective systems that facilitate flows of information that may be controlled by the users (Fowler, 2000; Lee and Runge, 2001). Collective systems support the buying and selling of goods and services, the distribution, and the customer service processes through web technologies (Cagliano *et al.*, 2003; Raymond and Bergeron, 2008) for example, by means of complete shopping cart solutions or tools that provide vendor recommendations.

The relationship between ICT and productivity has been a matter of debate for the past three decades. A great body of research has accumulated, but findings are plagued with ambiguities and inconsistencies. In the 1980s and the early 1990s, empirical research generally did not find relevant productivity improvements associated with ICT investment (Dos Santos *et al.*, 1993; Strassmann, 1990; Weill, 1992), suggesting that a productivity paradox exits. The productivity paradox – first exposed by Brynjolfsson (1993) – states that ICTs have negligible or even a negative effect on a firm's performance. More recently, as new data were made available and new methodologies were applied, empirical investigation have found evidence that ICT is associated with improvements in productivity (Ghosal and Nair-Reichert, 2009; Tavana *et al.*, 2009; Sircar and Choi, 2009). A possible explanation for the differing achievements during the three decades may relate to the dynamic change of the environment in the industry. In an economy witnessing explosive growth in consumer electronic commerce (Hoffman and Novak, 2000) and net-enabled organisations (Straub and Watson, 2001), it is no surprise that the internet presence represents an issue of considerable importance to the SMEs. An increasing number of businesses are choosing the internet as an alternative channel for developing brand reputation or for public relations purposes (Subramaniam *et al.*, 2000).

The relationship between the internet and CP has also been analysed by two-related streams, which we label as the negative and positive models. While the former places emphasis on negative viewpoints and scepticism regarding the role of the internet investments (Roach, 1989; Lohr, 1999), the latter encourages managers in the organisation to implement the internet, as it finds significant productivity gains from investments in the internet (Lee and Barua, 1999). Following the positive perspective, companies with a web site offering services such as product search and related information search tend to impress consumers, who in turn reward those companies that provide a comprehensive set of functionalities to facilitate information (Schubert and Selz, 1997). Following the negative view, in the early days of online trading, site popularity was considered as an indicator of positive online performance. However, it did not necessarily indicate business success (Gunawan *et al.*, 2008). For instance, there is no technical or legal reason why a shopper could not go to one site for help in selecting a product and then simply click to another site to buy it, which in turn may reduce the profits of a single web site and may not support

firm performance (Brynjolfsson and Smith, 2000; Saeed *et al.*, 2005). Consequently, it became apparent that the web site is necessary but not sufficient to ensure business success. Therefore, there is some ambiguity about the relationship between the use of internet technologies and CP.

In this study, we hold the positive view and understanding that the internet-based systems can be seen as a means of explaining and resolving the problems of implementing and using groupware and collective systems (Robey *et al.*, 2000). Further, we believe that the internet is seen as a way of classifying and preserving information (Sorensen and Lundh-Snis, 2001). Under this framework, the internet-based technologies can be useful in attracting customers but cannot differentiate the company in situations where consumers can use functionalities provided by one company to locate what they need and then move to other sites to buy the product. Therefore, this highlights the importance of other e-business technologies. These findings can be clarified by analysing the experience that consumers achieve in cyberspace when they visit a corporate web site (Agarwal and Venkatesh, 2002). In an attempt to reach this experience through the groupware applications and the collective systems and their outputs, the elimination of old logics by introducing new ones is frequently cited as the antecedents for CP (Cegarra *et al.*, 2007; Webb and Schlemmer, 2008; Gunawan *et al.*, 2008; Hinton and Barnes, 2009; Kim *et al.*, 2008).

On the one hand, groupware applications are not just used to make internal improvements but also to interact with the customers, manage the supply chain, and coordinate and collaborate with the trading partners. Their aim consists in integrating and sharing, through the internet or extranets, information on the extended value chain linking the firm with its upstream and downstream business partners (Raymond and Bergeron, 2008). This allows stakeholders within the same industry or network organisation that share the same objectives to collaborate in the design, development, production, and management of products and services at different stages of their life-cycle (Cassivi *et al.*, 2004). For instance, Sanders (2007), suggests that e-business technologies that particularly promote collaboration, such as groupware technologies positively influence a firm's performance. Organisational performance is treated here as a composite construct composed of multiple measures, including a financial metric. Raymond and Bergeron (2008) analysed the e-business capability of a sample of manufacturing SMEs finding that the use of the internet for collaborative purposes is shown to positively impact on the productivity. SMEs become more productive through online collaboration by their ability to leverage the resources and competencies of customers, suppliers and other business partners within an IT-enabled environment by inter-firm processes such as joint product research and development. In short, groupware applications provide significant benefits in terms of the duration, cost and effectiveness of collaborative R&D and product design projects. Moreover, according to Ordanini and Rubera (2008), these applications can create superior integration between different actors, enabling better knowledge creation and dissemination, and hence, acting as a positive moderator on performance.

These considerations lead us to frame the first hypothesis:

H1. Groupware systems are positively associated with CP.

