

# **Beyond Computation: Information Technology, Organizational Transformation and Business Performance**

Erik Brynjolfsson and Lorin M. Hitt

**H**ow do computers contribute to business performance and economic growth? Even today, most people who are asked to identify the strengths of computers tend to think of computational tasks like rapidly multiplying large numbers. Computers have excelled at computation since the Mark I (1939), the first modern computer, and the ENIAC (1943), the first electronic computer without moving parts. During World War II, the U.S. government generously funded research into tools for calculating the trajectories of artillery shells. The result was the development of some of the first digital computers with remarkable capabilities for calculation—the dawn of the computer age.

However, computers are not fundamentally number crunchers. They are symbol processors. The same basic technologies can be used to store, retrieve, organize, transmit, and algorithmically transform any type of information that can be digitized—numbers, text, video, music, speech, programs, and engineering drawings, to name a few. This is fortunate because most problems are not numerical problems. Ballistics, code breaking, parts of accounting, and bits and pieces of other tasks involve lots of calculation. But the everyday activities of most managers, professionals, and information workers involve other types of

■ *Erik Brynjolfsson is Associate Professor of Information Technology and Management, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Massachusetts and Co-director of the Center for eBusiness at MIT. Lorin M. Hitt is Assistant Professor of Operations and Information Management, Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania. Their e-mail addresses are <erikb@mit.edu> and <lhitt@wharton.upenn.edu> and their websites are <<http://ebusiness.mit.edu/erik>> and <<http://grace.wharton.upenn.edu/~lhitt>>, respectively.*

thinking. As computers become cheaper and more powerful, the business value of computers is limited less by computational capability and more by the ability of managers to invent new processes, procedures and organizational structures that leverage this capability. As complementary innovations continue to develop, the applications of computers will expand well beyond computation for the foreseeable future.

The fundamental economic role of computers becomes clearer if one thinks about organizations and markets as information processors (Galbraith, 1977; Simon, 1976; Hayek, 1945). Most of our economic institutions and intuitions emerged in an era of relatively high communications cost and limited computational capability. Information technology, defined as computers as well as related digital communication technology, has the broad power to reduce the costs of coordination, communications, and information processing. Thus, it is not surprising that the massive reduction in computing and communications costs has engendered a substantial restructuring of the economy. The majority of modern industries are being significantly affected by computerization.

As a result, information technology is best described not as a traditional capital investment, but as a “general purpose technology” (Bresnahan and Trajtenberg, 1995). In most cases, the economic contributions of general purpose technologies are substantially larger than would be predicted by simply multiplying the quantity of capital investment devoted to them by a normal rate of return. Instead, such technologies are economically beneficial mostly because they facilitate complementary innovations.

Earlier general purpose technologies, such as the telegraph, the steam engine and the electric motor, illustrate a pattern of complementary innovations that eventually lead to dramatic productivity improvements. Some of the complementary innovations were purely technological, such as Marconi’s “wireless” version of telegraphy. However, some of the most interesting and productive developments were organizational innovations. For example, the telegraph facilitated the formation of geographically dispersed enterprises (Milgrom and Roberts, 1992); while the electric motor provided industrial engineers more flexibility in the placement of machinery in factories, dramatically improving manufacturing productivity by enabling workflow redesign (David, 1990). The steam engine was at the root of a broad cluster of technological and organizational changes that helped ignite the first industrial revolution.

In this paper, we review the evidence on how investments in information technology are linked to higher productivity and organizational transformation, with emphasis on studies conducted at the firm level. Our central argument is twofold: first, that a significant component of the value of information technology is its ability to enable complementary organizational investments such as business processes and work practices; second, these investments, in turn, lead to productivity increases by reducing costs and, more importantly, by enabling firms to increase output quality in the form of new products or in improvements in intangible aspects of existing products like convenience, timeliness, quality, and

variety.<sup>1</sup> There is substantial evidence in both the case literature on individual firms and multi-firm econometric analyses supporting both these points, which we review and discuss in the first half of this paper. This emphasis on firm-level evidence stems in part from our own research focus but also because firm-level analysis has significant measurement advantages for examining intangible organizational investments and product and service innovation associated with computers.

Moreover, as we argue in the latter half of the paper, these factors are not well captured by traditional macroeconomic measurement approaches. As a result, the economic contributions of computers are likely to be understated in aggregate level analyses. Placing a precise number on this bias is difficult, primarily because of issues about how private, firm-level returns aggregate to the social, economy-wide benefits and assumptions required to incorporate complementary organizational factors into a growth accounting framework. However, our analysis suggests that the returns to computer investment may be substantially higher than what is assumed in traditional growth accounting exercises. Furthermore, total capital stock (including intangible assets) associated with the computerization of the economy may be understated by a factor of ten. Taken together, these considerations suggest the bias is on the same order of magnitude as the currently measured benefits of computers.

Thus, while the recent macroeconomic evidence about computer contributions is encouraging, our views are more strongly influenced by the microeconomic data. The micro data suggest that the surge in productivity that we now see in the macro statistics has its roots in over a decade of computer-enabled organizational investments. The recent productivity boom can in part be explained as a return on this large, but intangible form of capital.

## **Case Examples**

Companies using information technology to change the way they conduct business often say that their investment in information technology complements changes in other aspects of the organization. These complementarities have a number of implications for understanding the value of computer investment. To be successful, firms typically need to adopt computers as part of a “system” or “cluster” of mutually reinforcing organizational changes (Milgrom and Roberts, 1990). Changing incrementally, either by making computer investments without organizational change, or only partially implementing some organizational changes, can create significant productivity losses as any benefits of computerization are more than outweighed by negative interactions with existing organizational practices (Brynjolfsson, Renshaw and Van Alstyne, 1997). The need for “all or nothing”

<sup>1</sup> For a more general treatment of the literature on information technology value, see reviews by Brynjolfsson (1993); Wilson (1995); and Brynjolfsson and Yang (1996). For a discussion of the problems in economic measurement of computers contributions at the macroeconomic level, see Baily and Gordon (1988), Siegel (1997), and Gullickson and Harper (1999).

changes between complementary systems was part of the logic behind the organizational reengineering wave of the 1990s and the slogan “Don’t Automate, Obliterate” (Hammer, 1990). It can also explain why many large scale information technology projects fail (Kemerer and Sosa, 1991), while successful information technology adopters earn significant rents.

Many of the past century’s most successful and popular organizational practices reflect the historically high cost of information processing. For example, hierarchical organizational structures can reduce communications costs because they minimize the number of communications links required to connect multiple economic actors, as compared with more decentralized structures (Malone, 1987; Radner, 1993). Similarly, producing simple, standardized products is an efficient way to utilize inflexible, scale-intensive manufacturing technology. However, as the cost of automated information processing has fallen by over 99.9 percent since the 1960s, it is unlikely that the work practices of the previous era will also be the same ones that best leverage the value of cheap information and flexible production. In this spirit, Milgrom and Roberts (1990) construct a model in which firms’ transition from “mass production” to flexible, computer-enabled, “modern manufacturing” is driven by exogenous changes in the price of information technology. Similarly, Bresnahan (1999) and Bresnahan, Brynjolfsson and Hitt (2000) show how changes in information technology costs and capabilities lead to a cluster of changes in work organization and firm strategy that increase the demand for skilled labor.

In this section we will discuss case evidence on three aspects of how firms have transformed themselves by combining information technology with changes in work practices, strategy, and products and services; they have transformed the firm, supplier relations, and the customer relationship. These examples provide qualitative insights into the nature of the changes, making it easier to interpret the more quantitative econometric evidence that follows.

### **Transforming the Firm**

The need to match organizational structure to technology capabilities and the challenges of making the transition to an information technology-intensive production process is concisely illustrated by a case study of “MacroMed” (a pseudonym), a large medical products manufacturer (Brynjolfsson, Renshaw and Van Alstyne, 1997). In a desire to provide greater product customization and variety, MacroMed made a large investment in computer integrated manufacturing. This investment also coincided with an enumerated list of other major changes including: the elimination of piece rates, giving workers authority for scheduling machines, changes in decision rights, process and workflow innovation, more frequent and richer interactions with customers and suppliers, increased lateral communication and teamwork, and other changes in skills, processes, culture, and structure (see Table 1).

However, the new system initially fell well short of management expectations for greater flexibility and responsiveness. Investigation revealed that line workers still retained many elements of the now-obsolete old work practices, not necessarily from any conscious effort to undermine the change effort, but simply as an

Table 1

**Work Practices at MacroMed as Described in the Corporate Vision Statement**

*(introduction of computer-based equipment was accompanied by a large set of complementary changes)*

<i>Principles of the “old” factory</i>	<i>Principles of the “new” factory</i>
<ul style="list-style-type: none"> <li>• Designated equipment</li> <li>• Large inventories</li> <li>• Pay tied to amount produced</li> <li>• Keep line running no matter what</li> <li>• Thorough final inspection by quality assurance</li> <li>• Raw materials made in-house</li> <li>• Narrow job functions</li> <li>• Areas separated by machine type</li> <li>• Salaried employees make decisions</li> <li>• Hourly workers carry them out</li> <li>• Functional groups work independently</li> <li>• Vertical communication flow</li> <li>• Several management layers (6)</li> </ul>	<ul style="list-style-type: none"> <li>• Flexible computer-based equipment</li> <li>• Low inventories</li> <li>• All operators paid same flat rate</li> <li>• Stop line if not running at speed</li> <li>• Operators responsible for quality</li> <li>• All materials outsourced</li> <li>• Flexible job responsibilities</li> <li>• Areas organized in work cells</li> <li>• All employees contribute ideas</li> <li>• Supervisors can fill in on line</li> <li>• Concurrent engineering</li> <li>• Line rationalization</li> <li>• Few management layers (3–4)</li> </ul>

inherited pattern. For example, one earnest and well-intentioned worker explained that “the key to productivity is to avoid stopping the machine for product changeovers.” While this heuristic was valuable with the old equipment, it negated the flexibility of the new machines and created large work-in-process inventories. Ironically, the new equipment was sufficiently flexible that the workers were able to get it to work much like the old machines! The strong complementarities within the old cluster of work practices and within the new cluster greatly hindered the transition from one to the other.

Eventually, management concluded that the best approach was to introduce the new equipment in a “greenfield” site with a handpicked set of young employees who were relatively unencumbered by knowledge of the old practices. The resulting productivity improvements were significant enough that management ordered all the factory windows painted black to prevent potential competitors from seeing the new system in action. While other firms could readily buy similar computer-controlled equipment, they would still have to make the much larger investments in organizational learning before fully benefiting from them and the exact recipe for achieving these benefits was not trivial to invent (see Brynjolfsson, Renshaw, and Van Alstyne, 1997 for details). Similarly, large changes in work practices have been documented in case studies of information technology adoption in a variety of settings (Hunter, Bernhardt, Hughes and Skuratowicz, 2000; Levy, Beamish, Murnane and Autor, 2000; Malone and Rockart, 1991; Murnane, Levy and Autor, 1999; Orlikowski, 1992).

**Changing Interactions with Suppliers**

Due to problems coordinating with external suppliers, large firms often produce many of their required inputs in-house. General Motors is the classic example

of a company whose success was facilitated by high levels of vertical integration. However, technologies such as electronic data interchange, Internet-based procurement systems, and other interorganizational information systems have significantly reduced the cost, time and other difficulties of interacting with suppliers. For example, firms can place orders with suppliers and receive confirmations electronically, eliminating paperwork and the delays and errors associated with manual processing of purchase orders (Johnston and Vitale, 1988). However, even greater benefits can be realized when interorganizational systems are combined with new methods of working with suppliers.

An early successful interorganizational system is the Baxter ASAP system, which lets hospitals electronically order supplies directly from wholesalers (Vitale and Konsynski, 1988; Short and Venkatraman, 1992). The system was originally designed to reduce the costs of data entry—a large hospital could generate 50,000 purchase orders annually which had to be written out by hand by Baxter's field sales representatives at an estimated cost of \$25-35 each. However, once Baxter computerized its ordering and had data available on levels of hospital stock, it took increasing responsibility for the entire supply operation: designing stockroom space, setting up computer-based inventory systems, and providing automated inventory replenishment. The combination of the technology and the new supply chain organization substantially improved efficiency for both Baxter (no paper invoices, predictable order flow) and the hospitals (elimination of stockroom management tasks, lower inventories, and less chance of running out of items). Later versions of the ASAP system let users order from other suppliers, creating an electronic marketplace in hospital supplies.

ASAP was directly associated with costs savings on the order of \$10 to \$15 million per year, which allowed them to recover rapidly the \$30 million up front investment and approximately \$3 million annual operating costs. However, management at Baxter believed that even greater benefits were being realized through incremental product sales at the 5500 hospitals that had installed the ASAP system, not to mention the possibility of a reduction of logistics costs borne by the hospitals themselves, an expense which consumes as much as 30 percent of a hospital's budget.

Computer-based supply chain integration has been especially sophisticated in the consumer packaged goods industries. Traditionally, manufacturers promoted products such as soap and laundry detergent by offering discounts, rebates, or even cash payments to retailers to stock and sell their products. Because many consumer products have long shelf lives, retailers tended to buy massive amounts during promotional periods, which increased volatility in manufacturing schedules and distorted manufacturers' view of their market. In response, manufacturers sped up their packaging changes to discourage stockpiling of products and developed internal audit departments to monitor retailers' purchasing behavior for contractual violations (Clemons, 1993).

To eliminate these inefficiencies, Procter and Gamble pioneered a program called "efficient consumer response" (McKenney and Clark, 1995). In this approach, each retailer's checkout scanner data goes directly to the manufacturer;

ordering, payments, and invoicing are fully automated through electronic data interchange; products are continuously replenished on a daily basis; and promotional efforts are replaced by an emphasis on “everyday low pricing.” Manufacturers also involved themselves more in inventory decisions and moved toward “category management,” where a lead manufacturer would take responsibility for an entire retail category (say, laundry products), determining stocking levels for their own and other manufacturers’ products, as well as complementary items.

These changes, in combination, greatly improved efficiency. Consumers benefited from lower prices and increased product variety, convenience, and innovation. Without the direct computer-computer links to scanner data and the electronic transfer of payments and invoices, they could not have attained the levels of speed and accuracy needed to implement such a system.

Technological innovations related to the commercialization of the Internet have dramatically decreased the cost of building electronic supply chain links. Computer-enabled procurement and on-line markets enable a reduction in input costs through a combination of reduced procurement time and more predictable deliveries, which reduces the need for buffer inventories and reduces spoilage for perishable products, reduced price due to increasing price transparency and the ease of price shopping, and reduced direct costs of purchase order and invoice processing. Where they can be implemented, these innovations are estimated to lower the costs of purchased inputs by 10 to 40 percent, depending on the industry (Goldman Sachs, 1999).

Some of these savings clearly represent a redistribution of rents from suppliers to buyers, with little effect on overall economic output. However, many of the other changes represent direct improvements in productivity through greater production efficiency and indirectly by enabling an increase in output quality or variety without excessive cost. To respond to these opportunities, firms are restructuring their supply arrangements and placing greater reliance on outside contractors. Even General Motors, once the exemplar of vertical integration, has reversed course and divested its large internal suppliers. As one industry analyst recently stated, “What was once the greatest source of strength at General Motors—its strategy of making parts in-house—has become its greatest weakness” (Schnapp, 1998). To get some sense of the magnitude of this change, the spinoff in 1999 of Delphi Automotive Systems, only one of GM’s many internal supply divisions, created a separate company that by itself has \$28 billion in sales.

### **Changing Customer Relationships**

The Internet has opened up a new range of possibilities for enriching interactions with customers. Dell Computer has succeeded in attracting customer orders and improving service by placing configuration, ordering, and technical support capabilities on the web (Rangan and Bell, 1999). It coupled this change with systems and work practice changes that emphasize just-in-time inventory management, build-to-order production systems, and tight integration between sales and production planning. Dell has implemented a consumer-driven build-to-order business model, rather than using the traditional build-to-stock model of selling

computers through retail stores, which gives Dell as much as a 10 percent advantage over its rivals in production cost. Some of these savings represent the elimination of wholesale distribution and retailing costs. Others reflect substantially lower levels of inventory throughout the distribution channel. However, a subtle but important by-product of these changes in production and distribution is that Dell can be more responsive to customers. When Intel releases a new microprocessor, as it does several times each year, Dell can sell it to customers within seven days compared to eight weeks or more for some less Internet-enabled competitors. This is a nontrivial difference in an industry where adoption of new technology and obsolescence of old technology is rapid, margins are thin, and many component prices drop by 3 to 4 percent each month.

Other firms have also built closer relations with their customer via the web and related technologies. For instance, web retailers like Amazon.com provide personalized recommendations to visitors and allow them to customize numerous aspects of their shopping experience. As described by Denise Caruso (1998), "Amazon's on-line account maintenance system provides its customers with secure access to everything about their account at any time. [S]uch information flow to and from customers would paralyze most old-line companies." Merely providing Internet access to a traditional bookstore would have had a relatively minimal impact without the cluster of other changes implemented by firms like Amazon.

An increasingly ubiquitous example is using the web for handling basic customer inquiries. For instance, UPS now handles a total of 700,000 package tracking requests via the Internet every day. It costs UPS 10¢ per piece to serve that information via the Web vs. \$2 to provide it over the phone (Seybold and Marshak, 1998). Consumers benefit, too. Because customers find it easier to track packages over the web than via the phone, UPS estimates that two-thirds of the web users would not have bothered to check on their packages if they did not have web access.

## **Large-Sample Empirical Evidence on Information Technology, Organization and Productivity**

The case study literature offers many examples of strong links between information technology and investments in complementary organizational practices. However, to reveal general trends and to quantify the overall impact, we must examine these effects across a wide range of firms and industries. In this section we explore the results from large-sample statistical analyses. First, we examine studies on the direct relationship between information technology investment and business value. We then consider studies that measured organizational factors and their correlation with information technology use, as well as the few initial studies that have linked this relationship to productivity increases.

### **Information Technology and Productivity**

Much of the early research on the relationship between technology and productivity used economy-level or sector-level data and found little evidence of a

relationship. For example, Roach (1987) found that while computer investment per white-collar worker in the service sector rose several hundred percent from 1977 to 1989, output per worker, as conventionally measured, did not increase discernibly. In several papers, Morrison and Berndt examined Bureau of Economic Analysis data for manufacturing industries at the two-digit SIC level and found that the gross marginal product of “high-tech capital” (including computers) was less than its cost and that in many industries these supposedly labor-saving investments were associated with an increase in labor demand (Berndt and Morrison, 1995; Morrison, 1996). Robert Solow (1987) summarized this kind of pattern in his well-known remark: “[Y]ou can see the computer age everywhere except in the productivity statistics.”

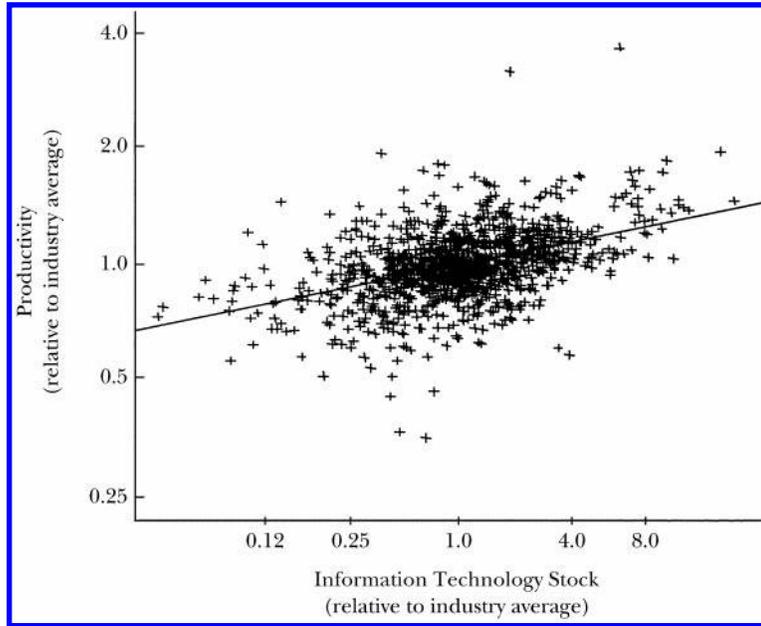
However, by the early 1990s, analyses at the firm-level were beginning to find evidence that computers had a substantial effect on firms’ productivity levels. Using data from over 300 large firms over the period 1988-92, Brynjolfsson and Hitt (1995, 1996) and Lichtenberg (1995) estimated production functions that use the firm’s output (or value-added) as the dependent variable and include ordinary capital, information technology capital, ordinary labor, information technology labor, and a variety of dummy variables for time, industry, and firm.<sup>2</sup> The pattern of these relationships is summarized in Figure 1, which compares firm-level information technology investment with multifactor productivity (excluding computers) for the firms in the Brynjolfsson and Hitt (1995) dataset. There is a clear positive relationship, but also a great deal of individual variation in firms’ success with information technology.

Estimates of the average annual contribution of computer capital to total output generally exceed \$.60 per dollar of capital stock often by a substantial margin, depending on the analysis and specification (Brynjolfsson and Hitt, 1995, 1996; Lichtenberg, 1995; Dewan and Min, 1997). These estimates are statistically different from zero, and in most cases significantly exceed the expected rate of return of about \$.42 (the Jorgensonian rental price of computers—see Brynjolfsson and Hitt, 2000). This suggests either abnormally high returns to investors or the existence of unmeasured costs or barriers to investment. Similarly, most estimates of the contribution of information systems labor to output exceed \$1 for every \$1 of labor costs.

Several researchers have also examined the returns to information technology using data on the use of various technologies rather than the size of the investment. Greenan and Mairesse (1996) matched data on French firms and workers to measure the relationship between a firm’s productivity and the fraction of its employees who report using a personal computer at work. Their estimates of computers’ contribution to output are consistent with earlier estimates of the computer’s output elasticity.

Other micro-level studies have focused on the use of computerized manufac-

<sup>2</sup> These studies assumed a standard form (Cobb-Douglas) for the production function, and measured the variables in logarithms. Later work using different functional forms, such as the transcendental logarithmic (translog) production function, has little effect on the measurement of output elasticities.

*Figure 1***Productivity Versus Information Technology Stock (Capital plus Capitalized Labor) for Large Firms (1988–1992), Adjusted for Industry**

turing technologies. Kelley (1994) found that the most productive metal-working plants use computer-controlled machinery. Black and Lynch (1996) found that plants where a larger percentage of employees use computers are more productive in a sample containing multiple industries. Computerization has also been found to increase productivity in government activities both at the process level, such as package sorting at the post office or toll collection (Muhkopadhyay, Rajiv and Srinivasan, 1997) and at higher levels of aggregation (Lehr and Lichtenberg, 1998).

Taken collectively, these studies suggest that information technology is associated with substantial increases in output and productivity. Questions remain about the mechanisms and direction of causality in these studies. Perhaps instead of information technology causing greater output, “good firms” or average firms with unexpectedly high sales disproportionately spend their windfall on computers. For example, while Doms, Dunne and Troske (1997) found that plants using more advanced manufacturing technologies had higher productivity and wages, they also found that this was commonly the case even before the technologies were introduced.

