

# ICT-linked firm reorganisation and productivity gains

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## Abstract

In the EU, most large firms use e-business applications, such as Enterprise Resource Planning (ERP) and online procurement. Based on e-business watch data for EU-4 (Germany, France, Italy and the UK), we find that the actual use of ERP and online procurement is positively correlated with labour productivity growth. Furthermore, we find that certain e-business applications, such as Knowledge Management Solution (KMS) systems and Customer Relationship Management (CRM) systems are significantly positively correlated to either sectoral skill intensity or information technology intensity. The results from the empirical analysis based on Community Innovation Survey (CIS III) data confirm the hypothesis that the introduction of business practices and new organisational practices are highly correlated. Furthermore, there is a significantly positive relationship between labour productivity growth and the percentage of enterprises with new or significantly changed organisational structures based on industry data for some EU countries.

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## 1. Introduction

In recent years, many European companies have introduced new or improved organisational structures, new human resource practices, new management techniques or business practices. These new forms of work organisation and business practices have been made possible by the use of new information and communication technologies (ICT). Companies also continue to invest heavily in ICT, particularly in e-business applications, such as Enterprise Resource Planning (ERP), Supply Chain Management (SCM) and Customer Relationship Management (CRM). These e-business applications have enabled new electronic business processes (e-business).

e-business can be defined as ‘the use of electronically enabled communication networks that allow business enterprises to transmit and receive information’ (Fellenstein and Wood, 2000). e-Business is a broader term that encompasses electronic business processes as well as e-Commerce (buying and selling). Simple examples of typical business

processes that may be carried out in electronic form include customer support and education, marketing, advertising and public relations, recruitment of new employees, information resource sharing among employees, strategic and tactical planning, distributed inventory control functions, payroll and benefits management. Note that none of the business process involves the direct buying and/or selling of materials but mainly address the quality, flexibility and availability of the product of service. The Internet plays a key role as the supporting medium for various e-business practices such as SCM and online procurement. e-business process are often referred to as ‘ICT-enabled organisational change’ (King and Tillquist, 2000), ‘ICT-enabled business transformation’ (Venkatraman, 1994) and ‘ICT-enabled Business Process Reengineering (BPR)’ (Davenport, 1993).

ICT-enabled business practices such as ERP systems also have important implications for the organisational structure of the firm. They imply changes to the hierarchical structure, to the decision-making strategies, to responsibilities and to the organisation’s culture (Davenport, 1998). The implementation of ICT-enabled business practices can be a difficult, time-consuming and expensive project for a company (Mabert et al., 2001). Therefore, it is important to

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understand the cost and potential benefits of e-business implementation. ICT-enabled business practices can significantly increase efficiency and productivity through improved customer service, reduced cost (i.e. lower procurement and inventory cost), and streamlined business processes. Empirical studies find that the greatest benefits from ICT are realised when ICT investment is combined with organisational changes, such as new business strategies and practices and new organisational structures (see Brynjolfsson and Hitt, 2000, 2002; Brynjolfsson et al., 2003 for a review of the literature).

The paper is divided as follows. After the introduction, we provide a review of the literature on the productivity effects of ICT-enabled organisational change. Section 3 looks at the incidence of reorganisation, particularly e-business practices and the relationship between labour productivity and e-business practices at the industry level. Here, we will draw extensively on the *e-business w@tch* data and on the e-Business Sector Impact Studies. In Section 4, we use the Community Innovation Survey (CIS) III data to analyse the productivity effects of two types of reorganisation (i.e. management techniques and organisational change in general). Finally, Section 5 concludes.

## 2. Review of the literature

### 2.1. Definitions of organisational change

Organisational change can be defined as changes in the strategies, structures and practices of organisations. This can involve a number of elements including (Betcherman and McMullen, 1998; Murphy, 2002):

- *Changes in organisational structure* of the firm including hierarchy, functional lines, and organisational boundaries;
- *Changes in the work process* or new forms of work organisation including the use of different production inputs, the flow of work, job design, work allocation, and the use of suppliers and subcontractors;
- *Innovative Human resource practices* including compensation, information sharing, employee involvement in decision-making, and scheduling;
- *Industrial relations practices* involving the strategies and institutional structures affecting the labour–management relationship; and
- *New business practices and new management techniques* (Total Quality Management (TQM), Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, Customer Relationship Management (CRM), lean production).