On the other hand, what is critical is how customers process the information provided by the groupware systems (Cegarra *et al.*, 2007). Collective systems provide

a framework of information retrieval that facilitates the absorption of the information transferred by the users. Such information could be applied to what has already been transferred to customers and their activities or decisions. Very often, this process takes place by shopping-cart solutions or payment and verification systems, as opposed to what is mentioned in informal e-mails or open discussion forums. Collective systems can reduce the cost to place an order online, and there are likely to be fewer errors in orders and invoicing. As Barrat and Rosdahl (2002) have pointed out, these technologies enable the participants to achieve high levels of service in the form of speed, convenience, personalisation, price and make, cost and volume requirements transparent, which in turn may have the effect of improving organisational performance (Mercader *et al.*, 2006). Dubelaar *et al.* (2005) argue that the use of collective systems, like all things related with the shopping process, influences company growth in terms of income. Other research has also found some positive effects on productivity levels, productivity growth, and stock market value of firms (Hitt and Brynjolfsson, 1996). These aspects are also studied in our investigation in the following hypothesis:

H2. Collective systems are positively associated with CP.

3. The empirical study

The above hypotheses were investigated on the UK telecommunications industry. The UK telecommunications industry represents 4.1 percent of the UK GDP and the turnover in the industry grew by 6 percent (to £50.8 billion) in 2003, employing around 164,000 people in the UK both directly and indirectly (MBD, 2007). The UK telecommunications sector was chosen for the following reasons:

- firms in this sector are well known for their high-technology capabilities and capacities, with many of them having an existential dependency on technology;
- this sector in the UK has been the recipient of special attention in the last few years in terms of support for ICT implementation; and
- government policies in the UK and elsewhere have actively focused on promoting this industry.

In addition, gathering data from a specific sector eliminates the contextual factors and business operational characteristics that may affect the ICT-productivity relationship (Sigala, 2003). Therefore, the UK telecommunications industry is an appropriate setting for an investigation of ICT and its impact on CP.

CP is defined as output per unit of capital services. Difficulty in measuring CP arises from both the output and input sides, depending mainly on the availability and accuracy of data (Agrawal *et al.*, 1996). Several measures of CP have appeared in the literature (Chen and Liaw, 2001; Raouf, 1994; Wheatley, 1988). In particular, in the telecommunications sector most previous studies used the total revenue or turnover as the output unit (Lam and Lam, 2005). Hence, following Nachum (1999), we measured CP by dividing the firm's turnover by the firm's expenditure in 2007. These continuous measures were collected using data from the financial analysis made easy (FAME) database (based on the statistical year 2007). Using the University of Hull's access to the FAME database, we generated a list of 214 companies (SMEs) provided by this database as an initial sampling frame. However, 82 companies were removed from the list because not all the

relevant information was available on the database (e.g. turnover, expenditures, and number of employees). Consequently, 132 surveys were carried out, which suggests that the size of the sample is sufficient since it is greater than ten times the number of predictors from the indicators on the most complex formative construct or antecedent construct leading to an endogenous construct (Hair *et al.*, 1998). All companies were classified according to the EU classification[1] as SMEs. Following the recommendation of the Commission of the European Communities of April 3, 1996 (COM, 1996), business size was measured with a continuous measure with a minimum value of ten and a maximum value of 250 employees.

Before undertaking the survey, in collaboration with the University of Hull's Logistics Institute, we organised and conducted a series of telephone interviews with the managers of a pilot sample of three leading UK telecommunications businesses. During the last week of July 2007, we gathered information from these three companies. The aim of the telephone interviews was to gain first-hand information about what owners and/or managers understood by e-business. All of them mentioned, online purchasing, selling, production management, logistics, as well as internal communication and support services, and specifically identified three broad categories of the ICT (internet, groupware, and collective systems). From this pilot survey, and to avoid the effects of extreme symmetry (Andrews, 1984) by facilitating discrimination and reducing statistical error (Fornell, 1995), eight technology applications in each of the three broad categories were identified, as shown in Table I. These 24 constructs were measured by adapting a scale designed by Cegarra and Sabater (2005) to measure

ICT use		
P1. Internet connection	Yes	No
P2. Web site or homepage	Yes	No
P3. Catalogue and/or stock list on the internet	Yes	No
P4. Banners or links with other sites	Yes	No
P5. Counters and trackers	Yes	No
P6. Site map	Yes	No
P7. Search engine	Yes	No
P8. Bulletin board systems	Yes	No
P9. e-Mail	Yes	No
P10. Open discussion forums	Yes	No
P11. Open voting systems	Yes	No
P12. Open distribution lists	Yes	No
P13. Online calendars or agendas	Yes	No
P14. Repository of documents	Yes	No
P15. Newsgroup (USENET)	Yes	No
P16. Access to shared data base	Yes	No
P17. Tools to provide vendor recommendations	Yes	No
P18. Tools to estimate costs	Yes	No
P19. Tools to provide timeframes	Yes	No
P20. Affiliate programs with tracking (e.g. cookies)	Yes	No
P21. Customised billing systems	Yes	No
P22. Customer service management solutions	Yes	No
P23. Complete shopping cart solutions	Yes	No
P24. Payment and verification systems	Yes	No

Table I.
Summary of survey items

information technology systems. By examining the web page of each company, the presence (1) or absence (0) of these 24 technology applications were identified and three variables: internet (P1-P8), groupware (P9-P16) and collective systems (P17-P24) with a minimum value of zero and a maximum value of eight were defined. During the last two weeks of August 2007, every web page of each company (the 132 companies that we had information about their turnover, expenditures, number of employees) was examined to identify the presence of specific information technologies applications (1) or otherwise (0). As a result, three variables (internet, groupware, and collective systems) with a minimum value of zero and a maximum value of eight were identified.