Efforts to disentangle causality have been limited by the lack of good instrumental variables for factor investment at the firm-level. However, attempts to correct for this bias using available instrumental variables typically increase the estimated coefficients on information technology even further (for example, Brynjolfsson and Hitt, 1996; 2000). Thus, it appears that reverse causality is not driving the results: firms with an unexpected increase in free cash flow invest in other factors, such as labor, before they change their spending on information technol-

ogy. Nonetheless, as the case studies underscore, there appears to be a fair amount of causality in both directions—certain organizational characteristics make information technology adoption more likely and vice versa.

The firm-level productivity studies can shed some light on the relationship between information technology and organizational restructuring. For example, productivity studies consistently find that the output elasticities of computers exceed their (measured) input shares. One explanation for this finding is that the output elasticities for information technology are about right, but the productivity studies are underestimating the input quantities because they neglect the role of unmeasured complementary investments. Dividing the output of the whole set of complements by only the factor share of information technology will imply disproportionately high rates of return for information technology.<sup>3</sup>

A variety of other evidence suggests that hidden assets play an important role in the relationship between information technology and productivity. Brynjolfsson and Hitt (1995) estimated a firm fixed effects productivity model. This method can be interpreted as dividing firm-level information technology benefits into two parts; one part is due to variation in firms' information technology investments over time, the other to fixed firm characteristics. Brynjolfsson and Hitt found that in the firm effects model, the coefficient on information technology was about 50 percent lower, compared to the results of an ordinary least squares regression, while the coefficients on the other factors, capital and labor, changed only slightly. This change suggests that unmeasured and slowly changing organizational practices (the "fixed effect") significantly affect the returns to information technology investment.

Another indirect implication from the productivity studies comes from evidence that effects of information technology are substantially larger when measured over longer time periods. Brynjolfsson and Hitt (2000) examined the effects of information technology on productivity *growth* rather than productivity *levels*, which had been the emphasis in most previous work, using data that included more than 600 firms over the period 1987 to 1994. When one-year differences in information technology are compared to one-year differences in firm productivity, the measured benefits of computers are approximately equal to their measured costs. However, the measured benefits rise by a factor of two to eight as longer time periods are considered, depending on the econometric specification used. One interpretation of these results is that short-term returns represent the direct effects of information technology investment, while the longer-term returns represent the effects of information technology when combined with related investments in organizational change. Further analysis, based on earlier results by Schankerman (1981) in the R&D context, suggested that these omitted factors were not simply information technology investments and complements that were erroneously misclassified as capital or labor. Instead, to be consistent with the econometric results, the omitted factors had to have been accumulated in ways that would not appear on

<sup>3</sup> Hitt (1996) and Brynjolfsson and Hitt (2000) present a formal analysis of this issue.

the current balance sheet. Firm-specific human capital and “organizational capital” are two examples of omitted inputs that would fit this description.<sup>4</sup>

A final perspective on the value of these organizational complements to information technology can be found using financial market data, drawing on the literature on Tobin’s  $q$ . This approach measures the rate of return of an asset indirectly, based on comparing the stock market value of the firm to the replacement value of the various capital assets it owns. Typically, Tobin’s  $q$  has been employed to measure the relative value of observable assets such as R&D or physical plant. However, as suggested by Hall (1999a, b), Tobin’s  $q$  can also be viewed as providing a measure of the total quantity of capital, including the value of “technology, organization, business practices, and other produced elements of successful modern corporation.” Using an approach along these lines, Brynjolfsson and Yang (1997) found that while one dollar of ordinary capital is valued at approximately one dollar by the financial markets, one dollar of information technology capital appears to be correlated with on the order of \$10 of additional stock market value for Fortune 1000 firms using data spanning 1987 to 1994. Since these results, for the most part, apply to large, established firms rather than new high-tech start-ups, and since they predate most of the massive increase in market valuations for technology stocks in the late 1990s, these results are not likely to be sensitive to the possibility of a recent “high-tech stock bubble.”

A more likely explanation for these results is that information technology capital is disproportionately associated with intangible assets like the costs of developing new software, populating a database, implementing a new business process, acquiring a more highly skilled staff, or undergoing a major organizational transformation, all of which go uncounted on a firm’s balance sheet. In this interpretation, for every dollar of information technology capital, the typical firm has also accumulated about \$9 in additional intangible assets. A related explanation is that firms must incur substantial “adjustment costs” before information technology is effective. These adjustment costs drive a wedge between the value of a computer resting on the loading dock and one that is fully integrated into the organization.

The evidence from both the productivity and Tobin’s  $q$  analyses provides some insights into the properties of information technology-related intangible assets, even if we cannot measure these assets directly. Such assets are large, potentially several multiples of the measured information technology investment. They are unmeasured in the sense that they do not appear as a capital asset or as other components of firm input, although they do appear to be unique characteristics of particular firms as opposed to industry effects. Finally, they have more effect in the long term than the short term, suggesting that multiple years of adaptation and investment is required before their influence is maximized.

<sup>4</sup> Part of the difference in coefficients between short and long difference specifications could also be explained by measurement error (which tends to average out over longer time periods). Such errors-in-variables can bias down coefficients based on short differences, but the size of the change is too large to be attributed solely to this effect (Brynjolfsson and Hitt, 2000).

### **Direct Measurement of the Interrelationship between Information Technology and Organization**

Some studies have attempted to measure organizational complements directly, and to determine whether they are correlated with information technology investment, or whether firms that combine complementary factors have better economic performance. Finding correlations between information technology and organizational change, or between these factors and measures of economic performance, is not sufficient to prove that these practices are complements, unless a full structural model specifies the production relationships and demand drivers for each factor. Athey and Stern (1997) discuss issues in the empirical assessment of complementarity relationships. However, after empirically evaluating possible alternative explanations and combining correlations with performance analyses, complementarities are often the most plausible explanation for observed relationships between information technology, organizational factors, and economic performance.

The first set of studies in this area focuses on correlations between use of information technology and extent of organizational change. An important finding is that information technology investment is greater in organizations that are decentralized and have a greater investment in human capital. For example, Bresnahan, Brynjolfsson and Hitt (2000) surveyed approximately 400 large firms to obtain information on aspects of organizational structure like allocation of decision rights, workforce composition, and investments in human capital. They found that greater levels of information technology are associated with increased delegation of authority to individuals and teams, greater levels of skill and education in the workforce, and greater emphasis on pre-employment screening for education and training. In addition, they find that these work practices are correlated with each other, suggesting that they are part of a complementary work system. Kelley (1994) found that the use of programmable manufacturing equipment is correlated with several aspects of human resource practices.

Research on jobs within specific industries has begun to explore the mechanisms within organizations that create these complementarities. Drawing on a case study on the automobile repair industry, Levy, Beamish, Murnane and Autor (2000) argue that computers are most likely to substitute for jobs that rely on rule-based decision-making while complementing nonprocedural cognitive tasks. In banking, researchers have found that many of the skill, wage and other organizational effects of computers depend on the extent to which firms couple computer investment with organizational redesign and other managerial decisions (Hunter, Bernhardt, Hughes and Skuratowicz, 2000; Murnane, Levy and Autor, 1999). Researchers focusing at the establishment level have also found complementarities between existing technology infrastructure and firm work practices to be a key determinant of the firm's ability to incorporate new technologies (Bresnahan and Greenstein, 1997); this also suggests a pattern of mutual causation between computer investment and organization.

A variety of industry-level studies also show a strong connection between investment in high technology equipment and the demand for skilled, educated workers (Berndt, Morrison and Rosenblum, 1992; Berman, Bound and Griliches,

1994; Autor, Katz and Krueger, 1998). Again, these findings are consistent with the idea that increasing use of computers is associated with a greater demand for human capital.

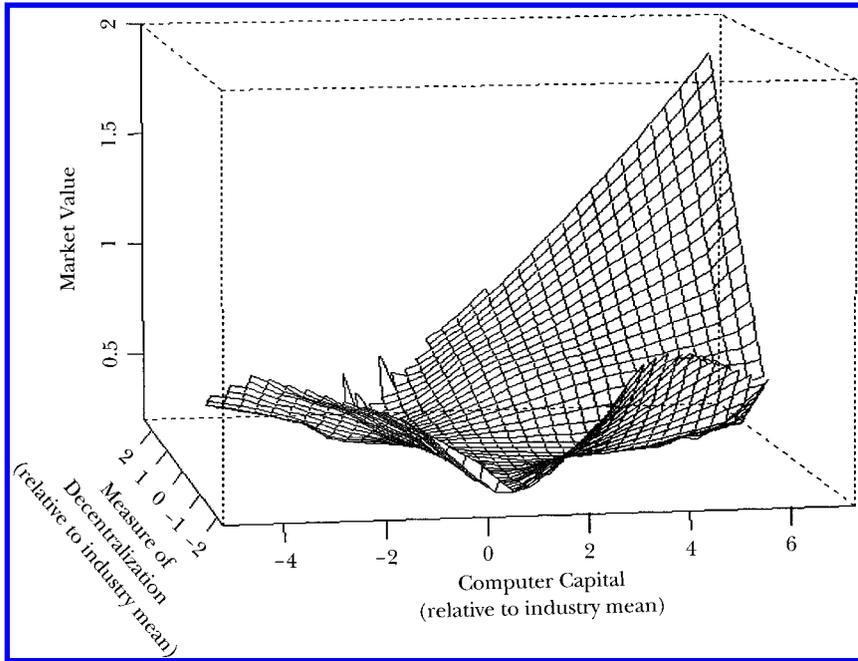
Several researchers have also considered the effect of information technology on macro-organizational structures. They have typically found that greater levels of investment in information technology are associated with smaller firms and less vertical integration. Brynjolfsson, Malone, Gurbaxani and Kambil (1994) found that increases in the level of information technology capital in an economic sector were associated with a decline in average firm size in that sector, consistent with information technology leading to a reduction in vertical integration. Hitt (1999), examining the relationship between a firm's information technology capital stock and direct measures of its vertical integration, arrived at similar conclusions. These results corroborate earlier case analyses and theoretical arguments that suggested that information technology would be associated with a decrease in vertical integration because it lowers the costs of coordinating externally with suppliers (Malone, Yates and Benjamin, 1987; Gurbaxani and Whang, 1991; Clemons and Row, 1992).

One difficulty in interpreting the literature on correlations between information technology and organizational change is that some managers may be predisposed to try every new idea and some managers may be averse to trying anything new at all. In such a world, information technology and a "modern" work organization might be correlated in firms because of the temperament of management, not because they are economic complements. To rule out this sort of spurious correlation, it is useful to bring measures of productivity and economic performance into the analysis. If combining information technology and organizational restructuring is economically justified, then firms that adopt these practices as a system should outperform those that fail to combine information technology investment with appropriate organizational structures.

In fact, firms that adopt decentralized organizational structures and work structures do appear to have a higher contribution of information technology to productivity (Bresnahan, Brynjolfsson and Hitt, 2000). For example, firms that are more decentralized than the median firm (as measured by individual organizational practices and by an index of such practices), have, on average, a 13 percent greater information technology elasticity and a 10 percent greater investment in information technology than the median firm. Firms that are in the top half of *both* information technology investment and decentralization are on average 5 percent more productive than firms that are above average only in information technology investment or only in decentralization.

Similar results also appear when economic performance is measured as stock market valuation. Firms in the top third of decentralization have a 6 percent higher market value after controlling for all other measured assets; this is consistent with the theory that organizational decentralization behaves like an intangible asset. Moreover, the stock market value of a dollar of information technology capital is between \$2 and \$5 greater in decentralized firms than in centralized firms (per standard deviation of the decentralization measure), and as shown in Figure 2 this

Figure 2

**Market Value as a Function of Information Technology and Work Organization**

Source: This graph was produced by nonparametric local regression models using data from Brynjolfsson, Hitt and Yang (2000).

relationship is particularly striking for firms that are simultaneously extensive users of information technology and highly decentralized (Brynjolfsson, Hitt and Yang, 2000).

The weight of the firm-level evidence shows that a combination of investment in technology and changes in organizations and work practices facilitated by these technologies contributes to firms' productivity growth and market value. However, much work remains to be done in categorizing and measuring the relevant changes in organizations and work practices, and relating them to information technology and productivity.

### **The Divergence of Firm-level and Aggregate Studies on Information Technology and Productivity**

While the evidence indicates that information technology has created substantial value for firms that have invested in it, it has sometimes been a challenge to link these benefits to macroeconomic performance. A major reason for the gap in interpretation is that traditional growth accounting techniques focus on the (relatively) observable aspects of output, like price and quantity, while neglecting the

intangible benefits of improved quality, new products, customer service and speed. Similarly, traditional techniques focus on the relatively observable aspects of investment, such as the price and quantity of computer hardware in the economy, and neglect the much larger intangible investments in developing complementary new products, services, markets, business processes, and worker skills. Paradoxically, while computers have vastly improved the ability to collect and analyze data on almost any aspect of the economy, the current computer-enabled economy has become increasingly difficult to measure using conventional methods. Nonetheless, standard growth accounting techniques provide a useful starting point for any assessment or for the contribution of information technology to economic growth.

Several studies of the contribution of information technology concluded that technical progress in computers contributed roughly 0.3 percentage points per year to real output growth when data from the 1970s and 1980s were used (Jorgenson and Stiroh, 1995; Oliner and Sichel, 1994; Brynjolfsson, 1996).

Much of the estimated growth contribution comes directly from the large quality-adjusted price declines in the computer producing industries. The nominal value of purchases of information technology hardware in the United States in 1997 was about 1.4 percent of GDP. Since the quality-adjusted prices of computers decline by about 25 percent per year, simply spending the same nominal share of GDP as in previous years represents an annual productivity increase for the real GDP of 0.3 percentage points (that is,  $1.4 \times .25 = .35$ ). A related approach is to look at the effect of information technology on the GDP deflator. Reductions in inflation, for a given amount of growth in output, imply proportionately higher real growth and, when divided by a measure of inputs, higher productivity growth as well. Gordon (1998, p. 4) calculates that “computer hardware is currently contributing to a reduction of U.S. inflation at an annual rate of almost 0.5 percent per year, and this number would climb toward one percent per year if a broader definition of information technology, including telecommunications equipment, were used.”

More recent growth accounting analyses by the same authors have linked the recent surge in measured productivity in the U.S. to increased investments in information technology. Using similar methods as in their earlier studies, Oliner and Sichel (this issue) and Jorgenson and Stiroh (1999) find that the annual contribution of computers to output growth in the second half of the 1990s is closer to 1.0 or 1.1 percentage points per year. Gordon (this issue) makes a similar estimate. This is a large contribution for any single technology, although researchers have raised concerns that computers are primarily an intermediate input and that the productivity gains are disproportionately visible in computer-producing industries as opposed to computer-using industries. For instance, Gordon notes that after he makes adjustments for the business cycle, capital deepening and other effects, there has been virtually no change in the rate of productivity growth outside of the durable goods sector. Jorgenson and Stiroh ascribe a larger contribution to computer-using industries, but still not as great as in the computer-producing industries.

Should we be disappointed by the productivity performance of the downstream firms?

Not necessarily. Two points are worth bearing in mind when comparing upstream and downstream sectors. First, the allocation of productivity depends on the quality-adjusted transfer prices used. If a high deflator is applied, the upstream sectors get credited with more output and productivity in the national accounts, but the downstream firms get charged with using more inputs and thus have less productivity. Conversely, a low deflator allocates more of the gains to the downstream sector. In both cases, the increases in the total productivity of the economy are, by definition, identical. Since it is difficult to compute accurate deflators for complex, rapidly changing intermediate goods like computers, one must be careful in interpreting the allocation of productivity across producers and users.<sup>5</sup>

The second point is more semantic. Arguably, downstream sectors are delivering on the information technology revolution by simply maintaining levels of measured total factor productivity growth in the presence of dramatic changes in the costs, nature and mix of intermediate computer goods. This reflects a success in costlessly converting technological innovations into real output that benefits end consumers. If a firm maintains a constant nominal information technology budget in the face of 50 percent information technology price declines over two years, it is treated in the national accounts as using 100 percent more real information technology input for production. A commensurate increase in real output is required merely to maintain the same measured productivity level as before. Such an output increase is not necessarily automatic since it requires a significant change in the input mix and organization of production. In the presence of adjustment costs and imperfect output measures, one might reasonably have expected measured productivity to *decline* initially in downstream sectors as they absorb a rapidly changing set of inputs and introduce new products and services.

Regardless of how the productivity benefits are allocated, these studies show that a substantial part of the upturn in measured productivity of the economy as a whole can be linked to increased real investments in computer hardware and declines in their quality-adjusted prices. However, there are several key assumptions implicit in economy- or industry-wide growth accounting approaches which can have a substantial influence on their results, especially if one seeks to know whether investment in computers are increasing productivity as much as alternate possible investments. The standard growth accounting approach begins by assuming that all inputs earn “normal” rates of return. Unexpected windfalls, whether the discovery of a single new oil field, or the invention of a new process which makes oil fields obsolete, show up not in the growth contribution of inputs but as changes in the

<sup>5</sup> It is worth noting that if the exact quality change of an intermediate good is mismeasured, then the total productivity of the economy is not affected, only the allocation between sectors. However, if computer-using industries take advantage of the radical changes in input in their quality to introduce new quality levels output (or entirely new goods) and these changes are not fully reflected in final output deflators, then total productivity will be underestimated. In periods of rapid technological change, both phenomena can be expected.

multifactor productivity residual. By construction, an input can contribute more to output in these analyses only by growing rapidly, not by having an unusually high net rate of return.

Changes in multifactor productivity growth, in turn, depend on accurate measures of final output. However, nominal output is affected by whether firm expenditures are expensed, and therefore deducted from value-added, or capitalized and treated as investment. As emphasized throughout this paper, information technology is only a small fraction of a much larger complementary system of tangible and intangible assets. However, current statistics typically treat the accumulation of intangible capital assets, such as new business processes, new production systems and new skills, as expenses rather than as investments. This leads to a lower level of measured output in periods of net capital accumulation. Second, current output statistics disproportionately miss many of the gains that information technology has brought to consumers such as variety, speed, and convenience. We will consider these issues in turn.

The magnitude of investment in intangible assets associated with computerization may be large. Analyses of 800 large firms by Brynjolfsson and Yang (1997) suggest that the ratio of intangible assets to information technology assets may be 10 to 1. Thus, the \$167 billion in computer capital recorded in the U.S. national accounts in 1996 may have actually been only the tip of an iceberg of \$1.67 trillion of information technology-related complementary assets in the United States.

Examination of individual information technology projects indicates that the 10:1 ratio may even be an underestimate in many cases. For example, a survey of a common category of software projects—namely, “enterprise resource planning”—found that the average spending on computer hardware accounted for less than 4 percent of the typical start-up cost of \$20.5 million, while software licenses and development were another 16 percent of total costs (Gormely et al., 1998). The remaining costs included hiring outside and internal consultants to help design new business processes and to train workers in the use of the system. The time of existing employees, including top managers, that went into the overall implementation were not included, although it too is typically quite substantial.

The up-front costs were almost all treated as current expenses by the companies undertaking the implementation projects. However, insofar as the managers who made these expenditures expected them to pay for themselves only over several years, the nonrecurring costs are properly thought of as investments, not expenses, when considering the impact on economic growth. In essence, the managers were adding to the nation’s capital stock not only of easily visible computers, but also of less visible business processes and worker skills.

How might these measurement problems affect economic growth and productivity calculations? In a steady state, it makes little difference, because the amount of new organizational investment in any given year is offset by the “depreciation” of organizational investments in previous years. The net change in capital stock is zero. Thus, in a steady state, classifying organizational investments as expenses does not bias overall output growth as long as it is done consistently from year to year. However, the economy has hardly been in a steady state with respect to comput-

ers and their complements. Instead, the U.S. economy has been rapidly adding to its stock of both types of capital. To the extent that this net capital accumulation has not been counted as part of output, output and output growth have been underestimated.

The software industry offers a useful example of the impact of classifying a category of spending as expense or investment. Historically, efforts on software development have been treated as expenses, but recently the government has begun recognizing that software is an intangible capital asset. Software investment by U.S. businesses and governments grew from \$10 billion in 1979 to \$159 billion in 1998 (Parker and Grimm, 2000). Properly accounting for this investment has added 0.15 to 0.20 percentage points to the average annual growth rate of real GDP in the 1990s. While capitalizing software is an important improvement in our national accounts, software is far from the only, or even most important, complement to computers.

If the wide array of intangible capital costs associated with computers were treated as investments rather than expenses, the results would be striking. According to some preliminary estimates from Yang (2000), building on estimates of the intangible asset stock derived from stock market valuations of computers, the true growth rate of U.S. GDP, after accounting for the intangible complements to information technology hardware, has been increasingly underestimated by an average of over 1 percent per year since the early 1980s, with the underestimate getting worse over time as net information technology investment has grown. Productivity growth has been underestimated by a similar amount. This reflects the large net increase in intangible assets of the U.S. economy associated with the computerization that was discussed earlier. Over time, the economy earns returns on past investment, converting it back into consumption. This has the effect of raising GDP growth as conventionally measured by a commensurate amount even if the “true” GDP growth remains unchanged.

While the quantity of intangible assets associated with information technology is difficult to estimate precisely, the central lesson is that these complementary changes are very large and cannot be ignored in any realistic attempt to estimate the overall economic contributions of information technology.

The productivity gains from investments in new information technology are underestimated in a second major way: failure to account fully for quality change in consumable outputs. It is typically much easier to count the number of units produced than to assess intrinsic quality—especially if the desired quality may vary across customers. A significant fraction of value of quality improvements due to investments in information technology—like greater timeliness, customization, and customer service—is not directly reflected as increased industry sales, and thus is implicitly treated as nonexistent in official economic statistics.

These issues have always been a concern in the estimation of the true rate of inflation and the real output of the U.S. economy (Boskin et al., 1997). If output mismeasurement for computers was similar to output mismeasurement for previous technologies, estimates of long-term productivity trends would be unaffected (Baily and Gordon, 1988). However, there is evidence that in several specific ways,

computers are associated with an increasing degree of mismeasurement that is likely to lead to increasing underestimates of productivity and economic growth.

The production of intangible outputs is an important consideration for information technology investments whether in the form of new products or improvements in existing products. Based on a series of surveys of information services managers conducted in 1993, 1995 and 1996, Brynjolfsson and Hitt (1997) found that customer service and sometimes other aspects of intangible output (specifically quality, convenience, and timeliness) ranked higher than cost savings as the motivation for investments in information services. Brooke (1992) found that information technology was also associated with increases in product variety.