New business practices often affect the external coordination of the firm, including changes in the interaction with suppliers (Just-In-Time delivery and Just-In-Time

production, sub-contracting of production and outsourcing) (Murphy, 2002; Greenan and Mairesse, 2002).<sup>1</sup>

Innovative human resource practices (also referred to as high performance work practices (HPW)) include employee involvement in decision-making (for example self-managed teams, quality circles, labour–management committees, works councils, employee representation on the board of directors), employee participation in the company’s financial results (e.g. profit-sharing and employee stock ownership), and supporting practices (such as information sharing, training and internal labour markets, job design, individual incentives, various pension schemes) (see Ichniowski et al., 2000).

### 2.2. Overview of e-business practices

A large number of innovative business management concepts recently emerged, e.g. BPR, e-business, and Total Quality Management.<sup>2</sup> However, of all these, e-business and BPR (other aliases: Business Process Redesign, Organisational Redesign, Core Process Redesign, Value Reengineering) probably have the greatest influence (Light and Holland, 1998). BPR typically refers to the idea of radical changes to the operations of a business, often utilising new information technology or information systems (Hammer and Champy, 1993).

ICT such as networked computer applications are seen as an ‘essential enabler’ of the change in business processes (Hammer and Champy, 1993). BPR critically examines the business process for redundant steps and opportunities for entirely new ways of achieving the desired output. It attempts to break down outdated assumptions and rules, support teamwork, and shorten cycle times (Grover et al., 1998). If successfully implemented, breakthrough performance gains in productivity can be achieved. In addition to ICTs, the success of process change also depends on organisational structure enablers, management system enablers and human resource enablers (Grover et al., 1998). ERP systems can be seen as an important tool for the reengineering process.

Beginning in the late 1990s, companies invested heavily in e-business solutions such as ERP, CRM, supply-chain management, e-procurement and data warehouse. e-business involves communication and performing business processes electronically through the internet. In particular, companies use the internet to implement CRM and SCM systems, which enable them to link their

<sup>1</sup> Outsourcing is not considered an element of organisational change because their main purpose is to change the amount of work rather than the way in which work is organized (OECD, 1999, p. 179).

<sup>2</sup> Total Quality Management (TQM) is frequently not considered to be an element of reorganisation, however. Although business practices and TQM have much in common, they differ significantly with respect to the interdependence with ICT. TQM focuses on minor continuous improvements of business processes and it is not related to the introduction of ICT.

operations seamlessly with customers and suppliers. In general, e-business goes beyond e-commerce and encompasses other areas such as CRM, knowledge management systems and SCM (O'Brien, 2003).

### 2.3. Enterprise resource planning (ERP) systems

Enterprise Resource Planning (ERP) systems (also called enterprise-wide systems or enterprise systems) can be seen as an important tool for reengineering processes. They consist of a software package that uses database technology to control and integrate all the information related to a company's business including customer, supplier, product, employee and financial data. A single enterprise-wide database is used in which all business transactions such as inventory management, customer order management, production planning and management, distribution, accounting, human resource management are entered, recoded, processed, monitored and reported (Davenport, 1998; Ragowsky and Somen, 2002; Umble and Umble, 2002). Thus, ERP systems connect the organisation to its customers and suppliers through the different stages of the product or the process life cycle.

It is well known that the implementation of an ERP system is a very expensive and complex task. ERP package implementation costs include consulting, process redesign, data conversion, training, integration and testing (Mendelson, 1999). For most of the ERP projects, the software portion only accounts for a small proportion of the total implementation costs. The other areas such as hardware, training and consulting tend to dominate the true costs of implementing ERP Systems (Mabert et al., 2001). Using data on 5000 US manufacturing firms engaged in ERP, Mabert et al. (2001) find that the cost of licensing the software itself is only 30% of the overall cost of implementing the ERP system. Additional costs include expenditures on new hardware (18%) and, most significantly, fees paid to consultants and programmers (24%), training (11%) and costs for the implementation team (14%)

#### Box 2.1:

##### *Enterprise Resource planning (ERP) systems*

'ERP (Enterprise Resource Planning Systems) comprise a commercial software package that promises the seamless integration of all the information flowing through the company—financial, accounting, human resources, supply chain and customer information.' (Davenport, 1998).