3.1. Latent class factor analysis

To analyse the relationships between the different constructs and their indicators, we have adopted the latent class (LC) approach. In this approach, the latent variable is understood to determine the indicators, which therefore are called reflective indicators (Lazarsfeld and Henry, 1968). The LC factor model was originally proposed for use with nominal manifest and dichotomous latent variables in various confirmatory applications (Goodman, 1974). In this paper, we have utilised Latent Gold software (version 4.0), which allows continuous and count variables to be included in the models (Vermunt and Magidson, 2005).

Following Vermunt and Magidson (2000), four models were estimated that contained all effects (full models). Next, we tried to reduce the number of parameters of the full models by omitting non-significant parameters and by imposing equality restrictions among covariate levels and among transitions. This resulted in three null models, in which we used 1 percent significance levels to decide whether a particular restriction deteriorated the model fit. Several indices were used to compare the fit of the full and null models. One of them is the ratio of the χ^2 value to the degrees of freedom. A ratio less than three ($\chi^2/\mathrm{df} < 3$) indicates a good fit for the hypothesised model (Carmines and McIver, 1981). We also used the L^2 value, the lower the L^2 value the better was the fit of the model (Vermunt and Magidson, 2000). Finally, we computed the Bayes information criterion (BIC). The lower the BIC value, the better was the fitting and the more parsimonious the model (Raftery, 1986). The values of L^2, BIC and the number of parameters for full and null models estimated are shown in Table II.

The results show that null models are preferable to full models in the first three constructs (internet, groupware and collective systems). For those constructs, the BIC values indicate that the variables (P4, P5, P8, P9, P12, P15, P17, P18, and P22) in the full models are not needed. So the remaining 15 measures were represented by three single factors labeled: internet systems, groupware systems and collective systems, with a minimum value of zero and a maximum value of five.

The hypothesised relationships were tested using hierarchical regression analysis. Hierarchical regression enables the researcher to maintain control over the variables entered into the model while simultaneously assessing the extra contribution of the new blocks of variables. This enables the researcher to analyse the proportion of variance shared with each individual variable (Licht, 2003).

As independent variables of hierarchical regressions may be highly correlated with the dependent variable when there is no correlation between them, independent variables can present problems of multicolinearity (Peterson, 1994). Therefore, using the correlation matrix (Table III) as an initial guide, "tolerance" and "variance inflation

Table II. Latent class factor models

	Internet systems					Groupware systems					Collective systems			
	Full model		Null model			Full model		Null model			Full model		Null model	
Items	Loadings	R^2	Loadings	R^2	Items	Loadings	R^2	Loadings	R^2	Items	Loadings	R^2	Loadings	R^2
P1	0.59*	0.35	0.61	0.37	P9	−0.07	0.00	–	–	P17	−0.07	0.00	–	–
P2	0.47*	0.22	0.45	0.20	P10	0.91*	0.83	0.93**	0.86	P18	−0.09	0.01	–	–
P3	0.71*	0.50	0.74	0.54	P11	0.33*	0.11	0.34**	0.11	P19	0.91*	0.83	0.93**	0.86
P4	0.14	0.02	–	–	P12	−0.09	0.01	–	–	P20	0.33*	0.11	0.34**	0.11
P5	0.20	0.04	–	–	P13	0.65*	0.42	0.63*	0.40	P21	0.65*	0.42	0.63*	0.40
P6	0.62*	0.38	0.64	0.40	P14	0.34*	0.12	0.33*	0.11	P22	−0.04	0.00	–	–
P7	0.50*	0.25	0.46	0.21	P15	−0.04	0.00	–	–	P23	0.34**	0.12	0.33*	0.11
P8	0.10	0.01	–	–	P16	0.47*	0.22	0.45**	0.20	P24	0.47*	0.23	0.46**	0.21
	$\chi^2_{(122)} = 212.8^*$		$\chi^2_{(20)} = 34.52^{**}$			$\chi^2_{(122)} = 169.89^*$		$\chi^2_{(20)} = 12.18$			$\chi^2_{(122)} = 172.94^*$		$\chi^2_{(20)} = 11.79$	
	$L^2 = 104.19^*$		$L^2 = 36.47^{**}$			$L^2 = 130.15$		$L^2 = 16.02$			$L^2 = 131.58^*$		$L^2 = 15.61$	
	$\chi^2/df = 1.79$		$\chi^2/df = 1.72$			$\chi^2/df = 1.39$		$\chi^2/df = 0.61$			$\chi^2/df = 1.41$		$\chi^2/df = 0.58$	
	BIC = 1063.75		BIC = 879.86			BIC = 1172.86		BIC = 573.57			BIC = 1170.75		BIC = 571.46	

Notes: * < 0.01; ** < 0.05; *** < 0.1; scale reliability coefficient (α = Cronbach's alpha); Kaiser-Meyer-Olkin (KMO); Bartlett's sphericity test (BST)

Table III.
Correlation matrix analysed

Eigenvalue	CNB		μ	σ	Business size	Internet systems	Groupware systems	Collective systems	Capital productivity	Collinearity statistics Tolerance	VIF
4.461	1.000	Business size	61.674	29.532	1.000					0.939	1.065
0.291	3.915	Internet systems	2.205	1.661	0.033	1.000				0.877	1.140
0.164	5.212	Groupware systems	3.848	1.195	0.099	0.323*	1.000			0.777	1.287
0.051	9.351	Collective systems	3.841	1.190	−0.170***	0.244*	0.380*	1.000		0.795	1.257
0.033	11.642	Capital productivity	22.681	2.100	0.036	0.182**	0.300*	0.304*	1.000	–	–