Indeed, government data show many inexplicable changes in productivity, especially in the sectors where output is measured poorly and where changes in quality may be especially important (Griliches, 1994). Moreover, simply removing anomalous industries from the aggregate productivity growth calculation can change the estimate of U.S. productivity growth by 0.5 percent or more (Corrado and Slifman, 1999). The problems with measuring quality change and true output growth are illustrated by selected industry-level productivity growth data over different time periods, shown in Table 2. According to official government statistics, a bank today is only about 80 percent as productive as a bank in 1977; a health care facility is only 70 percent as productive and a lawyer only 65 percent as productive as they were 1977.

These statistics seem out of touch with reality. In 1977, virtually all banking was conducted via the teller windows; today, customers can access a network of 139,000 automatic teller machines (ATMs) 24 hours a day, seven days a week (Osterberg and Sterk, 1997), as well as a vastly expanded array of banking services via the Internet. The more than tripling of cash availability via ATMs required an incremental investment on the order of \$10 billion compared with over \$70 billion invested in physical bank branches. Computer controlled medical equipment has facilitated more successful and less invasive medical treatment. Many procedures that previously required extensive hospital stays can now be performed on an outpatient basis; instead of surgical procedures, many medical tests now use non-invasive imaging devices such as x-rays, MRI, or CT scanners. Information technology has supported the research and analysis that has led to these advances plus a wide array of improvements in medication and outpatient therapies. A lawyer today can access a much wider range of information through on-line databases and manage many more legal documents. In addition, some basic legal services, such as drafting a simple will, can now be performed without a lawyer using inexpensive software packages such as Willmaker.

One of the most important types of unmeasured benefits arises from new goods. Sales of new goods are measured in the GDP statistics as part of nominal output, although this does not capture the new consumer surplus generated by such goods, which causes them to be preferred over old goods. Moreover, the Bureau of Labor Statistics has often failed to incorporate new goods into price indices until many years after their introduction; for example, it did not incorporate the VCR into the consumer price index until 1987, about a decade after they

Table 2

**Annual (Measured) Productivity Growth for Selected Industries** (based on dividing BEA gross output by industry figures by BLS hours worked by industry for comparable sectors)

<i>Industry</i>	<i>1948–1967</i>	<i>1967–1977</i>	<i>1977–1996</i>
Depository Institutions	.03%	.21%	–1.19%
Health Services	.99%	.04%	–1.81%
Legal Services	.23%	–2.01%	–2.13%

*Source:* Partial reproduction from Gordon (1998, Table 3).

began selling in volume. This leads the price index to miss the rapid decline in price that many new goods experience early in their product cycle. In a related example, in 1990, sales of the printed multi-volume Encyclopedia Britannica were \$650 million and the production cost for each set was over \$250, plus up to \$500 for the salesperson's commission (Evans and Wurster, 2000). Producing a CD-ROM with the same information now costs less than \$1, and presenting it via a website like [www.britannica.com](http://www.britannica.com), costs but a fraction of that. Sales of the printed version of all encyclopedias, including Britannica, collapsed by over 80 percent in the 1990s, as the content was bundled for "free" with office software or delivered on the web. The GDP statistics captured this collapse in sales, but not the value of the content that is now free or nearly free. As a result, the inflation statistics overstate the true rise in the cost of living, and when the nominal GDP figures are adjusted using that price index, the real rate of output growth is understated (Boskin et al., 1997). The problem extends beyond new high-tech products, like personal digital assistants and web browsers. Computers enable more new goods to be developed, produced, and managed in all industries. For instance, the number of new products introduced in supermarkets has grown from 1281 in 1964, to 1831 in 1975, and then to 16,790 in 1992 (Nakamura, 1997); the data management requirements to handle so many products would have overwhelmed the computerless supermarket of earlier decades. Consumers have voted with their pocketbooks for the stores with greater product variety.

This collection of results suggests that information technology may be associated with increases in the intangible component of output, including variety, customer convenience, and service. Because it appears that the amount of unmeasured output value is increasing with computerization, this measurement problem not only creates an underestimate of output level, but also errors in measurement of output and productivity growth when compared with earlier time periods which had a smaller bias due to intangible outputs.

Just as the Bureau of Economic Analysis successfully reclassified many software expenses as investments and is making quality adjustments, perhaps we will also find ways to measure the investment component of spending on intangible organizational capital and to make appropriate adjustments for the value of all gains attributable to improved quality, variety, convenience and service. Unfortunately,

addressing these problems can be difficult even for single firms and products, and the complexity and number of judgments required to address them at the macroeconomic level is extremely high. Moreover, because of the increasing service component of all industries (even basic manufacturing), which entails product and service innovation and intangible investments, these problems cannot be easily solved by focusing on a limited number of “hard to measure” industries—they are pervasive throughout the economy.

Meanwhile, however, firm-level studies can overcome some of the difficulties in assessing the productivity gains from information technology. For example, it is considerably easier at the firm level to make reasonable estimates of the investments in intangible organizational capital and to observe changes in organizations, while it is harder to formulate useful rules for measuring such investment at the macroeconomic level.

Firm-level studies may be less subject to aggregation error when firms make different levels of investments in computers and thus could have different capabilities for producing higher value products (Brynjolfsson and Hitt, 1996, 2000). Suppose a firm invests in information technology to improve product quality and consumers recognize and value these benefits. If other firms do not make similar investments, any difference in quality will lead to differences in the equilibrium product prices that each firm can charge. When an analysis is conducted across firms, variation in quality will contribute to differences in output and productivity and thus, will be measured as increases in the output elasticity of computers. However, when firms with high quality products and firms with low quality products are combined together in industry data (and subjected to the same quality-adjusted deflator for the industry), both the information technology investment and the difference in revenue will average out, and a lower correlation between information technology and (measured) output will be detected. Interestingly, Siegel (1997) found that the measured effect of computers on productivity was substantially increased when he used a structural equation framework to directly model the errors in production input measurement in industry-level data.

However, firm-level data can be an unreliable way to capture the social gains from improved product quality. For example, not all price differences reflect differences in product or service quality. When price differences are due to differences in market power that are not related to consumer preferences, then firm-level data will lead to inaccurate estimates of the productivity effects of information technology. Similarly, increases in quality or variety (like new product introductions in supermarkets) can be a by-product of anticompetitive product differentiation strategies, which may or may not increase total welfare. Moreover, firm-level data will not fully capture the value of quality improvements or other intangible benefits if these benefits are ubiquitous across an industry, because then there will not be any interfirm variation in quality and prices. Instead, competition will pass the gains on to consumers. In this case, firm-level data will also understate the contribution of information technology investment to social welfare.

## Conclusion

Concerns about an information technology “productivity paradox” were raised in the late 1980s. Over a decade of research since then has substantially improved our understanding of the relationship between information technology and economic performance. The firm-level studies in particular suggest that, rather than being paradoxically unproductive, computers have had an impact on economic growth that is disproportionately large compared to their share of capital stock or investment, and this impact is likely to grow further in coming years.

In particular, both case studies and econometric work point to organizational complements such as new business processes, new skills and new organizational and industry structures as a major driver of the contribution of information technology. These complementary investments, and the resulting assets, may be as much as an order of magnitude larger than the investments in the computer technology itself. However, they go largely uncounted in our national accounts, suggesting that computers have made a much larger real contribution to the economy than previously believed.

The use of firm-level data has cast a brighter light on the black box of production in the increasingly information technology-based economy. The outcome has been a better understanding of the key inputs, including complementary organizational assets, as well as the key outputs including the growing roles of new products, new services, quality, variety, timeliness and convenience. Measuring the intangible components of complementary systems will never be easy. But if researchers and business managers recognize the importance of the intangible costs and benefits of computers and undertake to evaluate them, a more precise assessment of these assets needn't be beyond computation.

■ *Portions of this manuscript are to appear in MIS Review and in an edited volume, The Puzzling Relations Between Computer and the Economy, Nathalie Greenan, Yannick Lhorty and Jacques Mairesse, eds., MIT Press, 2001.*

*The authors thank David Autor, Brad De Long, Robert Gordon, Shane Greenstein, Dale Jorgenson, Alan Krueger, Dan Sichel, Robert Solow, Kevin Stiroh and Timothy Taylor for valuable comments on (portions of) earlier drafts. This work is funded in part by NSF Grant IIS-9733877.*

## References

- Athey, S. and S. Stern. 1997. “An Empirical Framework for Testing Theories about Complementarities in Organizational Design,” Mimeo, MIT.
- Autor, D., L. F. Katz and A. B. Krueger. 1998. “Computing Inequality: Have Computers Changed the Labor Market?” *Quarterly Journal of Economics*. November, 113:4, pp. 1169–1213.

- Baily, M. N. and R. J. Gordon.** 1988. "The Productivity Slowdown, Measurement Issues, and the Explosion of Computer Power," in *Brookings Papers on Economic Activity*. W. C. Brainard and G. L. Perry, ed. Washington, DC, The Brookings Institution, pp. 347–431.
- Berman, E., J. Bound and Z. Griliches.** 1994. "Changes in the Demand for Skilled Labor within U.S. Manufacturing Industries." *Quarterly Journal of Economics*. May, 109, pp. 367–98.
- Berndt, E. R. and C. J. Morrison.** 1995. "High-tech Capital Formation and Economic Performance in U.S. Manufacturing Industries: An Exploratory Analysis." *Journal of Econometrics*. January, 65:1, pp. 9–43.
- Berndt, E. R., C. J. Morrison and L. S. Rosenblum.** 1992. "High-Tech Capital, Economic Performance and Labor Composition in U.S. Manufacturing Industries: An Exploratory Analysis." MIT Working Paper 3414EFA.
- Black, S.E. and L.M. Lynch.** 1996. "How to Compete: The Impact of Workplace Practices and IT on Productivity." Harvard University, Cambridge, MA and U.S. Department of Labor, Washington, D.C., September.
- Boskin, Michael J., Ellen R. Dulberger, Robert J. Gordon, Zvi Griliches and Dale Jorgenson.** 1997. "The CPI Commission: Findings and Recommendations." *American Economic Review*. 87:2, pp. 78–83.
- Bresnahan, T.F.** 1999. "Computerization and Wage Dispersion: An Analytic Reinterpretation." *Economic Journal*. June, 109:456, pp. F390–415.
- Bresnahan, T., E. Brynjolfsson and L. Hitt.** 2000. "IT, Workplace Organization and the Demand for Skilled Labor: A Firm-level Analysis." Mimeo, MIT, Stanford, and Wharton.
- Bresnahan, T. F. and M. Trajtenberg.** 1995. "General Purpose Technologies: 'Engines of Growth?'" *Journal of Econometrics*. 65, pp. 83–108.
- Bresnahan, T.F. and S. Greenstein.** 1997. "Technical Progress and Co-Invention in Computing and in the Use of Computers." *Brookings Papers on Economic Activity: Microeconomics*. January, pp. 1–78.
- Brooke, G. M.** 1992. "The Economics of Information Technology: Explaining the Productivity Paradox." MIT Sloan School of Management Center for Information Systems Research Working Paper No. 238, April.
- Brynjolfsson, E.** 1993. "The Productivity Paradox of Information Technology." *Communications of the ACM*. 35:12, pp. 66–77.
- Brynjolfsson, E.** 1996. "The Contribution of Information Technology to Consumer Welfare." *Information Systems Research*. 7:3, pp. 281–300.
- Brynjolfsson, E., T. Malone, V. Gurbaxani and A. Kambil.** 1994. "Does Information Technology Lead to Smaller Firms?" *Management Science*. 40:12, pp. 1628–1644.
- Brynjolfsson, E. and L. Hitt.** 1995. "Information Technology as a Factor of Production: The Role of Differences Among Firms." *Economics of Innovation and New Technology*. 3:4, pp. 183–200.
- Brynjolfsson, E. and L. Hitt.** 1996. "Paradox Lost? Firm-level Evidence on the Returns to Information Systems Spending." *Management Science* 42:4, pp. 541–58.
- Brynjolfsson, E. and L. Hitt.** 1997. "Breaking Boundaries." *Informationweek*. September, 22, pp. 54–61.
- Brynjolfsson, E. and L. Hitt.** 2000. "Computing Productivity: Are Computers Pulling Their Weight?" Mimeo, MIT and Wharton.
- Brynjolfsson, E. and S. Yang.** 1996. "Information Technology and Productivity: A Review of the Literature," in *Advances in Computers*. M. Zelkowitz, ed, Vol. 43.
- Brynjolfsson, E. and S. Yang.** 1997. "The Intangible Benefits and Costs of Computer Investments: Evidence from Financial Markets," in *Proceedings of the International Conference on Information Systems*. Atlanta, GA. Revised, 2000.
- Brynjolfsson, E., A. Renshaw and M. Van Alstyne.** 1997. "The Matrix of Change." *Sloan Management Review*, Winter.
- Brynjolfsson, E., L. Hitt and S.K. Yang.** 2000. "Intangible Assets: How the Interaction of Information Systems and Organizational Structure Affects Stock Market Valuations," mimeo, MIT and Wharton. A previous version appeared in the *Proceedings of the International Conference on Information Systems*, Helsinki, Finland, 1998.
- Caruso, Denise.** 1998. "Digital Commerce." *The New York Times*. May 11.
- Corrado, C. and L. Slifman.** 1999. "Decomposition of Productivity and Unit Costs." *American Economic Review*. 89:2, pp. 328–32.
- Clemons, Eric K. and Michael C. Row.** 1992. "Information Technology and Industrial Cooperation: The Changing Economics of Coordination and Ownership." *Journal of Management Information Systems*. 9:2, pp. 9–28.
- Clemons, Eric K.** 1993. "Reengineering the Sales Function: Reengineering Internal Operations." Teaching Case, The Wharton School.
- Clemons, Eric K., Matt E. Thatcher and Michael C. Row.** 1995. "Identifying Sources of Reengineering Failures: A Study of the Behavioral Factors Contributing to Reengineering Risks." *Journal of Management Information Systems*. 12:2, pp. 9–36.
- David, P. A.** 1990. "The Dynamo and the Computer: A Historical Perspective on the Modern Productivity Paradox." *American Economic Review Papers and Proceedings*. 1:2, pp. 355–61.

- Dewan, S. and C. K. Min.** 1997. "Substitution of Information Technology for Other Factors of Production: A Firm-level Analysis." *Management Science*. 43:12, pp. 1660–1675.
- Doms, Mark, Timothy Dunne and Kenneth R. Troske.** 1997. "Workers, Wages, and Technology." *The Quarterly Journal of Economics*. 112:1, pp. 253–90.
- Evans, Phillip and Thomas Wurster.** 2000. *Blown to Bits*. Boston: Harvard Business School Press.
- Galbraith, J.** 1977. *Organizational Design*. Reading, MA: Addison-Wesley.
- Gordon, Robert J.** 1998. "Monetary Policy in the Age of Information Technology: Computers and the Solow Paradox." Working Paper, Northwestern University.
- Goldman Sachs.** 1999. *B2B: To Be or Not 2B?* High Technology Group Whitepaper, November.
- Gormley, J., W. Bluestein, J. Gatoff and H. Chun.** 1998. "The Runaway Costs of Packaged Applications." *The Forrester Report*. 3:5, Cambridge, MA.
- Greenan, N. and J. Mairesse.** 1996. "Computers and Productivity in France: Some Evidence," NBER Working Paper 5836, November.
- Griliches, Z.** 1994. "Productivity, R&D and the Data Constraint." *American Economic Review*. 84:2, pp. 1–23.
- Gullickson, W. and M.J. Harper.** 1999. "Possible Measurement Bias in Aggregate Productivity Growth." *Monthly Labor Review*. February, 122:2, pp. 47–67.
- Gurbaxani, V. and S. Whang.** 1991. "The Impact of Information Systems on Organizations and Markets." *Communications of the ACM*. 34:1, pp. 59–73.
- Hall, R. E.** 1999a. "The Stock Market and Capital Accumulation," NBER Working Paper 7180, June.
- Hall, R. E.** 1999b. "Reorganization," NBER Working Paper 7181, June.
- Hammer, M.** 1990. "Reengineering Work: Don't Automate, Obliterate." *Harvard Business Review*. July-August, pp. 104–12.
- Hitt, L.** 1996. *Economic Analysis of Information Technology and Organization*. Unpublished doctoral dissertation, MIT Sloan School of Management.
- Hitt, Lorin M.** 1999. "Information Technology and Firm Boundaries: Evidence from Panel Data." *Information Systems Research*. June, 10:9, pp. 134–49.
- Hunter, Larry W., Annette Bernhardt, Katherine L. Hughes and Eva Skuratowicz.** 2000. "It's Not Just the ATMs: Firm Strategies, Work Restructuring and Workers' Earnings in Retail Banking," mimeo, Wharton School.
- Johnston, H. Russell and Michael R. Vitale.** 1988. "Creating Competitive Advantage with Interorganizational Information Systems." *MIS Quarterly*. 12:2, pp. 153–65.
- Jorgenson, Dale W. and Kevin Stiroh.** 1995. "Computers and Growth." *Journal of Economics of Innovation and New Technology*. 3. pp. 295–316.
- Jorgenson, Dale W. and Kevin Stiroh.** 1999. "Information Technology and Growth." *American Economic Review, Papers and Proceedings*. May, 89:2, pp. 109–15.
- Kelley, Maryellen R.** 1994. "Productivity and Information Technology: The Elusive Connection." *Management Science*. 40:11, pp. 1406–1425.
- Kemerer, C. F. and G. L. Sosa.** 1991. "Systems Development Risks in Strategic Information Systems." *Information and Software Technology*. 33:3, pp. 212–23.
- Lehr, W. and F.R. Lichtenberg.** 1998. "Computer Use and Productivity Growth in Federal Government Agencies 1987-92." *Journal of Industrial Economics*. 46:2, pp. 257–79.
- Levy, Frank, Anne Beamish, Richard J. Murnane and David Autor.** 2000. "Computerization and Skills: Examples from a Car Dealership," mimeo, MIT and Harvard.
- Lichtenberg, F. R.** 1995. "The Output Contributions of Computer Equipment and Personal: A Firm-level Analysis." *Economics of Innovation and New Technology*. 3, pp. 201–17.
- Malone, Thomas W.** 1987. "Modelling Coordination in Organizations and Markets." *Management Science*. 33:10, pp. 1317–1332.
- Malone, Thomas W. and John Rockart.** 1991. "Computers, Networks, and the Corporation." *Scientific American*. 265:3, pp. 128–36.
- Malone, T. W., J. Yates and R. I. Benjamin.** 1987. "Electronic Markets and Electronic Hierarchies." *Communications of the ACM*. 30:6, pp. 484–97.
- McKenney, J.L. and T.H. Clark.** 1995. "Pilot and Gamble: Improving Consumer Value through Process Redesign." Harvard Business School Case Study 9-195-126.
- Milgrom, P. and J. Roberts.** 1990. "The Economics of Modern Manufacturing: Technology, Strategy, and Organization." *American Economic Review*. 80:3, pp. 511–28.
- Milgrom, Paul and John Roberts.** 1992. *Economics, Organization and Management*. New York: Prentice-Hall.
- Morrison, Catherine J.** 1996. "Assessing the Productivity of Information Technology Equipment in U.S. Manufacturing Industries."

*Review of Economics and Statistics*. 79:3, pp. 471–81.

**Mukhopadhyay, Tridas, Surendra Rajiv and Kannan Srinivasan.** 1997. “Information Technology Impact on Process Output and Quality.” *Management Science*. 43:12, pp. 1645–1659.

**Murnane, Richard J., Frank Levy and David Autor.** 1999. “Technological Change, Computers and Skill Demands: Evidence from the Back Office Operations of a Large Bank,” mimeo, NBER Economic Research Labor Workshop, June.

**Nakamura, L. I.** 1997. “The Measurement of Retail Output and the Retail Revolution,” paper presented at the CSLS Workshop on Service Sector Productivity and the Productivity Paradox, Ottawa, Canada, April.

**Oliner, S. D. and D. E. Sichel.** 1994. “Computers and Output Growth Revisited: How Big is the Puzzle?” *Brookings Papers on Economic Activity: Microeconomics*. 2, pp. 273–334.

**Orlikowski, W. J.** 1992. “Learning from Notes: Organizational Issues in Groupware Implementation,” in *Conference on Computer Supported Cooperative Work*. J. Turner and R. Kraut. Toronto, Association for Computing Machinery, pp. 362–69.

**Osterberg, William P. and Sandy A. Sterk.** 1997. “Do More Banking Offices Mean More Banking Services?” *Economic Commentary* (Federal Reserve Bank of Cleveland), 1-5.

**Parker, Robert and Bruce Grimm.** 2000. “Recognition of Business and Government Expenditures on Software as Investment: Methodology and Quantitative Impacts, 1959–98.” Working Paper, Bureau of Economic Analysis. Presented at May 5, 2000, Meeting of BEA Advisory Committee.

**Radner, R.** 1993. “The Organization of Decentralized Information Processing.” *Econometrica*. 62, pp. 1109–1146.

**Rangan, V. and M. Bell.** 1998. *Dell Online*. Harvard Business School Case Study 9-598-116.

**Roach, Stephen S.** 1987. “America’s Technology Dilemma: A Profile of the Information Economy.” *Morgan Stanley Special Economic Study*. April.

**Schankerman, M.** 1981. “The Effects of Double-Counting and Expensing on the Measured Returns to R&D.” *Review of Economics and Statistics*. 63, pp. 454–58.

**Schnapp, John.** 1998. “An Old Strategy is Backfiring at G.M.” *New York Times*. July 12, section 3:12.

**Seybold, Patricia and Ronni Marshak.** 1998. *Customers.com: How to Create A Profitable Business Strategy for the Internet and Beyond*. Times Books.

**Short, James E. and N. Venkatraman.** 1992. “Beyond Business Process Redesign: Redefining Baxter’s Business Network.” *Sloan Management Review*. 34:1, pp. 7–20.

**Siegel, Donald.** 1997. “The Impact of Computers on Manufacturing Productivity Growth: A Multiple-Indicators Multiple-Causes Approach.” *Review of Economics and Statistics*. 79:1, pp. 68–78.

**Simon, Herbert A.** 1976. *Administrative Behavior*. New York: The Free Press, 3<sup>rd</sup> Edition.

**Solow, R.M.** 1987. “We’d Better Watch Out.” *New York Times Book Review*. July 12, 36.

**Vitale, M. and B. Konsynski.** 1988. Baxter Healthcare Corp.: ASAP Express, Harvard Business School Case 9-188-080.

**Wilson, Diane D.** 1995. “IT Investment and its Productivity Effects: An Organizational Sociologist’s Perspective on Directions for Future Research.” *Economics of Innovation and New Technology*. 3, pp. 235–51.

**Yang, Shinkyu.** 2000. “Productivity Measurement in the Information Economy: A Revised Estimate of Total Factor Productivity.” Mimeo, New York University.