'ERP is a software architecture that facilitates the flow of information among the different functions of an enterprise. Similarly, ERP facilitates information sharing across organisational units and geographical locations.' (Mendelson, 1999).

ICT-enabled business practices such as ERP systems also have important implications for the organisational structure of the firm. The changes to the organisation can be substantial, and can impact virtually every business process or function within the organization. ERP implementations mean changes to the organization chart, to job descriptions, to responsibilities, to internal power structures, and to the organisation's culture

#### Box 2.2:

##### *ERP systems and business process change*

'Typically, business process reengineering is a precondition to implement SAP systems. For instance, in order to implement SAP R/3 (one leading ERP supplier), the system must be configured to specifically meet the organisation's process requirements. This is a complex and lengthy process, which can take years to implement. Analysts identify and deconstruct thousands of business processes that constitute the company's operations such as production processes, inventory management rules, and accounting practices. The organisation, the business process and all transaction details must be explicitly modelled and entered as settings in about 8,000 configuration tables.' (Mendelson, 1999).

According to Davenport (1998), on the one hand, ERP systems allow organisations to streamline their management structures, creating flatter, more flexible and democratic organisations by providing real-time access to operating and financial data. On the other hand, they also involve the centralisation of control over information and the standardisation of processes, which are qualities that are more consistent with hierarchical organisations (Davenport, 1998). Often the outcome of an ERP implementation is flatter hierarchies and the distribution of decision-making to the lowest possible organisational level.

Most of the benefits of the ERP systems are expected from the change in business processes, in which the ERP software is just an enabler (Martin, 1998). Benefits of ERP systems include (Davenport, 1998):

- Integration of customer order information
  - One order in one system
  - Easier coordination and information sharing for departments
  - Better customer service
- Standardisation and acceleration of business processes
  - Save time (direct and easy access to essential data, improved information management, integration of systems and information within the enterprise)
  - Increase productivity (reduced administrative overhead for some business functions, simplified business processes, reduced paperwork)
  - Multiple sites could be managed as a single entity

Table 1  
Causes of ERP implementation failures

Causes of failure	Comments
Poor leadership from top management	Management must view the implementation as a transformation in the way of doing business
Automating non-value-added processes in the new system	The new ERP system will require the organisation to do business in a different way. Existing business processes need to be reengineered by means of a bottom-up approach to dovetail with the ERP structure and requirements
Unrealistic expectations	Underestimation of the amount of time, resources and outside assistance required to implement and run the new system. The new system is complex and difficult to master; therefore, organisations must be prepared for an initial decline in productivity after the new software is put into operation. The expected improvements will come as the company's familiarity with the system increases
Poor project management	Managers are not fully aware of the scope, size and complexity involved and do not initiate the necessary level of detailed project management planning and control
Inadequate training	Top managers and all system users must be fully educated in order to be able to understand the integration of the ERP system into the overall company operation, and to be able to take full advantage of the system's capabilities
Attempts to maintain the status quo	People are generally fearful of change brought about by any new system and reject innovations.
Bad match	Failures occur because the new software's capabilities and needs are mismatched with the organisation's existing business processes and procedures
Inaccurate data	Due to the integrated nature of ERP, erroneous data may cause a negative domino effect throughout the enterprise if entered into the common database
ERP implementation is viewed as an IT project	It is likely that business processes will not be properly reengineered and aligned with the software requirements, and staff will therefore resist using it
Technical difficulties	Bugs in the software, problems interfacing with existing systems and hardware difficulties

Source: Umble and Umble (2002).