Notes: * < 0.01; ** < 0.05; *** < 0.1; CNB; mean (μ); standard deviation (σ); VIF: variance inflation factor

factor" (VIF = 1/tolerance) were calculated. The "tolerance" value indicates the percent of variance in the predictor that cannot be accounted for by the other predictors, hence, very small values indicate that a predictor is redundant, and values that are less than (0.10) or equivalent when VIF > 10 suggest the need for further investigation. Furthermore, all condition number bounds (CNB) from the five components were not greater than 15, with the lowest eigenvalue for the fifth dimension being 0.033 (Table III), thus confirming that multicolinearity does not exist among the variables included in the analysis (Hair *et al.*, 1998). Table III also provides an overview of the construct's means, standard deviations and correlations. The hypotheses were tested using statistical package for the social sciences (version 15) and the results are shown in the next section.

4. Results

As shown in Table IV, a regression model is tested. This model examines the mediating effect of groupware and collective systems. We have adopted Baron and Kenny's (1986) three-step hierarchical regression analysis procedure. In Step 1, the control variables are entered into the regression equation (i.e. business size and internet systems). Step 2 includes the controls and groupware systems (the independent variable). Finally, in Step 3, the collective systems variable is added.

As shown in the groupware system model (Table IV), groupware systems have a significant impact on CP (the dependent variable) ($\beta = 0.269$, $p < 0.01$). Table IV also shows that the addition of the mediation term (Step 2) significantly improved the results from Step 1 ($p < 0.01$), and the previously significant relationship between internet systems and CP ($\beta = 0.181$, $p < 0.05$) became non-significant ($\beta = 0.095$, ns). These results support groupware variable as a full mediator of the relationship between internet systems and CP. Table IV indicates that the addition of the mediation term (Step 3) significantly improved the results from Step 2 ($p < 0.01$), and importantly, the previously significant relationship between the groupware variable and CP ($\beta = 0.269$, $p < 0.01$) remained significant ($\beta = 0.188$, $p < 0.05$). Furthermore, Table IV indicates that the second mediating variable, collective systems, also has a

	Control model	Groupware system model	Collective system model
Step 1			
Business size	0.03	0.06	0.053
Internet systems	0.181**	0.095	0.064
Step 2			
Groupware system		0.269*	0.188**
Step 3			
Collective system			0.226**
R^2	0.034	0.098	0.139
Adj. R^2	0.019	0.077	0.111
F	2.27	4.637*	5.105*
Change in R^2	0.034	0.064	0.040
Change in F	2.27	9.087*	5.968*
p-value	0.107	0.004	0.001

Notes: * < 0.01; ** < 0.05; *** < 0.1

Table IV.
Results of hierarchical regression for mediation impact of collective systems

significant positive effect on CP ($\beta = 0.226$, $p < 0.05$). These results provide support for groupware systems and collective systems as full mediators of the internet-CP relationship, providing substantial support for *H1* and *H2*.

5. Discussion

Research on the direct impact of IT on specific performance measures has been studied at length resulting in inconsistent results, suggesting that a productivity paradox exits. Whereas previous research has offered numerous explanations for this paradox, recent empirical investigation using new data and methodologies, have found that ICT is associated with improvements in productivity. Consequently, the first contribution of this research was to question the existing models that relate ICT and SME competitiveness. The results of this study provide interesting insights into the drivers of performance for companies using e-business technologies. The results support the conclusion that, to improve CP, managers need to provide and support a context with two dimensions:

(1) groupware applications (a framework from which information can be transferred); and

(2) collective systems (a framework from which information can be used).

The second contribution of this research derives from the results of the empirical test of the model. In this study, we have considered two models of e-business and their effects on "capital productivity" within the SMEs. We tested our "groupware system model" with groupware systems treated as an intermediate variable between the control variables and CP, and against the "collective system model", including groupware and collective systems as intermediate variables between the control variables and CP. The results suggest that internet programs need to be designed around "groupware applications and collective systems" to attain any benefit from the information provided by the web sites. As Saeed *et al.* (2005) state, once the consumer makes the decision to buy a product from a company, an exclusive relationship is developed, and switching among web sites becomes meaningless. Thus, functionalities related to post purchase could be instrumental in building long-term performance.

Another reason for SMEs failing to benefit from e-business systems could be that they fail to integrate groupware systems among their customers. Although groupware systems potentially facilitate information sharing and joint sense-making, if those processes are not balanced appropriately, purchasing by customers is likely to suffer, causing a decline in the competitiveness of the small companies. Considering this, we argue that collective systems can help customers remain committed to web sites and contribute to groupware utilisation and CP. Therefore, to consolidate e-business results, managers need to reinforce the environment in which customers operate and provide them with the means to make their own decisions. In this regard, customer loyalty programs that currently exist in the physical marketplace can provide guidance. Frequent flyer programs, product trade-in options, and maintenance plans are examples of programs used by companies in the physical marketplace to create customer value.