**This article has been cited by:**

1. Roberto Antonietti. 2016. From outsourcing to productivity, passing through training: microeconomic evidence from Italy. *Industry and Innovation* **23**:5, 407-425. [[CrossRef](#)]
2. Spyros Arvanitis, Euripidis N. Loukis, Vasiliki Diamantopoulou. 2016. Are ICT, Workplace Organization, and Human Capital Relevant for Innovation? A Comparative Swiss/Greek Study. *International Journal of the Economics of Business* 1-31. [[CrossRef](#)]
3. Jonghak Sun. 2016. The effect of information technology on IT-facilitated coordination, IT-facilitated autonomy, and decision-makings at the individual level. *Applied Economics* 1-18. [[CrossRef](#)]
4. Jan vom Brocke, Theresa Schmiedel, Alexander Simons, Alexander M. Schmid, Martin Petry, Christoph Baeck. 2016. From local IT needs to global process transformation: Hilti's customer service program. *Business Process Management Journal* **22**:3, 594-613. [[CrossRef](#)]
5. Sonal Daulatkar, Purnima S. Sangle. 2016. Proposed re-conceptualization of IT business value benefits. *Business Process Management Journal* **22**:3, 522-545. [[CrossRef](#)]
6. Hailin Liao, Bin Wang, Baibing Li, Tom Weyman-Jones. 2016. ICT as a general-purpose technology: The productivity of ICT in the United States revisited. *Information Economics and Policy* . [[CrossRef](#)]
7. Bharat Arora, Zillur Rahman. 2016. Information technology investment strategies: a review and synthesis of the literature. *Technology Analysis & Strategic Management* 1-22. [[CrossRef](#)]
8. Toma Lankauskienė. 2016. Application of the growth accounting method for the construction industry. *Journal of Business Economics and Management* **17**:3, 430-443. [[CrossRef](#)]
9. Stephan Kudyba, Richard Temple. An Introduction to the U.S. Healthcare Industry, Information Technology, and Informatics 1-24. [[CrossRef](#)]
10. Wen Chen, Thomas Niebel, Marianne Saam. 2016. Are intangibles more productive in ICT-intensive industries? Evidence from EU countries. *Telecommunications Policy* **40**:5, 471-484. [[CrossRef](#)]
11. Erik Brynjolfsson, Kristina McElheran. 2016. The Rapid Adoption of Data-Driven Decision-Making. *American Economic Review* **106**:5, 133-139. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
12. Paolo Neirotti, Elisabetta Raguseo. 2016. On the contingent value of IT-based capabilities for the competitive advantage of SMEs: Mechanisms and empirical evidence. *Information & Management* . [[CrossRef](#)]
13. Jose-Luis Hervás-Oliver, Francisca Ripoll-Sempere, Carles Boronat Moll. 2016. Does management innovation pay-off in SMEs? Empirical evidence for Spanish SMEs. *Small Business Economics* . [[CrossRef](#)]
14. Alex Coad, Gabriele Pellegrino, Maria Savona. 2016. Barriers to innovation and firm productivity. *Economics of Innovation and New Technology* **25**, 321-334. [[CrossRef](#)]
15. Gilbert Cetté, John Fernald, Benoît Mojon. 2016. The pre-Great Recession slowdown in productivity. *European Economic Review* . [[CrossRef](#)]
16. Saeed Moshiri. 2016. ICT spillovers and productivity in Canada: provincial and industry analysis. *Economics of Innovation and New Technology* 1-20. [[CrossRef](#)]
17. Robert Wentrup, Patrik Ström, H. Richard Nakamura. 2016. Digital oases and digital deserts in Sub-Saharan Africa. *Journal of Science and Technology Policy Management* **7**, 77-100. [[CrossRef](#)]
18. Steven Ji-fan Ren, Samuel Fosso Wamba, Shahriar Akter, Rameshwar Dubey, Stephen J. Childe. 2016. Modelling quality dynamics, business value and firm performance in a big data analytics environment. *International Journal of Production Research* 1-16. [[CrossRef](#)]
19. Luis Garicano, Luis Rayo. 2016. Why Organizations Fail: Models and Cases. *Journal of Economic Literature* **54**:1, 137-192. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]

20. Simona Popa, Pedro Soto-Acosta, Euripidis Loukis. 2016. Analyzing the complementarity of web infrastructure and eInnovation for business value generation. *Program* **50**, 118-134. [[CrossRef](#)]
21. Riaan Rudman, Rikus Bruwer. 2016. Defining Web 3.0: opportunities and challenges. *The Electronic Library* **34**:1, 132-154. [[CrossRef](#)]
22. Delivering services 152-188. [[CrossRef](#)]
23. Gianfranco Walsh, Peter Walgenbach, Heiner Evanschitzky, Mario Schaarschmidt. 2016. Service Productivity: What Stops Service Firms from Measuring It?. *Journal of Organisational Transformation & Social Change* **13**:1, 5-25. [[CrossRef](#)]
24. Derya Findik, Aysit Tansel 106. [[CrossRef](#)]
25. Ram C. Acharya. 2016. ICT use and total factor productivity growth: intangible capital or productive externalities?. *Oxford Economic Papers* **68**, 16-39. [[CrossRef](#)]
26. Wei Jin, ZhongXiang Zhang. 2016. The tragedy of product homogeneity and knowledge non-spillovers: explaining the slow pace of energy technological progress. *Annals of Operations Research* . [[CrossRef](#)]
27. Niki Kyriakou, Euripides Loukis, Spyros Arvanitis Enterprise Systems and Innovation -- An Empirical Investigation 4686-4696. [[CrossRef](#)]
28. Daniel W. E. Hein, Philipp A. Rauschnabel Augmented Reality Smart Glasses and Knowledge Management: A Conceptual Framework for Enterprise Social Networks 83-109. [[CrossRef](#)]
29. Janet H. Marler, Emma Parry. 2015. Human resource management, strategic involvement and e-HRM technology. *The International Journal of Human Resource Management* 1-21. [[CrossRef](#)]
30. Der-Fang Hung. 2015. Sustained Competitive Advantage and Organizational Inertia: The Cost Perspective of Knowledge Management. *Journal of the Knowledge Economy* **6**, 769-789. [[CrossRef](#)]
31. Francesco Vona, Davide Consoli. 2015. Innovation and skill dynamics: a life-cycle approach. *Industrial and Corporate Change* **24**, 1393-1415. [[CrossRef](#)]
32. Alberto Bayo-Moriones, Jonathan Calleja-Blanco, Fernando Lera-López. 2015. The relationship between ICTs and HPWPs across occupations. *International Journal of Manpower* **36**, 1164-1180. [[CrossRef](#)]
33. Masayuki Morikawa. 2015. Are large headquarters unproductive?. *Journal of Economic Behavior & Organization* **119**, 422-436. [[CrossRef](#)]
34. Alon Brav, Wei Jiang, Hyunseob Kim. 2015. The Real Effects of Hedge Fund Activism: Productivity, Asset Allocation, and Labor Outcomes. *Review of Financial Studies* **28**, 2723-2769. [[CrossRef](#)]
35. JANE BOURKE, FRANK CROWLEY. 2015. THE ROLE OF HRM AND ICT COMPLEMENTARITIES IN FIRM INNOVATION: EVIDENCE FROM TRANSITION ECONOMIES. *International Journal of Innovation Management* **19**, 1550054. [[CrossRef](#)]
36. Jerry Luftman, Kalle Lyytinen, Tal ben Zvi. 2015. Enhancing the measurement of information technology (IT) business alignment and its influence on company performance. *Journal of Information Technology* . [[CrossRef](#)]
37. Dawei Zhang, Zhuo (June) Cheng, Hasan A. Qurban H. Mohammad, Barrie R. Nault. 2015. Research Commentary—Information Technology Substitution Revisited. *Information Systems Research* **26**, 480-495. [[CrossRef](#)]
38. Lin-Kung Chen, Wei-Ning Yang. 2015. Perceived service quality discrepancies between telecommunication service provider and customer. *Computer Standards & Interfaces* **41**, 85-97. [[CrossRef](#)]

39. William Jones. 2015. Building a Better World with our Information: The Future of Personal Information Management, Part 3. *Synthesis Lectures on Information Concepts, Retrieval, and Services* 7, 1-203. [[CrossRef](#)]
40. Maria Veronica Alderete. 2015. Does digital proximity between countries impact entrepreneurship?. *info* 17, 46-65. [[CrossRef](#)]
41. Susan A Brown, Anne P Massey, Kerry W Ward. 2015. Handle mergers and acquisitions with care: the fragility of trust between the IT-service provider and end-users. *European Journal of Information Systems* . [[CrossRef](#)]
42. Luay Anaya, Mohammed Dulaimi, Sherief Abdallah. 2015. An investigation into the role of enterprise information systems in enabling business innovation. *Business Process Management Journal* 21, 771-790. [[CrossRef](#)]
43. Seunghee Yu, Abhay Nath Mishra, Anandasivam Gopal, Sandra Slaughter, Tridas Mukhopadhyay. 2015. E-Procurement Infusion and Operational Process Impacts in MRO Procurement: Complementary or Substitutive Effects?. *Production and Operations Management* 24:10.1111/poms.2015.24.issue-7, 1054-1070. [[CrossRef](#)]
44. Roya Gholami, Dolores Añón Higón, Ali Emrouznejad. 2015. Hospital performance: Efficiency or quality? Can we have both with IT?. *Expert Systems with Applications* 42, 5390-5400. [[CrossRef](#)]
45. Shiyi Chen, Zhen Xie. 2015. Is China's e-governance sustainable? Testing Solow IT productivity paradox in China's context. *Technological Forecasting and Social Change* 96, 51-61. [[CrossRef](#)]
46. Encarnación Moral-Pajares, Adoración Mozas-Moral, Enrique Bernal-Jurado, Miguel Jesús Medina-Viruel. 2015. Efficiency and exports: Evidence from Southern European companies. *Journal of Business Research* 68, 1506-1511. [[CrossRef](#)]
47. Hyun-Sun Ryu, Jae-Nam Lee. 2015. How Should Service Innovation Strategy be Aligned with Business Strategy? : Focused on the Moderating Effect of IT Capability. *Journal of the Korea society of IT services* 14, 195-229. [[CrossRef](#)]
48. Linda M. Pittenger. 2015. Emotional and social competencies and perceptions of the interpersonal environment of an organization as related to the engagement of IT professionals. *Frontiers in Psychology* 6. . [[CrossRef](#)]
49. Sonal Daulatkar, Purnima S. Sangle. 2015. Causality in information technology business value: a review. *Business Process Management Journal* 21, 482-516. [[CrossRef](#)]
50. Adam B. JaffeTechnology Diffusion 1-15. [[CrossRef](#)]
51. Adol Esquivel, Dean Sittig, Daniel Murphy, Hardeep SinghASSESSMENT OF CLINICIAN-TOCLINICIAN E-COMMUNICATION 341-366. [[CrossRef](#)]
52. Marlies Van der Wee, Sofie Verbrugge, Bert Sadowski, Menno Driesse, Mario Pickavet. 2015. Identifying and quantifying the indirect benefits of broadband networks for e-government and e-business: A bottom-up approach. *Telecommunications Policy* 39, 176-191. [[CrossRef](#)]
53. Martin Junge, Battista Severgnini, Anders Sørensen. 2015. Product-Marketing Innovation, Skills, and Firm Productivity Growth. *Review of Income and Wealth* n/a-n/a. [[CrossRef](#)]
54. Anjali Gupta, Karen J. Calfas, Simon J. Marshall, Thomas N. Robinson, Cheryl L. Rock, Jeannie S. Huang, Melanie Epstein-Corbin, Christina Servetas, Michael C. Donohue, Gregory J. Norman, Fredric Raab, Gina Merchant, James H. Fowler, William G. Griswold, B.J. Fogg, Kevin Patrick. 2015. Clinical trial management of participant recruitment, enrollment, engagement, and retention in the SMART study using a Marketing and Information Technology (MARKIT) model. *Contemporary Clinical Trials* 42, 185-195. [[CrossRef](#)]
55. Stan Maklan, Joe Peppard, Philipp Klaus. 2015. Show me the money. *European Journal of Marketing* 49, 561-595. [[CrossRef](#)]

56. Mahmood Hajli, Julian M. Sims, Valisher Ibragimov. 2015. Information technology (IT) productivity paradox in the 21st century. *International Journal of Productivity and Performance Management* **64**, 457-478. [[CrossRef](#)]
57. Fardad Zand, Sam Solaimani, Cees van Beers. 2015. A Role-based Typology of Information Technology: Model Development and Assessment. *Information Systems Management* **32**, 119-135. [[CrossRef](#)]
58. Raquel Ortega-Argilés, Mariacristina Piva, Marco Vivarelli. 2015. The productivity impact of R&D investment: are high-tech sectors still ahead?. *Economics of Innovation and New Technology* **24**, 204-222. [[CrossRef](#)]
59. G. Battisti, M. G. Colombo, L. Rabbiosi. 2015. Simultaneous versus sequential complementarity in the adoption of technological and organizational innovations: the case of innovations in the design sphere. *Industrial and Corporate Change* **24**, 345-382. [[CrossRef](#)]
60. Amir Gholam Abri, Mahmoud Mahmoudzadeh. 2015. Impact of information technology on productivity and efficiency in Iranian manufacturing industries. *Journal of Industrial Engineering International* **11**, 143-157. [[CrossRef](#)]
61. Sergei Koulayev, Emilia Simeonova. 2015. Can health IT adoption reduce health disparities?. *Health Systems* **4**:1, 55-63. [[CrossRef](#)]
62. Daeheon Choi. 2015. A Study of Effects of Interorganizational Relationship Factors on Technology Diffusion in Supply Chain Networks. *Journal of the Korea Academia-Industrial cooperation Society* **16**, 1006-1015. [[CrossRef](#)]
63. Noelle Chesley, Britta E. Johnson. 2015. Technology Use and the New Economy: Work Extension, Network Connectivity, and Employee Distress and Productivity 61-99. [[CrossRef](#)]
64. L. Martin, N. Omrani. 2015. An assessment of trends in technology use, innovative work practices and employees' attitudes in Europe. *Applied Economics* **47**, 623-638. [[CrossRef](#)]
65. Cornelia Storz, Federico Riboldazzi, Moritz John. 2015. Mobility and innovation: A cross-country comparison in the video games industry. *Research Policy* **44**, 121-137. [[CrossRef](#)]
66. Crispin R. Coombs. 2015. When planned IS/IT project benefits are not realized: a study of inhibitors and facilitators to benefits realization. *International Journal of Project Management* **33**, 363-379. [[CrossRef](#)]
67. Andrew Gemino, Blaize Horner Reich, Chris Sauer. 2015. Plans versus people: Comparing knowledge management approaches in IT-enabled business projects. *International Journal of Project Management* **33**, 299-310. [[CrossRef](#)]
68. Rameshwar Dubey, Angappa Gunasekaran, Anindya Chakrabarty. 2015. Ubiquitous manufacturing: overview, framework and further research directions. *International Journal of Computer Integrated Manufacturing* 1-14. [[CrossRef](#)]
69. References 215-242. [[CrossRef](#)]
70. Francesco Venturini. 2015. The modern drivers of productivity. *Research Policy* **44**:2, 357. [[CrossRef](#)]
71. Marianna Belloc, Paolo Guerrieri. 2015. Impact of ICT diffusion and adoption on sectoral industrial performance: evidence from a panel of European countries. *Economia Politica* **32**:1, 67. [[CrossRef](#)]
72. Birger Wernerfelt. 2015. The Comparative Advantages of Firms, Markets and Contracts: a Unified Theory. *Economica* **82**:326, 350. [[CrossRef](#)]
73. Hannes Lindblad, Susanna Vass. 2015. BIM Implementation and Organisational Change: A Case Study of a Large Swedish Public Client. *Procedia Economics and Finance* **21**, 178-184. [[CrossRef](#)]
74. Jiayu Chi, Ling Sun. 2015. IT and Competitive Advantage: A Study from Micro Perspective. *Modern Economy* **06**, 404-410. [[CrossRef](#)]

75. Cristiano Antonelli, Francesco Crespi, Giuseppe Scellato. 2015. Productivity growth persistence: firm strategies, size and system properties. *Small Business Economics* 45:1, 129. [[CrossRef](#)]
76. Fernando Suárez-Warden, Eduardo González Mendivil, Alejandro Fonseca Ramírez, Salvador García-Lumbreras. 2015. Profit Model for Incorporating AR Technology in Assembly Tasks of Aeronautical Maintenance. *Procedia Computer Science* 75, 113-122. [[CrossRef](#)]
77. Yen-Chun Chou, Howard Hao-Chun Chuang, Benjamin B.M. Shao. 2014. The impacts of information technology on total factor productivity: A look at externalities and innovations. *International Journal of Production Economics* 158, 290-299. [[CrossRef](#)]
78. Adi Masli, Vernon J. Richardson, Juan Manuel Sanchez, Rodney E. Smith. 2014. The Interrelationships Between Information Technology Spending, CEO Equity Incentives, and Firm Value. *Journal of Information Systems* 28, 41-65. [[CrossRef](#)]
79. Rinaldo Evangelista, Paolo Guerrieri, Valentina Meliciani. 2014. The economic impact of digital technologies in Europe. *Economics of Innovation and New Technology* 23, 802-824. [[CrossRef](#)]
80. Jose Manuel Esteves. 2014. An empirical identification and categorisation of training best practices for ERP implementation projects. *Enterprise Information Systems* 8, 665-683. [[CrossRef](#)]
81. Francesco D. Sandulli, Paul M.A. Baker, José I. López-Sánchez. 2014. Jobs mismatch and productivity impact of information technology. *The Service Industries Journal* 34, 1060-1074. [[CrossRef](#)]
82. Landon Kleis, Barrie R. Nault, Albert S. Dexter. 2014. Producing Synergy: Innovation, IT, and Productivity. *Decision Sciences* 45:10.1111/dec.2014.45.issue-5, 939-969. [[CrossRef](#)]
83. Hemant K. Bhargava, Abhay Nath Mishra. 2014. Electronic Medical Records and Physician Productivity: Evidence from Panel Data Analysis. *Management Science* 60. . [[CrossRef](#)]
84. Md. Al Mamun, Guneratne B. Wickremasinghe. 2014. Dynamic linkages between diffusion of Information Communication Technology and labour productivity in South Asia. *Applied Economics* 46, 3246-3260. [[CrossRef](#)]
85. Mark BallinNext Frontier: Sharing the Airspace with Increased Autonomy 779-794. [[CrossRef](#)]
86. Juha-Miikka Nurmilaakso. 2014. Coordination costs and ICT investments: an economic analysis. *NETNOMICS: Economic Research and Electronic Networking* 15, 57-67. [[CrossRef](#)]
87. Concetta Castiglione, Davide Infante. 2014. ICTs and time-span in technical efficiency gains. A stochastic frontier approach over a panel of Italian manufacturing firms. *Economic Modelling* 41, 55-65. [[CrossRef](#)]
88. Eric C. Y. Ng, Malick Souare. 2014. On investment and exchange-rate movements. *Applied Economics* 46, 2301-2315. [[CrossRef](#)]
89. Cristian Berrío-Zapata, Hernando Rojas-Hernández. 2014. The Digital Divide in the University: The Appropriation of ICT in Higher Education Students from Bogota, Colombia. *Comunicar* 22. . [[CrossRef](#)]
90. Robert G. Fichman, Nigel P. Melville. 2014. How Posture-Profile Misalignment in IT Innovation Diminishes Returns: Conceptual Development and Empirical Demonstration. *Journal of Management Information Systems* 31, 203-240. [[CrossRef](#)]
91. Prasanna Tambe. 2014. Big Data Investment, Skills, and Firm Value. *Management Science* 60, 1452-1469. [[CrossRef](#)]
92. Pekka Ilmakunnas, Hannu Piekkola. 2014. Intangible investment in people and productivity. *Journal of Productivity Analysis* 41, 443-456. [[CrossRef](#)]
93. Kristina McElheran. 2014. Delegation in Multi-Establishment Firms: Evidence from I.T. Purchasing. *Journal of Economics & Management Strategy* 23:10.1111/jems.2014.23.issue-2, 225-258. [[CrossRef](#)]
94. Sunil Mithas, Henry LucasInformation Technology and Firm Value 72-1-72-20. [[CrossRef](#)]

95. Heikki Topi. Evolving Discipline of Information Systems 1-1-1-26. [[CrossRef](#)]
96. Ellen Hoadley, Rajiv Kohli. Business Value of IS Investments 71-1-71-14. [[CrossRef](#)]
97. Pier Paolo Patrucco. 2014. The Evolution of Knowledge Organization and the Emergence of a Platform for Innovation in the Car Industry. *Industry and Innovation* **21**, 243-266. [[CrossRef](#)]
98. James T. Murphy, Pádraig Carmody, Björn Surborg. 2014. Industrial transformation or business as usual? Information and communication technologies and Africa's place in the global information economy. *Review of African Political Economy* **41**, 264-283. [[CrossRef](#)]
99. Anup Srivastava. 2014. Why have measures of earnings quality changed over time?. *Journal of Accounting and Economics* **57**, 196-217. [[CrossRef](#)]
100. Martin Hilbert. 2014. Technological information inequality as an incessantly moving target: The redistribution of information and communication capacities between 1986 and 2010. *Journal of the Association for Information Science and Technology* **65**:10.1002/asi.2014.65.issue-4, 821-835. [[CrossRef](#)]
101. Xiaoyu Yu, Yi Chen, Bang Nguyen, Wenhong Zhang. 2014. Ties with government, strategic capability, and organizational ambidexterity: evidence from China's information communication technology industry. *Information Technology and Management* . [[CrossRef](#)]
102. Evgeniya Yushkova. 2014. Impact of ICT on trade in different technology groups: analysis and implications. *International Economics and Economic Policy* **11**, 165-177. [[CrossRef](#)]
103. Noor Hazarina Hashim, Jamie Murphy, Olaru Doina, Peter O'Connor. 2014. Bandwagon and leapfrog effects in Internet implementation. *International Journal of Hospitality Management* **37**, 91-98. [[CrossRef](#)]
104. Pedro Soto-Acosta, Ricardo Colomo-Palacios, Simona Popa. 2014. Web knowledge sharing and its effect on innovation: an empirical investigation in SMEs. *Knowledge Management Research & Practice* **12**:1, 103-113. [[CrossRef](#)]
105. Benny M.E. de Waal, Ronald Batenburg. 2014. The process and structure of user participation: a BPM system implementation case study. *Business Process Management Journal* **20**, 107-128. [[CrossRef](#)]
106. Günther Schuh, Till Potente, Rawina Varandani, Carlo Hausberg, Bastian Fränken. 2014. Collaboration Moves Productivity to the Next Level. *Procedia CIRP* **17**, 3-8. [[CrossRef](#)]
107. Pilar Ficapal-Cusí, Joan Torrent-Sellens. 2014. New Human Resource Management Systems in Non-Based-Knowledge Firms: Applications for Decision Making on the Business Performance. *Modern Economy* **05**, 139-151. [[CrossRef](#)]
108. Mohamed Kossaï, Patrick Piget. 2014. Adoption of information and communication technology and firm profitability: Empirical evidence from Tunisian SMEs. *The Journal of High Technology Management Research* **25**, 9-20. [[CrossRef](#)]
109. Xueming Luo, Bin Gu, Cheng Zhang. IT Investments and Firm Stock Market Value: The Mediating Role of Stock Analysts 4093-4102. [[CrossRef](#)]
110. Freddy Moises Brofman Epelbaum, Marian Garcia Martinez. 2014. The Technological Evolution of Food Traceability Systems and their Impact on Firm Sustainable Performance: A RBV Approach. *International Journal of Production Economics* . [[CrossRef](#)]
111. Ana Salomé García-Muñiz, María Rosalía Vicente. 2014. ICT technologies in Europe: A study of technological diffusion and economic growth under network theory. *Telecommunications Policy* . [[CrossRef](#)]
112. Günther Schuh, Till Potente, Cathrin Wesch-Potente, Anja Ruth Weber, Jan-Philipp Prote. 2014. Collaboration Mechanisms to Increase Productivity in the Context of Industrie 4.0. *Procedia CIRP* **19**, 51-56. [[CrossRef](#)]