These results lead us to suggest that collective systems can play a more active role in SMEs by helping them to improve key customer relations and therefore enhance performance through adequate knowledge use (Sparrow, 2001). If this is the case, it can be said that managers should take steps to ensure that efforts in ICT initiatives not

only aim to implement internet and groupware applications, but also target the development of SME capabilities including collective systems. This level of governance can enable customers to use their existing knowledge to use and modify an electronic service. It can also allow them to gain more knowledge that could help their decision-making processes in the future, for instance by exerting accountability on the provision of services by their suppliers (Cegarra and Sabater, 2005).

Previous research has found that while e-commerce has spread rapidly throughout large firms, its growth among SMEs has been much less pervasive (Pool *et al.*, 2006). However, our results challenge these traditional views, as they suggest that firm size is not an important antecedent to improve CP through groupware and collective systems. A possible explanation for this would be the fact that although the implementation of e-business needs to involve initial set-up costs and subsequent maintenance and improvement, the cost of implementation of e-business in SMEs is not too high and the economic and institutional benefits are often short-term (Levy *et al.*, 2005). Our findings also support that although ICTs provide many opportunities for the SMEs, many of those companies have not capitalised on this new method of carrying out electronic business. This is because ICTs do not happen serendipitously or randomly. It must be carefully managed through the assignment of appropriate technologies (Levy *et al.*, 2005) and supported by mechanisms for improvement. Most importantly, continued efforts are required to address the ICT capability and information gaps identified among the SME's customers (Harindranath *et al.*, 2008). This is especially true if customers have not previously used any electronic means of communication (Nath *et al.*, 1998). For the purposes of this paper, the ICTs that facilitate CP are technologies that support interaction with the customers. The internet, groupware applications and collective systems allow the exploration and exploitation of the stored information and permit the users (e.g. customers) to understand and censor new products and services for their eventual benefit.

This study has some limitations. First, concurrent with the global move towards liberalisation over the last two decades research interests have shifted to the measurement of industry performance under alternative regulatory regimes. Productivity measurement has become a popular area in telecommunications research (Lam and Lam, 2005). However, Kholi *et al.* (2003) suggest that measuring payoff is more difficult in e-business environments because these applications cut across boundaries affecting multiple parties. Hence, considering alternative metrics to measure payoff from multiple perspectives could be necessary. Second, only a single research methodology was employed, and further research through interviews and observational case studies could be undertaken for triangulation. Finally, productivity measurement was conducted only in the UK telecommunications sector, and hence findings are valid within this specific context. Future research could investigate CP in different sectors and countries.

6. Conclusion

This paper has examined the relative importance and significance of e-business technologies on CP through an empirical investigation of 132 businesses in the UK Telecommunication sector by using a hierarchical regression. The main conclusions are that there is a significant lack of use of the internet by SMEs for increasing their CP and the improvement of CP is significantly affected by groupware applications and collective systems. Therefore, the UK SMEs, and possibly other large companies,

might be over-investing in the development of web sites to support their internet presence, but at the same time, they are under-investing in promoting awareness and use of these services by customers (i.e. groupware applications and collective systems). These findings can guide managers in focusing their energies on e-business technologies and suggest an approach to determine which e-business technologies are more likely to lead to a boost in productivity. Furthermore, a key challenge that needs to be addressed in the near future is the development of client governance with collective systems that can lead organisations to learn to trust their customers (not only customers trusting their suppliers!). With the ideas contained in our paper, we have taken a first step towards better approaches for the development of more useful, interactive, and accountable, electronic services to customers.

Note

1. According to the European Commission (2003, p. 36), SMEs comprise fewer than 250 employees, with an annual turnover not exceeding €50 million euros and an annual balance sheet total not exceeding €43 million euros.

References

Agarwal, R. and Venkatesh, V. (2002), "Assessing a firm's web presence: a heuristic evaluation procedure for the measurement of usability", *Information Systems Research*, Vol. 13 No. 2, pp. 168-86.

Agrawal, J., Findley, S., Greene, S., Huang, K., Jeddy, A., Lewis, W.W. and Petry, M. (1996), "Why the US leads and why it matters", *The McKinsey Quarterly*, Vol. 3, pp. 39-50.

Andrews, F.M. (1984), "Construct validity and error components of survey measures: a structural modelling approach", *Public Opinion Quarterly*, Vol. 48, pp. 409-22.

Artail, H.S. (2006), "Application of KM measures to the impact of a specialized groupware system on corporate productivity and operations", *Information & Management*, Vol. 43, pp. 551-64.

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17, pp. 99-120.

Baron, R.M. and Kenny, D.A. (1986), "The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, Vol. 51, pp. 1173-82.

Barrat, M. and Rosdahl, K. (2002), "Exploring business-to-business marketsite", *European Journal of Purchasing & Supply Management*, Vol. 8, pp. 111-22.

Brown, M. (2002), "The use of banner advertisement with pull-down menus: a copy testing approach", *Journal of Interactive Advertising*, Vol. 2 No. 2, pp. 12-37.

Brynjolfsson, E. (1993), "The productivity paradox of information technology", *Communications of the ACM*, Vol. 36 No. 12, pp. 67-77.

Brynjolfsson, E. and Smith, M.D. (2000), "Frictionless commerce? A comparison of internet and conventional retailers", *Management Science*, Vol. 46 No. 4, pp. 563-85.

Cagliano, R., Caniato, F. and Spina, G. (2003), "E-business strategy: how companies are shaping their supply chain through the internet", *International Journal of Operations & Production Management*, Vol. 23 No. 10, pp. 1142-62.

Carmines, E.G. and McIver, S.P. (1981), "Analyzing models with unobserved variables: analysis of covariance structures", in Bohrnstedt, G.W. and Borgatta, E.F. (Eds), *Social Measurement; Current Issues*, Sage, Beverly Hills, CA, pp. 65-115.

Cassivi, L., Lefebvre, E., Lefebvre, L.A. and Leger, P.-M. (2004), "The impact of e-collaboration tools on firms' performance", *International Journal of Logistics Management*, Vol. 15 No. 1, pp. 91-110.

Cegarra, J.G. and Sabater, R. (2005), "E-leearning: organizational requirements for successful feedback learning", *Journal of Workplace Learning*, Vol. 17 Nos 5/6, pp. 276-90.

Cegarra, J.G., Dewhurst, F.W. and Briones, A.J. (2007), "Factors affecting the use of e-government in the telecommunications industry of Spain", *Technovation*, Vol. 27, pp. 595-604.

Chen, L. and Liaw, S. (2001), "Investigating resource utilization and product competence to improve production management. An empirical study", *International Journal of Operations & Production Management*, Vol. 21 No. 9, pp. 1180-94.

COM (1996), *Recommendation on Definitions of Small and Medium-sized Enterprises*, COM, Brussels, (1996-07-10 COM, 96), 329 final.

Craig, C.E. and Harris, R.C. (1973), "Total productivity measurement at the firm level", *Sloan Management Review*, Vol. 14, pp. 13-29.

Croom, S.R. (2005), "The impact of e-business on supply chain management. An empirical study of key developments", *International Journal of Operations & Production Management*, Vol. 25 No. 1, pp. 55-73.

Cullen, A. and Webster, M. (2007), "A model of B2B e-commerce, based on connectivity and purpose", *International Journal of Operations & Production Management*, Vol. 27 No. 2, pp. 205-25.

Dos Santos, B.L., Peffers, G.K. and Mauer, D.C. (1993), "The impact of information technology investment announcements on the market value of the firm", *Information Systems Research*, Vol. 4 No. 1, pp. 1-23.

Dubelaar, C., Sohal, A. and Savic, V. (2005), "Benefits, impediments and critical success factors in B2C e-business adoption", *Technovation*, Vol. 25, pp. 1251-62.

European Commission (2003), SME definition: Commission Recommendation of 6 May 2003, Office for Official Publications of the European Communities, Luxembourg, p. 36, Report L 124/39, available at: http://europa.eu.int/comm/enterprise/enterprise_policy/sme_definition/index_en.htm

Falk, M. (2005), "ICT-linked firm reorganisation and productivity gains", *Technovation*, Vol. 25, pp. 1229-50.

Fornell, C. (1995), "The quality of economic output: empirical generalizations about its distribution and association of market share", *Marketing Science*, Vol. 14 No. 3, pp. 203-11.

Fowler, A. (2000), "The role of AI-based technology in support of the knowledge management value activity cycle", *Journal of Strategic Information Systems*, Vol. 9 Nos 2/3, pp. 107-28.

Ghosal, V. and Nair-Reichert, U. (2009), "Investments in modernization, innovation and gains in productivity: evidence from firms in the global paper industry", *Research Policy*, Vol. 38 No. 3, pp. 536-47.

Goodman, L.A. (1974), "The analysis of systems of qualitative variables when some of the variables are unobservable: Part I: a modified latent structure approach", *American Journal of Sociology*, Vol. 79, pp. 1179-259.

Grover, V. and Malhotra, M. (1997), "Business process reengineering: a tutorial concept, evolution, method, technology, and application", *Journal of Operations Management*, Vol. 15 No. 3, pp. 193-213.

Gummersson, E. (1998), "Productivity, quality, relationship marketing in service organizations", *International Journal of Contemporary Hospitality Management*, Vol. 10 No. 1, pp. 4-15.

Gunawan, G., Ellis-Chadwick, F. and King, M. (2008), "An empirical study of the uptake of performance measurement by internet retailers", *Internet Research*, Vol. 18 No. 4, pp. 361-81.

Hair, J.F.J., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998), *Multivariate Data Analysis*, 5th ed., Prentice-Hall, Englewood Cliffs, NJ.

Harindranath, G., Dyerson, R. and Barnes, D. (2008), "ICT adoption and use in UK SMEs: a failure of initiatives?", *The Electronic Journal Information Systems Evaluation*, Vol. 11 No. 2, pp. 91-6.

Hinton, M. and Barnes, D. (2009), "Discovering effective performance measurement for e-business", *International Journal of Productivity and Performance Management*, Vol. 58 No. 4, pp. 329-45.

Hitt, L.M. and Brynjolfsson, E. (1996), "Productivity, business profitability, and consumer surplus: three different measures of information technology value", *MIS Quarterly*, Vol. 20 No. 2, pp. 121-42.

Hoffman, D.L. and Novak, T.P. (2000), "How to acquire customers on the web", *Harvard Business Review*, Vol. 78, pp. 179-84.

Ittner, C.D., Larcker, D.F. and Rajan, M.V. (1997), "The choice of performance measures in annual bonus contracts", *Accounting Review*, Vol. 72 No. 2, pp. 231-55.