113. Changmok Hong, Jin-Hyang Jung. 2013. Determinants of Information Technology Personnel Size in Korean Listed Companies:A Cross-Sectional Analysis. *Journal of the Korea society of IT services* **12**, 91-108. [[CrossRef](#)]
114. Maria del Mar Alonso-Almeida, Josep Llach. 2013. Adoption and use of technology in small business environments. *The Service Industries Journal* **33**, 1456-1472. [[CrossRef](#)]
115. Davide Arduini, Mario Denni, Matteo Lucchese, Alessandra Nurra, Antonello Zanfei. 2013. The role of technology, organization and contextual factors in the development of e-Government services: An empirical analysis on Italian Local Public Administrations. *Structural Change and Economic Dynamics* **27**, 177-189. [[CrossRef](#)]
116. Adol Esquivel, Daniel Murphy, Hardeep Singh Improving the Effectiveness of Electronic Health Record-Based Referral Processes 261-277. [[CrossRef](#)]
117. Yan Chen, Grace YoungJoo Jeon, Yong-Mi Kim. 2013. A day without a search engine: an experimental study of online and offline searches. *Experimental Economics* . [[CrossRef](#)]
118. Tjahjanto, Benhard Sitohang, Sudarso Kaderi Wiryono A system design of productivity measurement internet bandwidth usage 1-5. [[CrossRef](#)]
119. Youngcheol Kang, William J. O'Brien, Stephen P. Mulva. 2013. Value of IT: Indirect impact of IT on construction project performance via Best Practices. *Automation in Construction* **35**, 383-396. [[CrossRef](#)]
120. Jonathan G. Koomey, H. Scott Matthews, Eric Williams. 2013. Smart Everything: Will Intelligent Systems Reduce Resource Use?. *Annual Review of Environment and Resources* **38**, 311-343. [[CrossRef](#)]
121. Spyros Arvanitis, Euripidis Loukis, Vasiliki Diamantopoulou. 2013. The effect of soft ICT capital on innovation performance of Greek firms. *Journal of Enterprise Information Management* **26**, 679-701. [[CrossRef](#)]
122. Oleg Badunenko, Daniel J. Henderson, R. Robert Russell. 2013. Polarization of the worldwide distribution of productivity. *Journal of Productivity Analysis* **40**, 153-171. [[CrossRef](#)]
123. Francesco D. Sandulli, Paul M.A. Baker, José I. López-Sánchez. 2013. Can small and medium enterprises benefit from skill-biased technological change?. *Journal of Business Research* **66**, 1976-1982. [[CrossRef](#)]
124. Daeheon Choi. 2013. Adoption and Diffusion Speed of New Technology with Network Externality in a Two-level Supply Chain : An Approach to Relative Factors in Buyer-Supplier Relationships. *Journal of the Korean Operations Research and Management Science Society* **38**, 51-70. [[CrossRef](#)]
125. Ahmad Fareed Ismail, Steffen Frank Zorn, Huey Chern Boo, Sambasivan Murali, Jamie Murphy. 2013. Information technology diffusion in Malaysia's foodservice industry. *Journal of Hospitality and Tourism Technology* **4**, 200-210. [[CrossRef](#)]
126. Marco Giovanni Mariani, Matteo Curcuruto, Ivan Gaetani. 2013. Training opportunities, technology acceptance and job satisfaction. *Journal of Workplace Learning* **25**, 455-475. [[CrossRef](#)]
127. Youngcheol Kang, William J. O'Brien, James T. O'Connor. 2013. Information-Integration Maturity Model for the Capital Projects Industry. *Journal of Management in Engineering* 04014061. [[CrossRef](#)]
128. Robert E. Overstreet, Benjamin T. Hazen, Terry Anthony Byrd, Dianne J. Hall. 2013. Innovativeness in the motor carrier industry. *International Journal of Logistics Research and Applications* 1-13. [[CrossRef](#)]
129. Prasanna Tambe, Lorin M. Hitt. 2013. Measuring Information Technology Spillovers. *Information Systems Research* 140304122235009. [[CrossRef](#)]
130. Young Bong Chang, Vijay Gurbaxani. 2013. An Empirical Analysis of Technical Efficiency: The Role of IT Intensity and Competition. *Information Systems Research* **24**, 561-578. [[CrossRef](#)]

131. Shivraj Kanungo, Vikas Jain. 2013. Organizational Culture and E-Government Performance. *International Journal of Electronic Government Research* 7:10.4018/jegr.20110401, 36-58. [[CrossRef](#)]
132. Matthew J. Bidwell. 2013. What Happened to Long-Term Employment? The Role of Worker Power and Environmental Turbulence in Explaining Declines in Worker Tenure. *Organization Science* 24, 1061-1082. [[CrossRef](#)]
133. Jason Dedrick, Kenneth L. Kraemer, Eric Shih. 2013. Information Technology and Productivity in Developed and Developing Countries. *Journal of Management Information Systems* 30, 97-122. [[CrossRef](#)]
134. A.R. Thurik, E. Stam, D.B. Audretsch. 2013. The rise of the entrepreneurial economy and the future of dynamic capitalism. *Technovation* . [[CrossRef](#)]
135. Yun Wu, Casey G. Cegielski, Benjamin T. Hazen, Dianne J. Hall. 2013. Cloud Computing in Support of Supply Chain Information System Infrastructure: Understanding When to go to the Cloud. *Journal of Supply Chain Management* 49:10.1111/jscm.2013.49.issue-3, 25-41. [[CrossRef](#)]
136. Farley Simon Nobre Fuzzy Theory in cognition, economic man and organization behavior 471-477. [[CrossRef](#)]
137. C. Corrado, J. Haskel, C. Jona-Lasinio, M. Iommi. 2013. Innovation and intangible investment in Europe, Japan, and the United States. *Oxford Review of Economic Policy* 29, 261-286. [[CrossRef](#)]
138. Benjamin Engelstätter, Miruna Sarbu. 2013. Does enterprise software matter for service innovation? Standardization versus customization. *Economics of Innovation and New Technology* 22, 412-429. [[CrossRef](#)]
139. Sooyoung Yoo, Seok Kim, Seungja Lee, Kee-Hyuck Lee, Rong-Min Baek, Hee Hwang. 2013. A study of user requests regarding the fully electronic health record system at Seoul National University Bundang Hospital: Challenges for future electronic health record systems. *International Journal of Medical Informatics* 82, 387-397. [[CrossRef](#)]
140. Bronwyn H. Hall, Francesca Lotti, Jacques Mairesse. 2013. Evidence on the impact of R&D and ICT investments on innovation and productivity in Italian firms. *Economics of Innovation and New Technology* 22, 300-328. [[CrossRef](#)]
141. Euripidis Loukis, Pedro Soto-Acosta, Konstantinos Pazalos. 2013. Using structural equation modelling for investigating the impact of e-business on ICT and non-ICT assets, processes and business performance. *Operational Research* 13, 89-111. [[CrossRef](#)]
142. Youngcheol Kang, William J. O'Brien, Jiukun Dai, Stephen P. Mulva, Stephen P. Thomas, Robert E. Chapman, David Butry. 2013. Interaction Effects of Information Technologies and Best Practices on Construction Project Performance. *Journal of Construction Engineering and Management* 139, 361-371. [[CrossRef](#)]
143. Alberto Bayo-Moriones, Margarita Billón, Fernando Lera-López. 2013. Perceived performance effects of ICT in manufacturing SMEs. *Industrial Management & Data Systems* 113, 117-135. [[CrossRef](#)]
144. Matej Marinč. 2013. Banks and information technology: marketability vs. relationships. *Electronic Commerce Research* 13, 71-101. [[CrossRef](#)]
145. Kamil J. Mizgier, Matthias P. Jüttner, Stephan M. Wagner. 2013. Bottleneck identification in supply chain networks. *International Journal of Production Research* 51, 1477-1490. [[CrossRef](#)]
146. Cristiana Donati, Domenico Sarno. 2013. The impact of ICT on productivity of Italian firms: evaluation of the micro-complementarity hypothesis. *Applied Economics Letters* 20, 349-352. [[CrossRef](#)]
147. Guido Schryen. 2013. Revisiting IS business value research: what we already know, what we still need to know, and how we can get there. *European Journal of Information Systems* 22:S2, 139-169. [[CrossRef](#)]

148. Mary E. Deily, Tianyan Hu, Sabrina Terrizzi, Shin-Yi Chou, Chad D. Meyerhoefer. 2013. The Impact of Health Information Technology Adoption by Outpatient Facilities on Pregnancy Outcomes. *Health Services Research* 48:10.1111/hesr.2013.48.issue-1, 70-94. [[CrossRef](#)]
149. FRANZISKA GÜNZEL, ANNA B. HOLM. 2013. ONE SIZE DOES NOT FIT ALL — UNDERSTANDING THE FRONT-END AND BACK-END OF BUSINESS MODEL INNOVATION. *International Journal of Innovation Management* 17, 1340002. [[CrossRef](#)]
150. Valeria Belvedere, Alberto Grando, Paola Bielli. 2013. A quantitative investigation of the role of information and communication technologies in the implementation of a product-service system. *International Journal of Production Research* 51, 410-426. [[CrossRef](#)]
151. Paul P. Tallon, Ronald V. Ramirez, James E. Short. 2013. The Information Artifact in IT Governance: Toward a Theory of Information Governance. *Journal of Management Information Systems* 30, 141-178. [[CrossRef](#)]
152. Robert Pellerin, Nathalie Perrier, Xavier Guillot, Pierre-Majorique Léger. 2013. Project Management Software Utilization and Project Performance. *Procedia Technology* 9, 857-866. [[CrossRef](#)]
153. Patrick Mikalef, Adamantia Pateli, Ronald Batenburg, Rogier van de Wetering. 2013. Investigating the Impact of Procurement Alignment on Supply Chain Management Performance. *Procedia Technology* 9, 310-319. [[CrossRef](#)]
154. Benjamin Engelstätter, Miruna Sarbu. 2013. Why adopt social enterprise software? Impacts and benefits. *Information Economics and Policy* . [[CrossRef](#)]
155. Carl Åke Walldius, Ann Lantz. 2013. Exploring the use of design pattern maps for aligning new technical support to new clinical team meeting routines. *Behaviour & Information Technology* 32, 68-79. [[CrossRef](#)]
156. M. Cardona, T. Kretschmer, T. Strobel. 2013. ICT and productivity: conclusions from the empirical literature. *Information Economics and Policy* . [[CrossRef](#)]
157. Nigel P. Melville, Terence Saldanha Information Systems for Managing Energy and Carbon Emission Information: Empirical Analysis of Adoption Antecedents 935-944. [[CrossRef](#)]
158. Danielle Galliano, Luis Orozco. 2013. New Technologies and Firm Organization: The Case of Electronic Traceability Systems in French Agribusiness. *Industry & Innovation* 20, 22-47. [[CrossRef](#)]
159. Thomas Borghoff Information and Communication Technologies in the Globalization of Small and Medium-Sized Firms during the Global Crisis: An Empirical Study in China, India, New Zealand, and Singapore 102-136. [[CrossRef](#)]
160. Mark Ford, Jim Cox, Jim Hagar, Robb Kirkman. 2012. Risk-Based Benefit-Cost Analysis of Information Technology Tools for Program Management. *Transportation Research Record: Journal of the Transportation Research Board* 2297, 104-111. [[CrossRef](#)]
161. Massimo G. Colombo, Annalisa Croce, Luca Grilli. 2012. ICT services and small businesses' productivity gains: An analysis of the adoption of broadband Internet technology. *Information Economics and Policy* . [[CrossRef](#)]
162. Francisco J. Mata, Ariella Quesada, Keynor Ruiz, Jeffrey Orozco The relationship between information and communication technology and productivity in Costa Rican companies 1-6. [[CrossRef](#)]
163. Euripidis Loukis, Spyros Arvanitis, Vasiliki Diamantopoulou An Empirical Investigation of the Effect of Hard and Soft ICT Investment on Innovation Activity of Greek Firms 31-36. [[CrossRef](#)]
164. K. Sapprasert, T. H. Clausen. 2012. Organizational innovation and its effects. *Industrial and Corporate Change* 21, 1283-1305. [[CrossRef](#)]
165. Jaime Gómez, Idana Salazar, Pilar Vargas. 2012. El acceso a canales de información y la adopción de tecnologías de proceso. *Cuadernos de Economía y Dirección de la Empresa* 15:4, 169-180. [[CrossRef](#)]

166. Young Bong Chang, Vijay Gurbaxani. 2012. The Impact of IT-Related Spillovers on Long-Run Productivity: An Empirical Analysis. *Information Systems Research* **23**, 868-886. [[CrossRef](#)]
167. J. Gilbert Silvius. 2012. A Conceptual Model for Aligning IT Valuation Methods. *International Journal of IT/Business Alignment and Governance* **1**:10.4018/jitbag.20100701, 36-54. [[CrossRef](#)]
168. Prasanna Tambe, Lorin M. Hitt. 2012. The Productivity of Information Technology Investments: New Evidence from IT Labor Data. *Information Systems Research* **23**, 599-617. [[CrossRef](#)]
169. Anna Giunta, Annamaria Nifo, Domenico Scalera. 2012. Subcontracting in Italian Industry: Labour Division, Firm Growth and the North-South Divide. *Regional Studies* **46**, 1067-1083. [[CrossRef](#)]
170. Farley Simon Nobre Contributions of fuzzy logic and bounded rationality to cognitive machines in organizations 1-6. [[CrossRef](#)]
171. R. Evangelista, A. Vezzani. 2012. The impact of technological and organizational innovations on employment in European firms. *Industrial and Corporate Change* **21**, 871-899. [[CrossRef](#)]
172. Murillo Campello, John R. Graham. 2012. Do stock prices influence corporate decisions? Evidence from the technology bubble. *Journal of Financial Economics* . [[CrossRef](#)]
173. Mariela Dal Borgo, Peter Goodridge, Jonathan Haskel, Annarosa Pesole. 2012. Productivity and Growth in UK Industries: An Intangible Investment Approach \*. *Oxford Bulletin of Economics and Statistics* no-no. [[CrossRef](#)]
174. Benjamin T. Hazen, Yun Wu, Chetan S. Sankar. 2012. Factors That Influence Dissemination in Engineering Education. *IEEE Transactions on Education* **55**, 384-393. [[CrossRef](#)]
175. Euripidis Loukis, Ioakim Sapounas. 2012. Innovation, Information Systems Strategic Alignment and Business Value. *International Journal of Strategic Information Technology and Applications* **1**:10.4018/jsit.20100401, 38-54. [[CrossRef](#)]
176. José David Vicente-Lorente, José Ángel Zúñiga-Vicente. 2012. Effects of process and product-oriented innovations on employee downsizing. *International Journal of Manpower* **33**, 383-403. [[CrossRef](#)]
177. Anjana Susarla. 2012. Contractual Flexibility, Rent Seeking, and Renegotiation Design: An Empirical Analysis of Information Technology Outsourcing Contracts. *Management Science* **58**, 1388-1407. [[CrossRef](#)]
178. Jean-Jacques Rosa, Julien Hanoteau. 2012. The Shrinking Hand: Why Information Technology Leads to Smaller Firms. *International Journal of the Economics of Business* **19**, 285-314. [[CrossRef](#)]
179. Govindan Marthandan, Tang Chun Meng. 2012. Thirst for Business Value of Information Technology. *International Journal of Technology Diffusion* **1**:10.4018/ijt.20100101, 28-40. [[CrossRef](#)]
180. John Wang, Bin Zhou, Jeffrey Hsu. 2012. Assessment and Contrast of the Effects of Information and Communication Technology. *International Journal of Information Communication Technologies and Human Development* **2**:10.4018/ijicthd.20100101, 18-42. [[CrossRef](#)]
181. ANNE-LAURE MENTION, ANNA-LEENA ASIKAINEN. 2012. INNOVATION & PRODUCTIVITY: INVESTIGATING EFFECTS OF OPENNESS IN SERVICES. *International Journal of Innovation Management* **16**, 1240004. [[CrossRef](#)]
182. Patrick Besson, Frantz Rowe. 2012. Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions. *The Journal of Strategic Information Systems* **21**, 103-124. [[CrossRef](#)]
183. Guodong (Gordon) Gao, Lorin M. Hitt. 2012. Information Technology and Trademarks: Implications for Product Variety. *Management Science* **58**, 1211-1226. [[CrossRef](#)]
184. Prasanna Tambe, Lorin M. Hitt, Erik Brynjolfsson. 2012. The Extroverted Firm: How External Information Practices Affect Innovation and Productivity. *Management Science* **58**, 843-859. [[CrossRef](#)]

185. Rahul C. Basole, Mark L. Braunstein, William B. Rouse. 2012. Enterprise Transformation Through Mobile ICT: a Framework and Case Study in Healthcare. *Journal of Enterprise Transformation* **2**, 130-156. [[CrossRef](#)]
186. Youngcheol Kang, William J. O'Brien, James T. O'Connor. 2012. IOP Tool: Assessing the Benefits and Hindrances of Information Integration Implementation Opportunities. *Journal of Management in Engineering* **28**, 160-169. [[CrossRef](#)]
187. Charles Steinfield, Robert LaRose, Han Ei Chew, Stephanie Tom Tong. 2012. Small and Medium-Sized Enterprises in Rural Business Clusters: The Relation Between ICT Adoption and Benefits Derived From Cluster Membership. *The Information Society* **28**, 110-120. [[CrossRef](#)]
188. Jee-Hae Lim, Theophanis C. Stratopoulos, Tony S. Wirjanto. 2012. Role of IT executives in the firm's ability to achieve competitive advantage through IT capability. *International Journal of Accounting Information Systems* **13**, 21-40. [[CrossRef](#)]
189. Steven C. Michael. 2012. Monitoring technical managers: Theory, evidence, and prescriptions. *The Journal of High Technology Management Research* . [[CrossRef](#)]
190. René Riedl, Harald Kindermann, Andreas Auinger, Andrija Javor. 2012. Technostress from a Neurobiological Perspective. *Business & Information Systems Engineering* . [[CrossRef](#)]
191. René Riedl, Harald Kindermann, Andreas Auinger, Andrija Javor. 2012. Technostress aus einer neurobiologischen Perspektive. *WIRTSCHAFTSINFORMATIK* . [[CrossRef](#)]
192. Thanos Papadopoulos, Udechukwu Ojiako, Maxwell Chipulu, Kwangwook Lee. 2012. The criticality of risk factors in customer relationship management projects. *Project Management Journal* **43**:10.1002/pmj.v43.1, 65-76. [[CrossRef](#)]
193. Charles Bérubé, Marc Duhamel, Daniel Ershov. 2012. Market Incentives for Business Innovation: Results from Canada. *Journal of Industry, Competition and Trade* . [[CrossRef](#)]
194. Loukis Euripidis, Michailidou FotiniERP and E-Business Systems Development, Innovation and Business Performance--An Empirical Investigation 4682-4691. [[CrossRef](#)]
195. A. C. Avgar, A. S. Litwin, P. J. Pronovost. 2012. Drivers and Barriers in Health IT Adoption. *Applied Clinical Informatics* **3**, 488-500. [[CrossRef](#)]
196. Lawton Robert Burns, Douglas R. Wholey, Jeffrey S. McCullough, Peter Kralovec, Ralph MullerThe Changing Configuration of Hospital Systems: Centralization, Federalization, or Fragmentation? 189-232. [[CrossRef](#)]
197. Adol Esquivel, Dean F Sittig, Daniel R Murphy, Hardeep Singh. 2012. Improving the Effectiveness of Electronic Health Record-Based Referral Processes. *BMC Medical Informatics and Decision Making* **12**, 107. [[CrossRef](#)]
198. R. E. DeVor, S. G. Kapoor, J. Cao, K. F. Ehmann. 2012. Transforming the Landscape of Manufacturing: Distributed Manufacturing Based on Desktop Manufacturing (DM)2. *Journal of Manufacturing Science and Engineering* **134**, 041004. [[CrossRef](#)]
199. A. S. Litwin, A. C. Avgar, P. J. Pronovost. 2012. Measurement Error in Performance Studies of Health Information Technology: Lessons from the Management Literature. *Applied Clinical Informatics* **3**, 210-220. [[CrossRef](#)]
200. Gimun Kim, Bongsik Shin, Ohbyung Kwon. 2012. Investigating the Value of Sociomaterialism in Conceptualizing IT Capability of a Firm. *Journal of Management Information Systems* **29**, 327-362. [[CrossRef](#)]
201. Ja-Shen Chen, Hung-Tai Tsou. 2012. Performance effects of IT capability, service process innovation, and the mediating role of customer service. *Journal of Engineering and Technology Management* **29**, 71-94. [[CrossRef](#)]
202. Serge Allegrezza, Anne DubrocardIntroduction 1-10. [[CrossRef](#)]