Kholi, R., Sherer, S.A. and Baron, A. (2003), "IT investment payoff in e-business environments: research issues", *Information Systems Frontiers*, Vol. 5 No. 3, pp. 239-47.

Kim, J.Y., Song, J. and Koo, C. (2008), "Exploring the effect of strategic positioning on firm performance in the e-business context", *International Journal of Information Management*, Vol. 28, pp. 203-14.

Koellinger, P. (2008), "The relationship between technology, innovation, and firm performance—empirical evidence from e-business in Europe", *Research Policy*, Vol. 37, pp. 1317-28.

Lam, P. and Lam, T. (2005), "Total factor productivity measures for Hong Kong telephone", *Telecommunications Policy*, Vol. 29, pp. 53-68.

Lazarsfeld, P.F. and Henry, N.W. (1968), *Latent Structure Analysis*, Houghton Mill, Boston, MA.

Lee, B. and Barua, A. (1999), "Assessing productivity and efficiency impacts of information technologies: old data, new analysis and evidence", *Journal of Productivity Analysis*, Vol. 12 No. 1, pp. 21-43.

Lee, J. and Runge, J. (2001), "Adoption of information technology in small business: testing drivers of adoption for entrepreneurs", *The Journal of Computer Information Systems*, Vol. 42 No. 1, pp. 44-57.

Levy, M., Powell, P. and Worrall, L. (2005), "Strategic intent and e-business in SMEs: enablers and inhibitors", *Information Resources Management Journal*, Vol. 18 No. 4, pp. 1-20.

Licht, M.H. (2003), "Multiple regression and correlation", in Grimm, L.G. and Yarnold, P.R. (Eds), *Reading and Understanding Multivariate Statistics*, American Psychological Association, Washington, DC.

Lohr, S. (1999), "Computer age gains respect of economists", *New York Times*, p. A1.

Mabert, V., Soni, A. and Venkataramanan, M. (2001), "Enterprise resource planning: common myths versus evolving reality", *Business Horizon*, Vol. 44 No. 3, pp. 69-76.

Mahoney, J.T. and Pandian, J.R. (1992), "The resource-based view within the conversation of strategic management", *Strategic Management Journal*, Vol. 13, pp. 363-80.

March, J.G. and Sutton, R.I. (1997), "Organizational performance as a dependent variable", *Organization Science*, Vol. 8 No. 6, pp. 698-706.

MBD (2007), *UK Telecommunications Equipment Market Development*, Market and Business Development, Manchester, pp. 1-65.

Mercader, J., Meroño, A.L. and Sabater, R. (2006), "Information technology and learning: their relationship and impact on organizational performance in small business", *International Journal of Information Management*, Vol. 26 No. 1, pp. 16-29.

Meroño-Cerdán, A.L. (2008), "Groupware uses and influence on performance in SMEs", *Journal of Computer Information Systems*, Vol. 48 No. 4, pp. 87-96.

Nachum, L. (1999), "Measurement of productivity of professional services: an illustration on Swedish management consultant firms", *International Journal of Operations & Production Management*, Vol. 19 No. 9, pp. 922-49.

Nath, R., Akmanligil, M., Hjelm, K., Sakaguchi, T. and Schultz, M. (1998), "Electronic commerce and the internet: issues, problems, and perspectives", *International Journal of Information Management*, Vol. 18 No. 2, pp. 91-101.

Naylor, J. and William, J. (1994), "The successful use of IT in SMEs on Merseyside", *European Journal of Information Systems*, Vol. 3 No. 1, pp. 48-56.

ONS (2006), *ONS e-Commerce Survey of Business 2006*, Office for National Statistics, Newport.

Ordanini, A. and Rubera, G. (2008), "Strategic capabilities and internet resources in procurement: a resource-based view of B-to-B buying Process", *International Journal of Operations & Production Management*, Vol. 28 No. 1, pp. 27-52.

Peterson, R.A. (1994), "A meta-analysis of Cronbach's coefficient alpha", *Journal of Consumer Research*, Vol. 21, pp. 381-91.

Pool, P.W., Parnell, J.A., Spillan, J.E., Carraher, S. and Lester, D.L. (2006), "Are SMEs meeting the challenge of integrating e-commerce into their businesses? A review of the development, challenges and opportunities", *International Journal of Information Technology and Management*, Vol. 5 Nos 2/3, pp. 97-113.

Porter, M.E. (2001), "Strategy and the internet", *Harvard Business Review*, Vol. 79, pp. 63-78.

Raftery, A.E. (1986), "Choosing models for cross-classifications", *American Sociological Review*, Vol. 51, pp. 145-6.

Raouf, A. (1994), "Improving capital productivity through maintenance", *International Journal of Operations & Production Management*, Vol. 14 No. 7, pp. 44-52.

Raymond, L. and Bergeron, F. (2008), "Enabling the business strategy of SMEs through e-business capabilities: a strategic alignment perspective", *Industrial Management & Data Systems*, Vol. 108 No. 5, pp. 577-95.

Rayport, J. and Jaworski, B. (2001), *e-Commerce*, McGraw-Hill, Irwin, NY.

Reis, F. (2006), "The internet and other computer networks and their use by European enterprises to do ebusiness", *Statistics in Focus*, Vol. 18, Eurostat, European Commission, Brussels.

Roach, S.S. (1989), *The Case of the Missing Technology Payback*, Tenth International Conference on Information Systems, Boston, MA, December.