203. Pierre J Richard, Tim R Coltman, Byron W Keating. 2012. Designing IS service strategy: an information acceleration approach. *European Journal of Information Systems* **21**:S1, 87-98. [[CrossRef](#)]
204. J. David Brown, John S. Earle, Hanna Vakhitova, Vitaliy ZhakaInnovation, Adoption, Ownership and Productivity: Evidence from Ukraine 76-97. [[CrossRef](#)]
205. Elena Vasilchenko, Sussie Morrish. 2011. The Role of Entrepreneurial Networks in the Exploration and Exploitation of Internationalization Opportunities by Information and Communication Technology Firms. *Journal of International Marketing* **19**, 88-105. [[CrossRef](#)]
206. Day-Yang Liu, Shou-Wei Chen, Tzu-Chuan Chou. 2011. Resource fit in digital transformation. *Management Decision* **49**, 1728-1742. [[CrossRef](#)]
207. Oluwole Alfred Olatunji. 2011. Modelling the costs of corporate implementation of building information modelling. *Journal of Financial Management of Property and Construction* **16**, 211-231. [[CrossRef](#)]
208. Changling Chen, Jee-Hae Lim, Theophanis C. Stratopoulos. 2011. IT Capability and a Firm's Ability to Recover from Losses: Evidence from the Economic Downturn of the Early 2000s. *Journal of Information Systems* **25**, 117-144. [[CrossRef](#)]
209. Adi Masli, Vernon J. Richardson, Juan Manuel Sanchez, Rodney E. Smith. 2011. The Business Value of IT: A Synthesis and Framework of Archival Research. *Journal of Information Systems* **25**, 81-116. [[CrossRef](#)]
210. Irene Bertschek. 2011. Wissensvermittlung versus Legitimationsfunktion. *Zeitschrift für Betriebswirtschaft* . [[CrossRef](#)]
211. Yanfei Li, Shuntian Yao, Wai-Mun Chia. 2011. Demand uncertainty, information processing ability, and endogenous firm. *Nankai Business Review International* **2**, 447-474. [[CrossRef](#)]
212. Youngcheol Kang, William J. O'Brien, James T. O'Connor. 2011. Analysis of information integration benefit drivers and implementation hindrances. *Automation in Construction* . [[CrossRef](#)]
213. Gerry Kerr. 2011. What Simon said: the impact of the major management works of Herbert Simon. *Journal of Management History* **17**, 399-419. [[CrossRef](#)]
214. Benjamin Engelstätter. 2011. It is not all about performance gains – enterprise software and innovations. *Economics of Innovation and New Technology* 1-23. [[CrossRef](#)]
215. Tim Jacks, Prashant Palvia, Richard Schilhavy, Lei Wang. 2011. A framework for the impact of IT on organizational performance. *Business Process Management Journal* **17**, 846-870. [[CrossRef](#)]
216. Spyros Arvanitis, Euripidis Loukis, Vasiliki DiamantopoulouInformation Systems and Innovation in Greek Firms - An Empirical Investigation 315-320. [[CrossRef](#)]
217. Martin Hilbert. 2011. The end justifies the definition: The manifold outlooks on the digital divide and their practical usefulness for policy-making. *Telecommunications Policy* **35**, 715-736. [[CrossRef](#)]
218. Guangming CaoThe Benefits and Limitations of Pairwise Understanding of IT Business Value 1-4. [[CrossRef](#)]
219. Tom R. Eikebrokk, Jon Iden, Dag H. Olsen, Andreas L. Opdahl. 2011. Understanding the determinants of business process modelling in organisations. *Business Process Management Journal* **17**, 639-662. [[CrossRef](#)]
220. Kunsoo Han, Young Bong Chang, Jungpil Hahn. 2011. Information Technology Spillover and Productivity: The Role of Information Technology Intensity and Competition. *Journal of Management Information Systems* **28**, 115-146. [[CrossRef](#)]
221. Winston T. Lin, Chung-Yean Chiang. 2011. The impacts of country characteristics upon the value of information technology as measured by productive efficiency. *International Journal of Production Economics* **132**, 13-33. [[CrossRef](#)]

222. S. Moshiri, W. Simpson. 2011. Information technology and the changing workplace in Canada: firm-level evidence. *Industrial and Corporate Change* . [[CrossRef](#)]
223. Chon Abraham, Iris Junglas. 2011. From cacophony to harmony: A case study about the IS implementation process as an opportunity for organizational transformation at Sentara Healthcare. *The Journal of Strategic Information Systems* **20**, 177-197. [[CrossRef](#)]
224. Albert Boonstra, Manda Broekhuis, Marjolein van Offenbeek, Hans Wortmann. 2011. Strategic alternatives in telecare design. *The Journal of Strategic Information Systems* **20**, 198-214. [[CrossRef](#)]
225. Jisun Lim, Elias Sanidas. 2011. The impact of organisational and technical innovations on productivity: the case of Korean firms and sectors. *Asian Journal of Technology Innovation* **19**, 21-35. [[CrossRef](#)]
226. Linda M. Pittenger, Dick Boland, Sheri Perelli. Stretching role breadth: Overachieving IT managers in underperforming IT organizations 89-99. [[CrossRef](#)]
227. Derek C. Jones, Panu Kalmi, Antti Kauhanen. 2011. Firm and employee effects of an enterprise information system: Micro-econometric evidence. *International Journal of Production Economics* **130**, 159-168. [[CrossRef](#)]
228. Kemal Altinkemer, Yasin Ozcelik, Zafer D. Ozdemir. 2011. Productivity and Performance Effects of Business Process Reengineering: A Firm-Level Analysis. *Journal of Management Information Systems* **27**, 129-162. [[CrossRef](#)]
229. Sonali Bhattacharya. 2011. Innovation in India: A Path to Knowledge Economy. *Journal of the Knowledge Economy* . [[CrossRef](#)]
230. Nagy K. Hanna. 2011. E-Sri Lanka as a Deliberate and Emergent Strategy Process. *Journal of the Knowledge Economy* **2**, 3-37. [[CrossRef](#)]
231. Achim Hecker. 2011. Specialization, implicit coordination and organizational performance: trading off common and idiosyncratic knowledge. *Review of Managerial Science* **5**, 19-47. [[CrossRef](#)]
232. Richard T. Watson, Marie-Claude Boudreau, Adela J. Chen, Héctor Hito Sepúlveda. 2011. Green projects: An information drives analysis of four cases. *The Journal of Strategic Information Systems* **20**, 55-62. [[CrossRef](#)]
233. Danny Leung, Yi Zheng. 2011. What affects MFP in the long-run? Evidence from Canadian industries. *Applied Economics* 1-12. [[CrossRef](#)]
234. Young Bong Chang. 2011. Does RFID improve firms' financial performance? an empirical analysis. *Information Technology and Management* . [[CrossRef](#)]
235. Robin Cowan, Bulat Sanditov, Rifka Weehuizen. 2011. Productivity effects of innovation, stress and social relations#. *Journal of Economic Behavior & Organization* . [[CrossRef](#)]
236. António Madureira, Nico Baken, Harry Bouwman. 2011. Value of digital information networks: a holonic framework. *NETNOMICS: Economic Research and Electronic Networking* . [[CrossRef](#)]
237. Guangming Cao, Frank Wiengarten, Paul Humphreys. 2011. Towards a Contingency Resource-Based View of IT Business Value. *Systemic Practice and Action Research* **24**, 85-106. [[CrossRef](#)]
238. Gaaitzen J. De Vries, Michael Koetter. 2011. ICT Adoption and Heterogeneity in Production Technologies: Evidence for Chilean Retailers\*. *Oxford Bulletin of Economics and Statistics* no-no. [[CrossRef](#)]
239. Polly Rizova. 2011. Finding Testable Causal Mechanisms to Address Critical Public Management Issues. *Journal of Comparative Policy Analysis: Research and Practice* **13**, 105-114. [[CrossRef](#)]
240. Rajiv D. Banker, Rong Huang, Ramachandran Natarajan. 2011. Equity Incentives and Long-Term Value Created by SG&A Expenditure\*. *Contemporary Accounting Research* no-no. [[CrossRef](#)]

241. Davide Antonioli, Massimiliano Mazzanti, Paolo Pini. 2011. Innovation, industrial relations and employee outcomes: evidence from Italy. *Journal of Economic Studies* **38**, 66-90. [[CrossRef](#)]
242. Saeid Khajeh dangolani. 2011. The Impact of Information Technology in Banking System (A Case Study in Bank Keshavarzi IRAN). *Procedia - Social and Behavioral Sciences* **30**, 13-16. [[CrossRef](#)]
243. Susan A Sherer Value Realization from Adoption of Integrated Electronic Health Records 1-10. [[CrossRef](#)]
244. Hossein Ahmadirezaei. 2011. The Effect of Information Technology in Saderat Banking System. *Procedia - Social and Behavioral Sciences* **30**, 23-26. [[CrossRef](#)]
245. Christina W. Y. Wong, Kee-hung Lai, T. C. E. Cheng. 2011. Value of Information Integration to Supply Chain Management: Roles of Internal and External Contingencies. *Journal of Management Information Systems* **28**, 161-200. [[CrossRef](#)]
246. Jee-Hae Lim, Theophanis C. Stratopoulos, Tony S. Wirjanto. 2011. Path Dependence of Dynamic Information Technology Capability: An Empirical Investigation. *Journal of Management Information Systems* **28**, 45-84. [[CrossRef](#)]
247. Andreas I. Nicolaou Integrated Information Systems and Interorganizational Performance: The Role of Management Accounting Systems Design 117-141. [[CrossRef](#)]
248. Concetta Castiglione. 2011. Technical efficiency and ICT investment in Italian manufacturing firms. *Applied Economics* 1-15. [[CrossRef](#)]
249. Benjamin T. Hazen, Yun Wu, Chetan S. Sankar, L. Allison Jones-Farmer. 2011. A Proposed Framework for Educational Innovation Dissemination. *Journal of Educational Technology Systems* **40**, 301-321. [[CrossRef](#)]
250. Sharon Levin, Paula Stephan, Anne Winkler. 2011. Innovation in academe: the diffusion of information technologies. *Applied Economics* 1-18. [[CrossRef](#)]
251. Shirish C. Srivastava, Thompson S.H. Teo. 2011. Development and impact of e-government: the intertwined role of e-commerce from a cross-country stakeholder's perspective. *Electronic Government, an International Journal* **8**, 144. [[CrossRef](#)]
252. Gholamreza Torkzadeh, Jerry Cha-Jan Chang, Andrew M Hardin. 2011. Usage and impact of technology enabled job learning. *European Journal of Information Systems* **20**:1, 69-86. [[CrossRef](#)]
253. G. Dosi, S. Lechevalier, A. Secchi. 2010. Introduction: Interfirm heterogeneity--nature, sources and consequences for industrial dynamics. *Industrial and Corporate Change* **19**, 1867-1890. [[CrossRef](#)]
254. A. J. Gilbert Silvius, Benny de Waal Assessing Business and IT Alignment in Educational Organizations 1-7. [[CrossRef](#)]
255. Raluca Bunduchi, Alison U. Smart. 2010. Process Innovation Costs in Supply Networks: A Synthesis. *International Journal of Management Reviews* **12**:10.1111/ijmr.2010.12.issue-4, 365-383. [[CrossRef](#)]
256. Rinaldo Evangelista, Antonio Vezzani. 2010. The economic impact of technological and organizational innovations. A firm-level analysis#. *Research Policy* **39**, 1253-1263. [[CrossRef](#)]
257. Ing-Long Wu, Cheng-Hung Chuang. 2010. Examining the diffusion of electronic supply chain management with external antecedents and firm performance: A multi-stage analysis. *Decision Support Systems* **50**, 103-115. [[CrossRef](#)]
258. Stefanie Haller, Iulia Siedschlag. 2010. Determinants of ICT adoption: evidence from firm-level data. *Applied Economics* 1-14. [[CrossRef](#)]
259. Jenny Meyer. 2010. Does Social Software Support Service Innovation?. *International Journal of the Economics of Business* **17**, 289-311. [[CrossRef](#)]

260. Leonardo Becchetti, Annalisa Castelli, Iftekhar Hasan. 2010. Investment–cash flow sensitivities, credit rationing and financing constraints in small and medium-sized firms. *Small Business Economics* **35**, 467-497. [[CrossRef](#)]
261. Hwan-Joo Seo, Young Soo Lee, Jai-Joon Hur, Jin Ki Kim. 2010. The impact of information and communication technology on skilled labor and organization types. *Information Systems Frontiers* . [[CrossRef](#)]
262. Ellen R. McGrattan,, Edward C. Prescott. 2010. Unmeasured Investment and the Puzzling US Boom in the 1990s. *American Economic Journal: Macroeconomics* **2**:4, 88-123. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
263. Jouni Kauremaa, Juha-Miikka Nurmilaakso, Kari Tanskanen. 2010. E-business enabled operational linkages: The role of RosettaNet in integrating the telecommunications supply chain. *International Journal of Production Economics* **127**, 343-357. [[CrossRef](#)]
264. R. E. Goodhue, S. Mohapatra, G. C. Rausser. 2010. Interactions Between Incentive Instruments: Contracts and Quality in Processing Tomatoes. *American Journal of Agricultural Economics* **92**, 1283-1293. [[CrossRef](#)]
265. Sonali Bhattacharya. 2010. Knowledge Economy in India: Challenges and Opportunities. *Journal of Information & Knowledge Management* **09**, 203-225. [[CrossRef](#)]
266. Guido Schryen. 2010. Preserving Knowledge on IS Business Value. *Business & Information Systems Engineering* **2**, 233-244. [[CrossRef](#)]
267. Guido Schryen. 2010. Ökonomischer Wert von Informationssystemen. *WIRTSCHAFTSINFORMATIK* **52**, 225-237. [[CrossRef](#)]
268. Corey M. Angst, Ritu Agarwal, V. Sambamurthy, Ken Kelley. 2010. Social Contagion and Information Technology Diffusion: The Adoption of Electronic Medical Records in U.S. Hospitals. *Management Science* **56**, 1219-1241. [[CrossRef](#)]
269. Daniel Q. Chen, David S. Preston, Weidong Xia. 2010. Antecedents and Effects of CIO Supply-Side and Demand-Side Leadership: A Staged Maturity Model. *Journal of Management Information Systems* **27**, 231-272. [[CrossRef](#)]
270. Saggi Nevo, Michael Wade, Wade D. Cook. 2010. An empirical study of IT as a factor of production: The case of Net-enabled IT assets. *Information Systems Frontiers* **12**, 323-335. [[CrossRef](#)]
271. Wang Yanting, Li Feng, Li DanThe research on the coupling development between IT policy and industry 557-560. [[CrossRef](#)]
272. James Arrowsmith, Paul Marginson. 2010. The decline of incentive pay in British manufacturing. *Industrial Relations Journal* **41**:10.1111/irj.2010.41.issue-4, 289-311. [[CrossRef](#)]
273. Eric K. Clemons. 2010. The Power of Patterns and Pattern Recognition When Developing Information-Based Strategy. *Journal of Management Information Systems* **27**, 69-96. [[CrossRef](#)]
274. Davide Antonioli, Massimiliano Mazzanti, Paolo Pini. 2010. Productivity, innovation strategies and industrial relations in SMEs. Empirical evidence for a local production system in northern Italy. *International Review of Applied Economics* **24**, 453-482. [[CrossRef](#)]
275. Brian P. Cozzarin, Jennifer C. Percival. 2010. IT, productivity and organizational practices: large sample, establishment-level evidence. *Information Technology and Management* **11**, 61-76. [[CrossRef](#)]
276. Abhay Nath Mishra, Ritu Agarwal. 2010. Technological Frames, Organizational Capabilities, and IT Use: An Empirical Investigation of Electronic Procurement. *Information Systems Research* **21**, 249-270. [[CrossRef](#)]
277. Paul Chwelos, Ronald Ramirez, Kenneth L. Kraemer, Nigel P. Melville. 2010. Research Note —Does Technological Progress Alter the Nature of Information Technology as a Production Input? New Evidence and New Results. *Information Systems Research* **21**, 392-408. [[CrossRef](#)]

278. Keld Laursen, Valentina Meliciani. 2010. The role of ICT knowledge flows for international market share dynamics. *Research Policy* **39**, 687-697. [[CrossRef](#)]
279. S. K. Majumdar, O. Carare, H. Chang. 2010. Broadband adoption and firm productivity: evaluating the benefits of general purpose technology. *Industrial and Corporate Change* **19**, 641-674. [[CrossRef](#)]
280. ELIE GEISLER. 2010. MEASURING THE CONTRIBUTIONS OF KNOWLEDGE MANAGEMENT SYSTEMS TO THE STRATEGIC COMPETITIVENESS OF ORGANIZATIONS: A REVIEW AND A MODEL. *International Journal of Innovation and Technology Management* **07**, 89-107. [[CrossRef](#)]
281. Guangming Cao. 2010. A four-dimensional view of IT business value. *Systems Research and Behavioral Science* **27**:10.1002/sres.v27:3, 267-284. [[CrossRef](#)]
282. Jeffrey S. McCullough, Eli M. Snir. 2010. Monitoring technology and firm boundaries: Physician-hospital integration and technology utilization. *Journal of Health Economics* **29**, 457-467. [[CrossRef](#)]
283. Hans Ulrich Buhl, Peter Mertens, Matthias Schumann, Nils Urbach, Stefan Smolnik, Gerold Riempp. 2010. Leserbrief: Stellungnahme zum Beitrag von Urbach et al. aus Heft 4/2009. *WIRTSCHAFTSINFORMATIK* **52**, 109-114. [[CrossRef](#)]
284. Hans Ulrich Buhl, Peter Mertens, Matthias Schumann, Nils Urbach, Stefan Smolnik, Gerold Riempp. 2010. Letter to the Editor: Statements on the Contribution by Urbach et al. from Issue 4/2009. *Business & Information Systems Engineering* **2**, 109-120. [[CrossRef](#)]
285. S. Helper, M. Sako. 2010. Management innovation in supply chain: appreciating Chandler in the twenty-first century. *Industrial and Corporate Change* **19**, 399-429. [[CrossRef](#)]
286. Ky-hyang Yuhn, Seung R. Park. 2010. Information Technology, Organizational Transformation and Productivity Growth: An Examination of the Brynjolfsson-Hitt Proposition. *Asian Economic Journal* **24**:10.1111/asej.2010.24.issue-1, 87-108. [[CrossRef](#)]
287. Giuliana Battisti, Paul Stoneman. 2010. How Innovative are UK Firms? Evidence from the Fourth UK Community Innovation Survey on Synergies between Technological and Organizational Innovations. *British Journal of Management* **21**:10.1111/bjom.2010.21.issue-1, 187-206. [[CrossRef](#)]
288. Govindan Marthandan, Chun Meng Tang. 2010. Information technology evaluation: issues and challenges. *Journal of Systems and Information Technology* **12**, 37-55. [[CrossRef](#)]
289. Maria F.O. Martins, Tiago Oliveira. 2010. Semiparametric Estimation of Information Technology Diffusion Models: A Study Based on Portuguese Firm-Level Data. *American Journal of Mathematical and Management Sciences* **30**, 257-283. [[CrossRef](#)]
290. A. D. Elyakov. 2010. The nature of the modern information society. *Scientific and Technical Information Processing* **37**, 60-73. [[CrossRef](#)]
291. S J Ho, S K Mallick. 2010. The impact of information technology on the banking industry. *Journal of the Operational Research Society* **61**:2, 211-221. [[CrossRef](#)]
292. She-I Chang, David C. Yen, Celeste See-Pui Ng, I-Cheng Chang, Sheng-Yu Yu. 2010. An ERP system performance assessment model development based on the balanced scorecard approach. *Information Systems Frontiers* . [[CrossRef](#)]
293. Shane Greenstein Innovative Conduct in Computing and Internet Markets 477-537. [[CrossRef](#)]
294. Timothy Bresnahan General Purpose Technologies 761-791. [[CrossRef](#)]
295. Naresh Khatri, Kalyan Pasupathy, Lanis L. Hicks The crucial role of people and information in health care organizations 195-211. [[CrossRef](#)]
296. Ariel Avcig, Lorin M Hitt, Prasanna Tambe The Effects of Organizational Factors on Healthcare IT Adoption Costs: Evidence from New York Nursing Homes 1-9. [[CrossRef](#)]

297. Tom R. Eikebrokk, Jon Iden, Dag H. Olsen, Andreas L. Opdahl|Determinants to the Use of Business Process Modeling 1-10. [[CrossRef](#)]
298. Giovanni Dosi, Richard R. Nelson|Technical Change and Industrial Dynamics as Evolutionary Processes 51-127. [[CrossRef](#)]
299. Paul Stoneman, Giuliana Battisti|The Diffusion of New Technology 733-760. [[CrossRef](#)]
300. Luis Rubalcaba, David Gago, Jorge Gallego. 2010. On the differences between goods and services innovation. *Journal of Innovation Economics* 5, 17. [[CrossRef](#)]
301. Simon Commander, Rupert Harrison, Naercio Menezes-Filho. 2010. ICT and Productivity in Developing Countries: New Firm-Level Evidence from Brazil and India. *Review of Economics and Statistics* 110301164542093. [[CrossRef](#)]
302. Simon Commander|How Do Emerging Markets Innovate? Evidence from Brazil and India 211-217. [[CrossRef](#)]
303. Gensheng (Jason) Liu, Kathleen McKone-Sweet, Rachna Shah. 2009. Assessing the performance impact of supply chain planning in net-enhanced organizations. *Operations Management Research* 2, 33-43. [[CrossRef](#)]
304. Jenny Meyer. 2009. Workforce age and technology adoption in small and medium-sized service firms. *Small Business Economics* . [[CrossRef](#)]
305. Mariacristina Piva, Marco Vivarelli. 2009. The role of skills as a major driver of corporate R&D. *International Journal of Manpower* 30, 835-852. [[CrossRef](#)]
306. Farley S. Nobre, Andrew M. Tobias, David S. Walker. 2009. The impact of cognitive machines on complex decisions and organizational change. *AI & SOCIETY* 24, 365-381. [[CrossRef](#)]
307. E. Loukis, K. Pazalos, St. Georgiou. 2009. An empirical investigation of the moderating effects of BPR and TQM on ICT business value. *Journal of Enterprise Information Management* 22, 564-586. [[CrossRef](#)]
308. Sung-Yul Ryoo, Woo-Jong Suh, Chul-Mo Koo. 2009. An Empirical Study on Joint Decision Making and Business Performance between Corporations. *The Journal of Information Systems* 18, 89-110. [[CrossRef](#)]
309. Rita Santos, Ronald Wennersten, Eduardo B.L. Oliva, Walter Leal Filho. 2009. Strategies for competitiveness and sustainability: Adaptation of a Brazilian subsidiary of a Swedish multinational corporation. *Journal of Environmental Management* 90, 3708-3716. [[CrossRef](#)]
310. Guangming Cao|A Contingency and Resource-Based View of Fit between IT and Organisational Factors 1-5. [[CrossRef](#)]
311. Susanna Mancinelli, Massimiliano Mazzanti. 2009. Innovation, networking and complementarity: evidence on SME performances for a local economic system in North-Eastern Italy. *The Annals of Regional Science* 43, 567-597. [[CrossRef](#)]
312. Yao Lu, Hong-wen Zhu|An approach for quantifying enterprise value of information (EVI) 594-600. [[CrossRef](#)]
313. Ben Dolman. 2009. What Happened to Australia's Productivity Surge?. *Australian Economic Review* 42:10.1111/aere.2009.42.issue-3, 243-263. [[CrossRef](#)]
314. Yueh H. Chen, Winston T. Lin. 2009. Analyzing the relationships between information technology, inputs substitution and national characteristics based on CES stochastic frontier production models. *International Journal of Production Economics* 120, 552-569. [[CrossRef](#)]
315. Forrest V. Morgeson, Sunil Mithas. 2009. Does E-Government Measure Up to E-Business? Comparing End User Perceptions of U.S. Federal Government and E-Business Web Sites. *Public Administration Review* 69:10.1111/puar.2009.69.issue-4, 740-752. [[CrossRef](#)]