Robey, D., Boudreau, M.C. and Rose, G.M. (2000), "Information technology and organizational learning: a review and assessment of research", *Accounting Management and Information Technologies*, Vol. 10 No. 2, pp. 125-55.

Rodgers, S. and Thorson, E. (2000), "The interactive advertising model: how users perceive and process online ads", *Journal of Interactive Advertising*, Vol. 1 No. 1, pp. 15-22.

Saeed, K.A., Grover, V. and Hwang, Y. (2005), "The relationship of e-commerce competence to customer value and firm performance: an empirical investigation", *Journal of Management Information Systems*, Vol. 22 No. 1, pp. 223-56.

Sanders, N.R. (2007), "An empirical study of the impact of e-business technologies on organizational collaboration and performance", *Journal of Operations Management*, Vol. 25, pp. 1332-47.

Sauer, C. (2000), "Managing the infrastructure", in Willcocks, L. and Sauer, C. (Eds), *Moving to e-Business*, Random House, London.

Schubert, P. and Selz, D. (1997), "Web assessment—measuring the effectiveness of electronic commerce sites going beyond traditional marketing paradigms", *Journal of Electronic Markets*, Vol. 7 No. 3, pp. 46-8.

Sigala, M. (2003), "The information and communication technologies productivity impact on the UK hotel sector", *International Journal of Operations & Production Management*, Vol. 23 No. 10, pp. 1224-45.

Simpson, M. and Docherty, A.J. (2004), "E-commerce adoption support and advice for UK SMEs", *Journal of Small Business and Enterprise Development*, Vol. 11 No. 3, pp. 315-28.

Sircar, S. and Choi, J. (2009), "A study of the impact of information technology on firm performance: a flexible production function approach", *Information Systems Journal*, Vol. 19 No. 3, pp. 313-39.

Sorensen, C. and Lundh-Snis, U. (2001), "Innovation through knowledge codification", *Journal of Information Technology*, Vol. 16, pp. 83-97.

Soto-Acosta, P. and Meroño-Cerdán, A.L. (2008), "Analyzing e-business value creation from a resource-based perspective", *International Journal of Information Management*, Vol. 28, pp. 49-60.

Sparrow, J. (2001), "Knowledge management in small firms", *Knowledge and Process Management*, Vol. 8 No. 1, pp. 3-16.

Strassmann, P. (1990), *The Business Value of Computers: An Executive's Guide*, Information Economic Press, New Canaan, CT.

Straub, D. and Watson, R. (2001), "Transformational issues in researching IS and net-enabled organizations", *Information Systems Research*, Vol. 12, pp. 337-45.

Subramaniam, C., Shaw, M.J. and Gardner, D.M. (2000), "Product marketing and channel management in electronic commerce", *Information Systems Frontiers*, Vol. 1, pp. 363-79.

Sumanth, D.J. (1984), *Productivity Engineering and Management*, McGraw-Hill, New York, NY.

Tavana, M., Khakbaz, M.H. and Jafari-Songhori, M. (2009), "Information technology's impact on productivity in conventional power plants", *International Journal of Business Performance Management*, Vol. 11 No. 3, pp. 187-202.

Tetteh, E. and Burn, J. (2001), "Global strategies for SME business: applying the SMALL, framework", *Logistic Information Management*, Vol. 14 Nos 1/2, pp. 171-80.

Timmers, P. (1998), "Business models for electronic markets", *Electronic Markets*, Vol. 2 No. 2, pp. 3-8.

Vermunt, J.K. and Magidson, J. (2000), *Latent GOLD 2.0 User's Guide*, Statistical Innovations, Belmont, MA.

Vermunt, J.K. and Magidson, J. (2005), *Latent GOLD 4.0 User's Guide*, Statistical Innovations, Belmont, MA.

Webb, B.R. and Schlemmer, F. (2008), "Predicting web services performance from internet performance: an empirical study of resources and capabilities in e-business SMEs", *Journal of Knowledge Management*, Vol. 12 No. 6, pp. 137-55.

Weill, P. (1992), "The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector", *Information Systems Research*, Vol. 3 No. 4, pp. 307-33.

Wheatley, J.J. (1988), "Performance measures in telecommunications: changing needs", *Technovation*, Vol. 8, pp. 201-16.

Wilson, R.L. (1994), "An improved goal-oriented method for measuring productivity", *International Journal of Operations & Production Management*, Vol. 14 No. 1, pp. 50-9.

Further reading

Brynjolfsson, E. and Hitt, L. (1996), "Paradox lost? Firm-level evidence on the returns to information systems spending", *Management Science*, Vol. 42 No. 4, pp. 541-58.

Gunnlaugsdottir, J. (2003), "Seek and you will find, share and you will benefit: organising knowledge using groupware systems", *International Journal of Information Management*, Vol. 23 No. 5, pp. 363-80.

Konings, J. and Roodhooft, F. (2002), "The effect of e-business on corporate performance: firm level evidence for Belgium", *De Economist*, Vol. 150, pp. 569-81.

Lehr, B. and Lichtenberg, F. (1999), "Information technology and its impact on productivity: firm-level evidence from government and private data sources, 1977-1993", *Canadian Journal of Economics*, Vol. 32 No. 2, pp. 335-62.

Stratopoulos, T. and Dehning, B. (2000), "Does successful investment in information technology solve the productivity paradox?", *Information & Management*, Vol. 38, pp. 103-17.

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