316. Sanjay Kumar, Anurag Keshan. 2009. Erp Implementation In Tata Steel: Focus On Benefits And Roi. *Journal of Information Technology Case and Application Research* **11**, 68-103. [[CrossRef](#)]
317. Leire San-Jose, Txomin Iturralde, Amaia Maseda. 2009. The influence of information communications technology (ICT) on cash management and financial department performance: An explanatory model. *Canadian Journal of Administrative Sciences / Revue Canadienne des Sciences de l'Administration* **26**:10.1002/cjas.v26:2, 150-169. [[CrossRef](#)]
318. Alfons Palangkaraya, Andreas Stierwald, Jongsay Yong. 2009. Is Firm Productivity Related to Size and Age? The Case of Large Australian Firms. *Journal of Industry, Competition and Trade* **9**, 167-195. [[CrossRef](#)]
319. Andrew J. Clarke, Alok Johri. 2009. PROCYCLICAL SOLOW RESIDUALS WITHOUT TECHNOLOGY SHOCKS. *Macroeconomic Dynamics* **13**, 366. [[CrossRef](#)]
320. Caroline Chibelushi, Pat Costello. 2009. Challenges facing W. Midlands ICT-oriented SMEs. *Journal of Small Business and Enterprise Development* **16**, 210-239. [[CrossRef](#)]
321. David M. Hart. 2009. Accounting for change in national systems of innovation: A friendly critique based on the U.S. case. *Research Policy* **38**, 647-654. [[CrossRef](#)]
322. Peter Brödner. 2009. The misery of digital organisations and the semiotic nature of IT. *AI & SOCIETY* **23**, 331-351. [[CrossRef](#)]
323. R. Gholami, Xiaojia Guo, M.D.A. Higon, S.-Y.T. Lee. 2009. Information and Communications Technology (ICT) International Spillovers. *IEEE Transactions on Engineering Management* **56**, 329-340. [[CrossRef](#)]
324. Vivek Ghosal, Usha Nair-Reichert. 2009. Investments in modernization, innovation and gains in productivity: Evidence from firms in the global paper industry. *Research Policy* **38**, 536-547. [[CrossRef](#)]
325. Neeraj Mittal, Barrie R. Nault. 2009. Research Note —Investments in Information Technology: Indirect Effects and Information Technology Intensity. *Information Systems Research* **20**, 140-154. [[CrossRef](#)]
326. S ARVANITIS, E LOUKIS. 2009. Information and communication technologies, human capital, workplace organization and labour productivity: A comparative study based on firm-level data for Greece and Switzerland. *Information Economics and Policy* **21**, 43-61. [[CrossRef](#)]
327. M BADESCU, C GARCESAYERBE. 2009. The impact of information technologies on firm productivity: Empirical evidence from Spain. *Technovation* **29**, 122-129. [[CrossRef](#)]
328. A. Yadollahi, Z. Shojaei Asadiyeh. 2009. Some Physiological Parameters and Sugar Concentration Changing of Sugar Beet (*Beta vulgaris* L.) Under Controlled Climatical Conditions. *Asian Journal of Crop Science* **1**, 49-57. [[CrossRef](#)]
329. Madjid Tavana, Mohammad H. Khakbaz, Mohsen Jafari Songhori. 2009. Information technology's impact on productivity in conventional power plants. *International Journal of Business Performance Management* **11**, 187. [[CrossRef](#)]
330. Irene Bertschek, Jenny Meyer. 2009. Do Older Workers Lower IT-Enabled Productivity?. *Jahrbücher für Nationalökonomie und Statistik* **229**:2-3. . [[CrossRef](#)]
331. Paola Bielli, Andras Nemeslaki Reinventing Organizations with Information and Communication Technologies 94-115. [[CrossRef](#)]
332. Stephen T Parente. 2009. Health Information Technology and Financing's Next Frontier: The Potential of Medical Banking. *Business Economics* **44**:1, 41-50. [[CrossRef](#)]
333. Davide Consoli. 2008. Systems of Innovation and Industry Evolution: The Case of Retail Banking in the UK. *Industry & Innovation* **15**, 579-600. [[CrossRef](#)]

334. Chiara Francalanci, Vincenzo Morabito. 2008. IS integration and business performance: The mediation effect of organizational absorptive capacity in SMEs. *Journal of Information Technology* **23**:4, 297-312. [[CrossRef](#)]
335. Jun Yang, Kenneth J. Klassen. 2008. How financial markets reflect the benefits of self-service technologies. *Journal of Enterprise Information Management* **21**, 448-467. [[CrossRef](#)]
336. Maria Åkesson, Bo Edvardsson. 2008. Effects of e-government on service design as perceived by employees. *Managing Service Quality: An International Journal* **18**, 457-478. [[CrossRef](#)]
337. SUSHANTA K. MALLICK, SHIRLEY J. HO. 2008. ON NETWORK COMPETITION AND THE SOLOW PARADOX: EVIDENCE FROM US BANKS. *Manchester School* **76**:10.1111/manc.2008.76.issue-s1, 37-57. [[CrossRef](#)]
338. Philipp Koellinger. 2008. The relationship between technology, innovation, and firm performance—Empirical evidence from e-business in Europe. *Research Policy* **37**, 1317-1328. [[CrossRef](#)]
339. STEVEN PENNING, ROD TYERS. 2008. Increasing Returns, Financial Capital Mobility and Real Exchange Rate Dynamics\*. *Economic Record* **84**:10.1111/ecor.2008.84.issue-s1, S141-S158. [[CrossRef](#)]
340. Oleg Badunenko, Daniel J. Henderson, Valentin Zelenyuk. 2008. Technological Change and Transition: Relative Contributions to Worldwide Growth During the 1990s\*. *Oxford Bulletin of Economics and Statistics* **70**:10.1111/obes.2008.70.issue-4, 461-492. [[CrossRef](#)]
341. Helana Scheepers, Rens Scheepers. 2008. A process-focused decision framework for analyzing the business value potential of IT investments. *Information Systems Frontiers* **10**, 321-330. [[CrossRef](#)]
342. Nicholas C. Georgantzias, Evangelos G. Katsamakas. 2008. Information systems research with system dynamics. *System Dynamics Review* **24**:10.1002/sdr.v24:3, 247-264. [[CrossRef](#)]
343. Jonathan C. Javitt, James B. Rebitzer, Lonny Reisman. 2008. Information technology and medical missteps: Evidence from a randomized trial. *Journal of Health Economics* **27**, 585-602. [[CrossRef](#)]
344. B TETHER, A TAJAR. 2008. The organisational-cooperation mode of innovation and its prominence amongst European service firms. *Research Policy* **37**, 720-739. [[CrossRef](#)]
345. Jim Spohrer, Paul P. Maglio. 2008. The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value. *Production and Operations Management* **17**, 238-246. [[CrossRef](#)]
346. H HOLLENSTEIN, M WOERTER. 2008. Inter- and intra-firm diffusion of technology: The example of E-commerce An analysis based on Swiss firm-level data. *Research Policy* **37**, 545-564. [[CrossRef](#)]
347. Pingsheng Tong, Jean L. Johnson, U.N. Umesh, Ruby P. Lee. 2008. A typology of interfirm relationships: the role of information technology and reciprocity. *Journal of Business & Industrial Marketing* **23**, 178-192. [[CrossRef](#)]
348. M BENMENACHEM. 2008. Towards management of software as assets: A literature review with additional sources. *Information and Software Technology* **50**, 241-258. [[CrossRef](#)]
349. K. Stiroh. 2008. Information Technology and Productivity: Old Answers and New Questions. *CEifo Economic Studies* **54**, 358-385. [[CrossRef](#)]
350. Dale W. Jorgenson, Mun S. Ho, Kevin J. Stiroh. 2008. A Retrospective Look at the U.S. Productivity Growth Resurgence. *Journal of Economic Perspectives* **22**:1, 3-24. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
351. Toshihiko Takemura, Hiroyuki Ebara Spam Mail Reduces Economic Effects 20-24. [[CrossRef](#)]
352. Michael K. Fung. 2008. To What Extent Are Labor-Saving Technologies Improving Efficiency in the Use of Human Resources? Evidence from the Banking Industry. *Production and Operations Management* **17**, 75-92. [[CrossRef](#)]

353. Elaine Ramsey, Patrick Ibbotson, Patrick Mccole. 2008. The mitigating effects of uncertainty on 'e' innovation propensity: some service sector evidence. *The Service Industries Journal* **28**, 53-72. [[CrossRef](#)]
354. Thomas Hempell, Thomas Zwick. 2008. NEW TECHNOLOGY, WORK ORGANISATION, AND INNOVATION. *Economics of Innovation and New Technology* **17**, 331-354. [[CrossRef](#)]
355. R KEMP, M VOLPI. 2008. The diffusion of clean technologies: a review with suggestions for future diffusion analysis. *Journal of Cleaner Production* **16**, S14-S21. [[CrossRef](#)]
356. Sundar Bharadwaj, Anandhi Bharadwaj, Elliot Bendoly. 2007. The Performance Effects of Complementarities Between Information Systems, Marketing, Manufacturing, and Supply Chain Processes. *Information Systems Research* **18**, 437-453. [[CrossRef](#)]
357. Minseong Kim, Soonkyoung Youn, Minjeong Park, Kyoung-Oh Song, Tacksoo Shin, Jeongmin Chi, Jongho Shin, Deokhee Seo, Sungdo Hong. 2007. A review of human competence in educational research: Levels of K- 12, College, Adult, and Business Education. *Asia Pacific Education Review* **8**, 500-520. [[CrossRef](#)]
358. Neil Fligstein, Taekjin Shin. 2007. Shareholder Value and the Transformation of the U.S. Economy, 1984-2000 1. *Sociological Forum* **22**:10.1111/socf.2007.22.issue-4, 399-424. [[CrossRef](#)]
359. PETER DOLTON, GERRY MAKEPEACE, HELEN ROBINSON. 2007. USE IT OR LOSE IT? THE IMPACT OF COMPUTERS ON EARNINGS. *The Manchester School* **75**:10.1111/manc.2007.75.issue-6, 673-694. [[CrossRef](#)]
360. Oana Velcu. 2007. Exploring the effects of ERP systems on organizational performance. *Industrial Management & Data Systems* **107**, 1316-1334. [[CrossRef](#)]
361. Giuliana Battisti, Heinz Hollenstein, Paul Stoneman, Martin Woerter. 2007. INTER AND INTRA FIRM DIFFUSION OF ICT IN THE UNITED KINGDOM (UK) AND SWITZERLAND (CH) AN INTERNATIONALLY COMPARATIVE STUDY BASED ON FIRM-LEVEL DATA. *Economics of Innovation and New Technology* **16**, 669-687. [[CrossRef](#)]
362. Chung-Jen Chen. 2007. Information Technology, Organizational Structure, and New Product Development---The Mediating Effect of Cross-Functional Team Interaction. *IEEE Transactions on Engineering Management* **54**, 687-698. [[CrossRef](#)]
363. Jungsoo Park, Seung Kyoon Shin, Hyun-Han Shin. 2007. The Intensity and Externality Effects of Information Technology Investments on National Productivity Growth. *IEEE Transactions on Engineering Management* **54**, 716-728. [[CrossRef](#)]
364. CLAUDIO MICHELACCI, DAVID LOPEZ-SALIDO. 2007. Technology Shocks and Job Flows. *Review of Economic Studies* **74**:10.1111/roes.2007.74.issue-4, 1195-1227. [[CrossRef](#)]
365. Sinan Aral, Peter Weill. 2007. IT Assets, Organizational Capabilities, and Firm Performance: How Resource Allocations and Organizational Differences Explain Performance Variation. *Organization Science* **18**, 763-780. [[CrossRef](#)]
366. Helal Almutairi. 2007. Information System and Productivity in Kuwaiti Public Organizations: Looking Inside the Black Box. *International Journal of Public Administration* **30**, 1263-1290. [[CrossRef](#)]
367. Lourens Broersma, Bart Van Ark. 2007. ICT, BUSINESS SERVICES AND LABOUR PRODUCTIVITY GROWTH. *Economics of Innovation and New Technology* **16**, 433-449. [[CrossRef](#)]
368. Todd A. Watkins. 2007. DO WORKFORCE AND ORGANIZATIONAL PRACTICES EXPLAIN THE MANUFACTURING TECHNOLOGY IMPLEMENTATION ADVANTAGE OF SMALL DEFENSE CONTRACTORS OVER NON-DEFENSE ESTABLISHMENTS?. *Defence and Peace Economics* **18**, 353-375. [[CrossRef](#)]
369. Zhuo (June) Cheng, Barrie R. Nault. 2007. Industry Level Supplier-Driven IT Spillovers. *Management Science* **53**, 1199-1216. [[CrossRef](#)]

370. Nakil Sung. 2007. Information technology, efficiency and productivity: evidence from Korean local governments. *Applied Economics* **39**, 1691-1703. [[CrossRef](#)]
371. M OLUGBODE, R RICHARDS, T BISS. 2007. The role of information technology in achieving the organisation's strategic development goals: A case study. *Information Systems* **32**, 641-648. [[CrossRef](#)]
372. E BECCALLI. 2007. Does IT investment improve bank performance? Evidence from Europe. *Journal of Banking & Finance* **31**, 2205-2230. [[CrossRef](#)]
373. Vasant Dhar, Arun Sundararajan. 2007. Issues and Opinions—Information Technologies in Business: A Blueprint for Education and Research. *Information Systems Research* **18**, 125-141. [[CrossRef](#)]
374. A. Albadvi, A. Keramati, J. Razmi. 2007. Assessing the impact of information technology on firm performance considering the role of intervening variables: organizational infrastructures and business processes reengineering. *International Journal of Production Research* **45**, 2697-2734. [[CrossRef](#)]
375. H.-J. Engelbrecht, V. Xayavong. 2007. THE ELUSIVE CONTRIBUTION OF ICT TO PRODUCTIVITY GROWTH IN NEW ZEALAND: EVIDENCE FROM AN EXTENDED INDUSTRY-LEVEL GROWTH ACCOUNTING MODEL. *Economics of Innovation and New Technology* **16**, 255-275. [[CrossRef](#)]
376. A BAYOMORIONES, F LERALOPEZ. 2007. A firm-level analysis of determinants of ICT adoption in Spain. *Technovation* **27**, 352-366. [[CrossRef](#)]
377. R SHAH, H SHIN. 2007. Relationships among information technology, inventory, and profitability: An investigation of level invariance using sector level data. *Journal of Operations Management* **25**, 768-784. [[CrossRef](#)]
378. Anna Giunta, Francesco Trivieri. 2007. Understanding the determinants of information technology adoption: evidence from Italian manufacturing firms. *Applied Economics* **39**, 1325-1334. [[CrossRef](#)]
379. Darrene Hackler, Gregory D. Saxton. 2007. The Strategic Use of Information Technology by Nonprofit Organizations: Increasing Capacity and Untapped Potential. *Public Administration Review* **67**:10.1111/puar.2007.67.issue-3, 474-487. [[CrossRef](#)]
380. Antao Moura, Jacques Sauve, Claudio Bartolini. Research Challenges of Business-Driven IT Management 19-28. [[CrossRef](#)]
381. Susanto Basu, John Fernald. 2007. Information and Communications Technology as a General-Purpose Technology: Evidence from US Industry Data. *German Economic Review* **8**:10.1111/geer.2007.8.issue-2, 146-173. [[CrossRef](#)]
382. Sotiris K. Papaioannou, Sophia P. Dimelis. 2007. Information Technology as a Factor of Economic Development: Evidence from Developed and Developing Countries. *Economics of Innovation and New Technology* **16**, 179-194. [[CrossRef](#)]
383. U JERMANN, V QUADRINI. 2007. Stock market boom and the productivity gains of the 1990s#. *Journal of Monetary Economics* **54**, 413-432. [[CrossRef](#)]
384. Yasuharu Ukai, Toshihiko Takemura. 2007. Spam mails impede economic growth. *The Review of Socionetwork Strategies* **1**, 14-22. [[CrossRef](#)]
385. Nicos Koussis, Spiros H. Martzoukos, Lenos Trigeorgis. 2007. Real R&D options with time-to-learn and learning-by-doing. *Annals of Operations Research* **151**, 29-55. [[CrossRef](#)]
386. Andrew Atkeson, Patrick J. Kehoe. 2007. Modeling the Transition to a New Economy: Lessons from Two Technological Revolutions. *American Economic Review* **97**:1, 64-88. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
387. Jacques Crémer, Luis Garicano, Andrea Prat. 2007. Language and the Theory of the Firm\*. *Quarterly Journal of Economics* **122**:10.1162/qjec.2007.122.issue-1, 373-407. [[CrossRef](#)]
388. David Gago, Luis Rubalcaba. 2007. Innovation and ICT in service firms: towards a multidimensional approach for impact assessment. *Journal of Evolutionary Economics* **17**, 25-44. [[CrossRef](#)]

389. W. Erwin Diewert, Alice O. Nakamura Chapter 66 The Measurement of Productivity for Nations 4501-4586. [[CrossRef](#)]
390. José María González González, Constancio Zamora Ramírez, Bernabé Escobar Pérez. 2007. La reingeniería de procesos de negocio (BPR) aplicada a la gestión de tesorería: su estudio en una compañía de electricidad española. *Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad* **36**, 537-568. [[CrossRef](#)]
391. Margarita Billón Currás, Fernando Lera López, Salvador Ortiz Serrano. 2007. Evidencias del impacto de las TIC en la productividad de la empresa. ¿Fin de la «paradoja de la productividad»? *Cuadernos de Economía* **30**, 5-36. [[CrossRef](#)]
392. John Ward, Steven Hertogh, Stijn Viaene Managing Benefits from IS/IT Investments: An Empirical Investigation into Current Practice 206a-206a. [[CrossRef](#)]
393. Nizamettin Bayyurt. 2007. The Performance of Turkish Manufacturing Firms in Stable And Unstable Economic Periods. *South East European Journal of Economics and Business* **2**. . [[CrossRef](#)]
394. R DUH, C CHOW, H CHEN. 2006. Strategy, IT applications for planning and control, and firm performance: The impact of impediments to IT implementation. *Information & Management* **43**, 939-949. [[CrossRef](#)]
395. G. Udechukwu Ojiako, Stuart Maguire. 2006. Divestiture as a strategic option for change in NITEL: lessons from the BT and AT&T experience. *info* **8**, 79-94. [[CrossRef](#)]
396. Irene Bertschek, Helmut Fryges, Ulrich Kaiser. 2006. B2B or Not to Be: Does B2B E-Commerce Increase Labour Productivity?. *International Journal of the Economics of Business* **13**, 387-405. [[CrossRef](#)]
397. R SAMANIEGO. 2006. Organizational capital, technology adoption and the productivity slowdown#. *Journal of Monetary Economics* **53**, 1555-1569. [[CrossRef](#)]
398. Mark Beukers, Johan Versendaal, Ronald Batenburg, Sjaak Brinkkemper. 2006. The procurement alignment framework construction and application. *WIRTSCHAFTSINFORMATIK* **48**, 323-330. [[CrossRef](#)]
399. Daniel Beimborn, Jochen Franke, Peter Gomber, Heinz-Theo Wagner, Tim Weitzel. 2006. Die Bedeutung des Alignment von IT und Fachressourcen in Finanzprozessen Eine empirische Untersuchung. *WIRTSCHAFTSINFORMATIK* **48**, 331-339. [[CrossRef](#)]
400. Marcin Piatkowski. 2006. Can Information and Communication Technologies Make a Difference in the Development of Transition Economies?. *Information Technologies and International Development* **3**:10.1162/itid.2006.3.issue-1, 39-53. [[CrossRef](#)]
401. Thomas A Hemphill. 2006. US Innovation Policy: Creating (and expanding) a national agenda for global competitiveness. *Innovation: Management, Policy & Practice* **8**, 288-295. [[CrossRef](#)]
402. S GREGOR, M MARTIN, W FERNANDEZ, S STERN, M VITALE. 2006. The transformational dimension in the realization of business value from information technology. *The Journal of Strategic Information Systems* **15**, 249-270. [[CrossRef](#)]
403. Chiang Ku Fan, Chen-Liang Cheng. 2006. A study to identify the training needs of life insurance sales representatives in Taiwan using the Delphi approach. *International Journal of Training and Development* **10**:10.1111/ijtd.2006.10.issue-3, 212-226. [[CrossRef](#)]
404. Seda Turan, Selmin Danis, Sitki Gozlu Performance Criteria for Radio Frequency Identification Technology: Cases of Vehicle Identification Systems in Gas Stations and Automobile Manufacturing 1647-1656. [[CrossRef](#)]
405. Nancy Roberts, Fred Thompson. 2006. "Netcentric" Organization. *Public Administration Review* **66**:10.1111/puar.2006.66.issue-4, 619-622. [[CrossRef](#)]

406. H SCHMIEDEL, M MALKAMAKI, J TARKKA. 2006. Economies of scale and technological development in securities depository and settlement systems. *Journal of Banking & Finance* **30**, 1783-1806. [[CrossRef](#)]
407. Dilip Mookherjee. 2006. Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective. *Journal of Economic Literature* **44**:2, 367-390. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
408. Abbas Keramati ., Amir Albadvi .. 2006. A Proposal for a Framework of Research Approaches on Information Technology Impacts on Corporate Level Productivity. *Information Technology Journal* **5**, 813-822. [[CrossRef](#)]
409. Shyamal K. Chowdhury. 2006. Investments in ICT-capital and economic performance of small and medium scale enterprises in East Africa. *Journal of International Development* **18**:10.1002/jid.v18:4, 533-552. [[CrossRef](#)]
410. Rinaldo Evangelista, Valeria Mastrostefano. 2006. Firm size, sectors and countries as sources of variety in innovation. *Economics of Innovation and New Technology* **15**, 247-270. [[CrossRef](#)]
411. Metka Stare, Andreja Jaklic, Patricia Kotnik. 2006. Exploiting ICT potential in service firms in transition economies. *The Service Industries Journal* **26**, 287-302. [[CrossRef](#)]
412. I WU, J CHEN. 2006. A hybrid performance measure system for e-business investments in high-tech manufacturing: An empirical study. *Information & Management* **43**, 364-377. [[CrossRef](#)]
413. T ANTHONYBYRD, B LEWIS, R BRYAN. 2006. The leveraging influence of strategic alignment on IT investment: An empirical examination. *Information & Management* **43**, 308-321. [[CrossRef](#)]
414. Neil Dias Karunaratne. 2006. The New Economy and The Dollar Puzzle\*\*Originally published as The University of Queensland School of Economics Discussion Paper No. 305; republished with permission. *Economic Analysis and Policy* **36**, 25-43. [[CrossRef](#)]
415. J. Sarkis, R.P. Sundarraj. 2006. Evaluation of enterprise information technologies: a decision model for high-level consideration of strategic and operational issues. *IEEE Transactions on Systems, Man and Cybernetics, Part C (Applications and Reviews)* **36**, 260-273. [[CrossRef](#)]
416. Robert W. Fairlie. 2006. The Personal Computer and Entrepreneurship. *Management Science* **52**, 187-203. [[CrossRef](#)]
417. Lex Borghans, Bas Weel. 2006. The Division of Labour, Worker Organisation, and Technological Change\*. *The Economic Journal* **116**:10.1111/ecoj.2006.116.issue-509, F45-F72. [[CrossRef](#)]
418. Pierre-Alain Muet. 2006. Impacts économiques de la révolution numérique. *Revue économique* **57**, 347. [[CrossRef](#)]
419. Sumit K. Lodhia. 2006. Corporate perceptions of web-based environmental communication. *Journal of Accounting & Organizational Change* **2**, 74-88. [[CrossRef](#)]
420. O. Prokein, T. FaupelUsing Web Services for Intercompany Cooperation &#8212; An Empirical Study within the German Industry 103a-103a. [[CrossRef](#)]
421. Philippe Askenazy, David Thesmar, Mathias Thoenig. 2006. On the Relation Between Organisational Practices and New Technologies: the Role of (Time Based) Competition\*. *The Economic Journal* **116**:10.1111/ecoj.2006.116.issue-508, 128-154. [[CrossRef](#)]
422. Mariacristina Piva, Enrico Santarelli, Marco Vivarelli. 2006. Technological and organizational changes as determinants of the skill bias: evidence from the Italian machinery industry. *Managerial and Decision Economics* **27**:10.1002/mde.v27:1, 63-73. [[CrossRef](#)]
423. D.S. Soper, H. Demirkan, M. Goul, R. St. LouisThe Impact of ICT Expenditures on Institutionalized Democracy and Foreign Direct Investment in Developing Countries 65b-65b. [[CrossRef](#)]
424. Chris Forman, Avi GoldfarbChapter 1 Diffusion of Information and Communication Technologies to Businesses 1-52. [[CrossRef](#)]

425. P. Davamanirajan, R.J. Kauffman, C.H. Kriebel, T. Mukhopadhyay. Systems Design, Process Performance and Economic Outcomes 168c-168c. [[CrossRef](#)]
426. Peter Brödner. 2006. BEHIND THE IT PRODUCTIVITY PARADOX: THE SEMIOTIC NATURE OF COMPUTER ARTIFACTS. *IFAC Proceedings Volumes* **39**:4, 295-300. [[CrossRef](#)]
427. Marcin Piatkowski. Can ICT Make a Difference in the Development of Transition Economies? 89-109. [[CrossRef](#)]
428. Chinkook Lee. 2005. Information Technology for the Food Manufacturing Industry. *Journal of International Food & Agribusiness Marketing* **17**, 165-193. [[CrossRef](#)]
429. Hartmut Egger, Volker Grossmann. 2005. Non-Routine Tasks, Restructuring of Firms, and Wage Inequality Within and Between Skill-Groups. *Journal of Economics - Zeitschrift für Nationalökonomie* **86**, 197-228. [[CrossRef](#)]
430. Robert Inklaar, Mary O'Mahony, Marcel Timmer. 2005. ICT AND EUROPE'S PRODUCTIVITY PERFORMANCE: INDUSTRY-LEVEL GROWTH ACCOUNT COMPARISONS WITH THE UNITED STATES. *Review of Income and Wealth* **51**:10.1111/roiw.2005.51.issue-4, 505-536. [[CrossRef](#)]
431. Robert S Rhodes, Andrew Resnick. 2005. Towards optimal surgical outcomes. *Expert Review of Pharmacoeconomics & Outcomes Research* **5**, 741-749. [[CrossRef](#)]
432. Luis Garicano, Richard A. Posner. 2005. Intelligence Failures: An Organizational Economics Perspective. *Journal of Economic Perspectives* **19**:4, 151-170. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
433. 2005. ICT-linked firm reorganisation and productivity gains. *Technovation* **25**, 1229-1250. [[CrossRef](#)]
434. Teck-Yong Eng. 2005. The Influence of a Firm's Cross-Functional Orientation on Supply Chain Performance. *The Journal of Supply Chain Management* **41**:10.1111/jscm.2005.41.issue-4, 4-16. [[CrossRef](#)]
435. Marco Vivarelli. 2005. Boyer, R.: The Future of Economic Growth: As New Becomes Old. *Journal of Economics - Zeitschrift für Nationalökonomie* **86**, 191-195. [[CrossRef](#)]
436. Mary O'Mahony, Michela Vecchi. 2005. Quantifying the Impact of ICT Capital on Output Growth: A Heterogeneous Dynamic Panel Approach. *Economica* **72**:10.1111/ecca.2005.72.issue-288, 615-633. [[CrossRef](#)]
437. Satish Jayachandran, Subhash Sharma, Peter Kaufman, Pushkala Raman. 2005. The Role of Relational Information Processes and Technology Use in Customer Relationship Management. *Journal of Marketing* **69**, 177-192. [[CrossRef](#)]
438. Leonardo Becchetti, Fabrizio Adriani. 2005. Does the digital divide matter? The role of information and communication technology in cross-country level and growth estimates. *Economics of Innovation and New Technology* **14**, 435-453. [[CrossRef](#)]
439. David Boddy, Robert Paton. 2005. Maintaining alignment over the long-term: lessons from the evolution of an electronic point of sale system. *Journal of Information Technology* **20**:3, 141-151. [[CrossRef](#)]
440. B. K. ATROSTIC, SANG V. NGUYEN. 2005. IT AND PRODUCTIVITY IN U.S. MANUFACTURING: DO COMPUTER NETWORKS MATTER?. *Economic Inquiry* **43**, 493-506. [[CrossRef](#)]
441. Nicola Matteucci, Mary O'Mahony, Catherine Robinson, Thomas Zwick. 2005. PRODUCTIVITY, WORKPLACE PERFORMANCE AND ICT: INDUSTRY AND FIRM-LEVEL EVIDENCE FOR EUROPE AND THE US. *Scottish Journal of Political Economy* **52**:10.1111/sjpe.2005.52.issue-3, 359-386. [[CrossRef](#)]

442. Thomas Hempell. 2005. Does experience matter? innovations and the productivity of information and communication technologies in German services. *Economics of Innovation and New Technology* **14**, 277-303. [[CrossRef](#)]
443. Osman Kulak, Cengiz Kahraman, Başar Öztayşi, Mehmet Tanyaş. 2005. Multi-attribute information technology project selection using fuzzy axiomatic design. *Journal of Enterprise Information Management* **18**, 275-288. [[CrossRef](#)]
444. Steve Weber, Jennifer Bussell. 2005. Will Information Technology Reshape the North-South Asymmetry of Power in the Global Political Economy?. *Studies in Comparative International Development* **40**, 62-84. [[CrossRef](#)]
445. Spyros Arvanitis. 2005. Computerization, workplace organization, skilled labour and firm productivity: Evidence for the Swiss business sector. *Economics of Innovation and New Technology* **14**, 225-249. [[CrossRef](#)]
446. Mariacristina Piva, Enrico Santarelli, Marco Vivarelli. 2005. The skill bias effect of technological and organisational change: Evidence and policy implications. *Research Policy* **34**, 141-157. [[CrossRef](#)]
447. M.J. Gallivan, R. Benunan-Fich. 2005. A framework for analyzing levels of analysis issues in studies of e-collaboration. *IEEE Transactions on Professional Communication* **48**, 87-104. [[CrossRef](#)]
448. GAVIN A. WOOD, JOHN B. PARR. 2005. Transaction Costs, Agglomeration Economies, and Industrial Location\*. *Growth and Change* **36**:10.1111/grow.2005.36.issue-1, 1-15. [[CrossRef](#)]
449. Dale W. Jorgenson Chapter 10 Accounting for Growth in the Information Age 743-815. [[CrossRef](#)]
450. Tarek M. Harchaoui, Faouzi Tarkhani. 2005. Qu'en est-il des externalités du capital des technologies de l'information?. *L'Actualité économique* **81**, 231. [[CrossRef](#)]
451. Dean Parham. 2005. Les gains de productivité au moyen de l'usage des technologies de l'information : l'expérience australienne. *L'Actualité économique* **81**, 143. [[CrossRef](#)]
452. Jinghua Huang, Hui Wang, Chunjun Zhao E-commerce success factors: exploratory and empirical research on the Chinese publishing industry 465-472. [[CrossRef](#)]
453. Stephen D. Oliner, Daniel E. Sichel. 2005. Les technologies de l'information et la productivité : situation actuelle et perspectives d'avenir. *L'Actualité économique* **81**, 339. [[CrossRef](#)]
454. Fredri William Swiercze, Pritam K. Shrestha, Clemens Bechter. 2005. Information Technology, Productivity and Profitability in Asia-Pacific Banks. *Journal of Global Information Technology Management* **8**, 6-26. [[CrossRef](#)]
455. Andreas Hornstein, Per Krusell, Giovanni L. Violante The Effects of Technical Change on Labor Market Inequalities 1275-1370. [[CrossRef](#)]
456. Cédric Audenis, Julien Deroyon, Nathalie Fourcade. 2005. L'impact des Nouvelles Technologies de l'Information et de la Communication sur l'économie française. *Revue économique* **56**, 99. [[CrossRef](#)]
457. Anitesh Barua, P.L Brockett, W.W Cooper, Honghui Deng, Barnett R Parker, T.W Ruefli, A Whinston. 2004. DEA evaluations of long- and short-run efficiencies of digital vs. physical product "dot com" companies. *Socio-Economic Planning Sciences* **38**, 233-253. [[CrossRef](#)]
458. Matteo Bugamelli, Patrizio Pagano. 2004. Barriers to investment in ICT. *Applied Economics* **36**, 2275-2286. [[CrossRef](#)]
459. Stephan KUDYBA. 2004. The productivity pay-off from effective allocation of IT and non-IT labour. *International Labour Review* **143**:10.1111/ilr.2004.143.issue-3, 235-247. [[CrossRef](#)]
460. Stephan KUDYBA. 2004. Trabajo con tecnologías de la información y productividad empresarial. *Revista Internacional del Trabajo* **123**:10.1111/ilrs.2004.123.issue-3, 269-282. [[CrossRef](#)]
461. Walter W. Powell, Kaisa Snellman. 2004. The Knowledge Economy. *Annual Review of Sociology* **30**:1, 199-220. [[CrossRef](#)]

462. Ira Lewis, Alexander Talalayevsky. 2004. Improving the interorganizational supply chain through optimization of information flows. *Journal of Enterprise Information Management* 17, 229-237. [[CrossRef](#)]
463. George R G Clarke. 2004. Effect of Enterprise Ownership and Foreign Competition on Internet Diffusion in the Transition Economies. *Comparative Economic Studies* 46:2, 341-370. [[CrossRef](#)]
464. Roger W. Ferguson Jr., William L. Wascher. 2004. Distinguished Lecture on Economics in Government: Lessons from Past Productivity Booms. *Journal of Economic Perspectives* 18:2, 3-28. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
465. Nicholas Crafts. 2004. Steam as a general purpose technology: A growth accounting perspective\*. *The Economic Journal* 114:10.1111/eoj.2004.114.issue-495, 338-351. [[CrossRef](#)]
466. Irene Bertschek, Ulrich Kaiser. 2004. Productivity Effects of Organizational Change: Microeconomic Evidence. *Management Science* 50, 394-404. [[CrossRef](#)]
467. G.R. Arabsheibani, J.M. Emami, A. Marin. 2004. The Impact of Computer Use On Earnings in the UK. *Scottish Journal of Political Economy* 51:10.1111/sjpe.2004.51.issue-1, 82-94. [[CrossRef](#)]
468. Nirvikar Singh Digital Economy . [[CrossRef](#)]
469. International Monetary Fund. 2004. United States: Selected Issues. *IMF Staff Country Reports* 04, i. [[CrossRef](#)]
470. Henry van der Wiel, George van Leeuwen ICT and Productivity 93-114. [[CrossRef](#)]
471. Olaf Hübler. 2003. Fördern oder behindern Betriebsräte die Unternehmensentwicklung?. *Perspektiven der Wirtschaftspolitik* 4, 379-397. [[CrossRef](#)]
472. David H. Autor, Frank Levy, Richard J. Murnane. 2003. The Skill Content of Recent Technological Change: An empirical exploration\*. *Quarterly Journal of Economics* 118:10.1162/qjec.2003.118.issue-4, 1279-1333. [[CrossRef](#)]
473. Erik Brynjolfsson, Lorin M. Hitt. 2003. Computing Productivity: Firm-Level Evidence. *Review of Economics and Statistics* 85, 793-808. [[CrossRef](#)]
474. Marianna Sigala. 2003. The information and communication technologies productivity impact on the UK hotel sector. *International Journal of Operations & Production Management* 23, 1224-1245. [[CrossRef](#)]
475. DALE W. JORGENSON, MUN S. HO, KEVIN J. STIROH. 2003. Growth of US Industries and Investments in Information Technology and Higher Education. *Economic Systems Research* 15, 279-325. [[CrossRef](#)]
476. John Laitner, Dmitriy Stolyarov. 2003. Technological Change and the Stock Market. *American Economic Review* 93:4, 1240-1267. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
477. Reggie Davidrajuh. 2003. Realizing a new e-commerce tool for formation of a virtual enterprise. *Industrial Management & Data Systems* 103, 434-445. [[CrossRef](#)]
478. A Del Monte. 2003. R&D and the growth of firms: empirical analysis of a panel of Italian firms. *Research Policy* 32, 1003-1014. [[CrossRef](#)]
479. Rajiv Kohli, Sarv Devaraj. 2003. Measuring Information Technology Payoff: A Meta-Analysis of Structural Variables in Firm-Level Empirical Research. *Information Systems Research* 14, 127-145. [[CrossRef](#)]
480. Frank Beurskens. 2003. The Economics of Dot.coms and E-commerce in the Agrifood Sector. *Review of Agricultural Economics* 25:10.1111/raec.2003.25.issue-1, 22-28. [[CrossRef](#)]
481. Shantanu Bagchi, Shivraj Kanungo, Subhasish Dasgupta. 2003. Modeling use of enterprise resource planning systems: a path analytic study. *European Journal of Information Systems* 12:2, 142-158. [[CrossRef](#)]

482. Albert Lejeune, Tom Roehl. 2003. Hard and Soft Ways to Create Value from Information Flows: Lessons from the Canadian Financial Services Industry. *Canadian Journal of Administrative Sciences / Revue Canadienne des Sciences de l'Administration* **20**, 35-53. [[CrossRef](#)]
483. Casey Ichniowski, Kathryn Shaw. 2003. Beyond Incentive Pay: Insiders' Estimates of the Value of Complementary Human Resource Management Practices. *Journal of Economic Perspectives* **17**:1, 155-180. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
484. Catherine L. Mann. 2003. Information Technologies and International Development: Conceptual Clarity in the Search for Commonality and Diversity. *Information Technologies and International Development* **1**:10.1162/itid.2003.1.issue-2, 67-79. [[CrossRef](#)]
485. Kevin J. Stiroh. Economic Impacts of Information Technology 1-14. [[CrossRef](#)]
486. Lucio Fuentelsaz, Juan Pablo Maicas-López, Yolanda Polo. 2002. Assessments of the "new economy" scenario. *Qualitative Market Research: An International Journal* **5**, 301-310. [[CrossRef](#)]
487. Kevin J. Stiroh. 2002. Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?. *American Economic Review* **92**:5, 1559-1576. [[Citation](#)] [[View PDF article](#)] [[PDF with links](#)]
488. J KOOMEY. 2002. Information technology and resource use: editor's introduction to the special issue. *Resources, Conservation and Recycling* **36**, 169-173. [[CrossRef](#)]
489. Karl Whelan. 2002. Computers, Obsolescence, and Productivity. *Review of Economics and Statistics* **84**, 445-461. [[CrossRef](#)]
490. James Bessen. 2002. Technology Adoption Costs and Productivity Growth: The Transition to Information Technology. *Review of Economic Dynamics* **5**, 443-469. [[CrossRef](#)]
491. Timothy F. Bresnahan, Erik Brynjolfsson, Lorin M. Hitt. 2002. Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence\*. *Quarterly Journal of Economics* **117**:10.1162/qjec.2002.117.issue-1, 339-376. [[CrossRef](#)]
492. James Morsink, Markus Haacker. 2002. You Say You Want a Revolution: Information Technology and Growth. *IMF Working Papers* **02**, 1. [[CrossRef](#)]
493. César Alonso-Borrego, Dolores Collado. 2002. Innovation and Job Creation and Destruction . *Recherches économiques de Louvain* **68**, 148. [[CrossRef](#)]
494. Michael T Kiley. 2001. Computers and growth with frictions: aggregate and disaggregate evidence. *Carnegie-Rochester Conference Series on Public Policy* **55**, 171-215. [[CrossRef](#)]
495. John Reenen. 2001. The New Economy: Reality and Policy. *Fiscal Studies* **22**:10.1111/fisc.2001.22.issue-3, 307-336. [[CrossRef](#)]
496. Hans-Jurgen Engelbrecht. 2001. Gender and the Information Work Force: New Zealand Evidence and Issues. *Prometheus* **19**, 135-145. [[CrossRef](#)]
497. Martin Neil Baily,, Robert Z. Lawrence. 2001. Do We Have a New E-conomy?. *American Economic Review* **91**:2, 308-312. [[Citation](#)] [[View PDF article](#)] [[PDF with links](#)]
498. JOHN FREEBAIRN. 2001. SOME MARKET EFFECTS OF E-COMMERCE. *The Singapore Economic Review* **46**, 49-62. [[CrossRef](#)]
499. Dale W. Jorgenson. 2001. Information Technology and the U.S. Economy. *American Economic Review* **91**:1, 1-32. [[Citation](#)] [[View PDF article](#)] [[PDF with links](#)]
500. Henk J. de Vries, George W. J. Hendrikse. 2001. The Dutch Banking Chipcard Game. *International Studies of Management & Organization* **31**, 106-125. [[CrossRef](#)]
501. David H. Autor. 2001. Wiring the Labor Market. *Journal of Economic Perspectives* **15**:1, 25-40. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]

502. IMF. Research Dept. World Economic Outlook, October 2001: The Information Technology Revolution . [\[CrossRef\]](#)
503. J. Zysman, S. Weber Electronic Economy: Governance Issues 4399-4405. [\[CrossRef\]](#)
504. N. Forbes. 2000. Biologically inspired computing. *Computing in Science & Engineering* 2, 83-87. [\[CrossRef\]](#)
505. Saulius Kuzminskis, Giedrė Česonytė, Vladislav V. Fomin The Effects of E-Journal System on Organizational and Study Processes 302-316. [\[CrossRef\]](#)
506. Euripidis Loukis, Yannis Charalabidis, Vasiliki Diamantopoulou The Multidimensional Business Value of Information Systems Interoperability 137-155. [\[CrossRef\]](#)
507. Euripidis Loukis, Yannis Charalabidis, Vasiliki Diamantopoulou The Multidimensional Business Value of Information Systems Interoperability 77-95. [\[CrossRef\]](#)
508. Sangeeta Sharma Evolving Verifiable Causal Mechanisms through Governometrics to Study Critical Policy Issues 1-23. [\[CrossRef\]](#)
509. Bryan Soh Yuen Liew, T. Ramayah, Jasmine Yeap Ai Leen Customer Relationship Management (CRM) Implementation Intensity and Performance 233-244. [\[CrossRef\]](#)
510. Glòria Estapé-Dubreuil, Consol Torreguitart-Mirada ICT Adoption in the Small and Medium-Size Social Enterprises in Spain 200-220. [\[CrossRef\]](#)
511. Chris Forman, Avi Goldfarb, Shane Greenstein WHICH INDUSTRIES USE THE INTERNET? 47-72. [\[CrossRef\]](#)
512. Organizational Culture and E-Government Performance 141-163. [\[CrossRef\]](#)
513. Lori Anderson Snyder, Deborah E. Rupp, George C. Thornton Personnel Selection of Information Technology Workers: The People, the Jobs, and Issues for Human Resource Management 305-376. [\[CrossRef\]](#)
514. James B. Rebitzer, Mari Rege, Christopher Shepard Influence, information overload, and information technology in health care 43-69. [\[CrossRef\]](#)
515. Robert van Wessel IT, Business Processes & Performance 50-77. [\[CrossRef\]](#)
516. George Leal Jamil Why Quality? Why Value? Is it Information Related to These Aspects? 1-18. [\[CrossRef\]](#)
517. Jason G. Caudill Tools That Drive Innovation 640-652. [\[CrossRef\]](#)
518. Govindan Marthandan, Tang Chun Meng Thirst for Business Value of Information Technology 29-43. [\[CrossRef\]](#)
519. Bruce A. Weinberg New technologies, skills obsolescence, and skill complementarity 101-118. [\[CrossRef\]](#)
520. Jorge A. Romero Business Value of Information Technology: 82-90. [\[CrossRef\]](#)
521. John Wang, Bin Zhou, Jeffrey Hsu Assessment and Contrast of the Effects of Information and Communication Technology 15-32. [\[CrossRef\]](#)
522. Bryan Soh Yuen Liew, T. Ramayah, Jasmine Yeap Ai Leen Customer Relationship Management (CRM) Implementation Intensity and Performance 129-140. [\[CrossRef\]](#)
523. Pedro Soto Acosta, Ricardo Colomo-Palacios, Euripidis Loukis E-Innovation as Source of Business Value in Firms 86-97. [\[CrossRef\]](#)
524. Bryan Soh Yuen Liew, T. Ramayah, Jasmine A. L. Yeap Market Orientation, Customer Relationship Management (CRM) Implementation Intensity, and CRM Performance: 149-172. [\[CrossRef\]](#)
525. Li Chen Mobile Technostress 732-744. [\[CrossRef\]](#)

526. Tiago Oliveira, Gurpreet Dhillon From Adoption to Routinization of B2B e-Commerce: 1477-1497. [[CrossRef](#)]
527. Ronald S. Batenburg, Werner Raub, Chris Snijders CONTACTS AND CONTRACTS: DYADIC EMBEDDEDNESS AND THE CONTRACTUAL BEHAVIOR OF FIRMS 135-188. [[CrossRef](#)]
528. J. Gilbert Silvius A Conceptual Model for Aligning IT Valuation Methods 182-201. [[CrossRef](#)]
529. Dieter Spath, Wilhelm Bauer, Claus-Peter Praeg IT Service Quality Management 1-21. [[CrossRef](#)]
530. Antonio-Juan Briones-Peñalver, José Poças-Rascão Information Technologies (ICT), Network Organizations, and Information Systems for Business Cooperation 324-348. [[CrossRef](#)]
531. Ke Li, Li Li The comparative efficiency and pricing model of on-line brokerage 934-939. [[CrossRef](#)]
532. Kim Huat Goh, R.J. Kauffman Towards a Theory of Value Latency for IT Investments 231a-231a. [[CrossRef](#)]
533. Harald Edquist, Magnus Henrekson Technological Breakthroughs and Productivity Growth 1-53. [[CrossRef](#)]
534. Fred Thompson, Lawrence R. Jones Chapter 8 Cultural Evolution of Organizations from Bureaucracy to Hyperarchy and Netcentricity: Reaping the Advantages of It and Modern Technology 203-230. [[CrossRef](#)]
535. K. Pechter Dis-organizing structure as a policy reform objective: public-private networks in Japan's innovation system 46-51. [[CrossRef](#)]