- Reduction in inventory
- Integrated supply chain
  - Reduced inventory obsolescence
  - Integration with suppliers and increased visibility
  - Standardisation of HR information.

In summarizing a number of studies, Ragowsky and Somen (2002) suggest that the benefit an organisation derives from using information technology (IT) is dependent on the characteristics of the organisation. Therefore, not all companies will gain the same benefit from using the same ERP applications, and different ERP software packages will better suit different organisations. Umble and Umble (2002) listed a number of causes of ERP implementation failures including poor leadership from top management, automating non-value-added processes in the new system, unrealistic expectations, poor project management, inadequate training, attempts to maintain the status quo and inaccurate data. Hereby, ERP implementation is viewed as an IT project as well as a technical challenge (see Table 1). Dignum (2002) suggests that the biggest mistake that companies have made is that they expected huge benefits from just implementing new IT components without changing the organisational structure.

#### 2.4. Supply chain management (SCM) and customer relationship management (CRM)

An important role of ERP is to serve as a platform for other applications, such as Customer Relationship Management (CRM) and Supply Chain Management (SCM) (Ragowsky and Somen, 2002). SCM covers every aspect of the corporate supply chain process, starting from

the production of raw materials to establishing relationships with the customers (Yen et al., 2002). It provides instant data access to information about orders, forecasts, production plans, and key performance indicators such as inventory levels and filling rates, as well as the ability to increase service quality and reduce investments in inventory.

In the last years, all major ERP suppliers have integrated SCM strategy into their ERP systems. CRM is also linked to ERP. CRM provides solutions that help companies improve the relationship to their customers. The integration of the front-end CRM and the back-end ERP create a new business architecture for enterprises, placing the customer at the centre (Yen et al., 2002). CRM can help businesses enhance their customer relationships by attracting more profitable customers and establishing stronger and more durable customer relationships. CRM and ERP have been converging for some time. Web-based product availability and delivery information are just a few of the common business applications that involve blending technologies from both disciplines

#### Box 2.3:

##### *Customer relationship management (CRM)*

Customer Relationship Management (CRM) enables companies to identify, select, acquire, develop, and retain profitable customers. CRM allows companies to build lasting relationships with its customers (O'Brien, 2003).

##### *Supply chain management (SCM)*

The process of optimising the delivery of goods, services and information from supplier to customer.

This set of business processes encompasses a trading-partner community engaged in the common goal of satisfying the end customer (Gartner Group, 1999).

*Application service provider (ASP)*

An Application Service Provider (ASP) manages and delivers application capabilities to multiple entities from data centres across a wide area network (Verwaal et al., 2002).

*Knowledge management solutions*

Knowledge management solutions are web-based products that revolutionise how businesses access, manage, and use their information assets. Knowledge management solutions can be defined as a system and managerial approach to collecting, processing, and organizing enterprise-specific knowledge assets for business functions and decision-making (Chen, 2001).

### 2.5. *e-procurement and e-marketplaces*

Online procurement (e-procurement) and business-to-business (B2B) is another commonly used e-business practice. Online procurement changes the process of ordering goods and services. Company personnel can access and browse a list of goods and services directly from the desktops. E-procurement turns the slow, error-prone and costly paper-based process into an efficient, interactive real-time electronic process (Boykin, 2000). Many of the e-procurement systems are a component of an ERP system (Boykin, 2000). One of the main benefits of e-procurement is the reduction in transaction costs. According to Dignum (2002), the cost reduction will be between 50 and 56% per order. However, the benefits of cost reduction may only arise for large firms that process hundreds of orders each week (Dignum, 2002). For small companies, the costs of the e-procurement system may outweigh the benefits

**Box 2.4:**

*Online procurement (e-procurement)*

Online procurement (e-procurement) can be defined as ‘a process which allows any designated user to requisition a product or service through a web interface and generate a purchase order to send to a supplier’ (Boykin, 2000). E-procurement technologies include e-procurement software, B2B (business-to-business) auctions, B2B market exchanges, and purchasing consortia. Online procurement is focused on automating workflows, consolidating and leveraging organisational spending power, and identifying new sourcing opportunities (Davila et al., 2002).

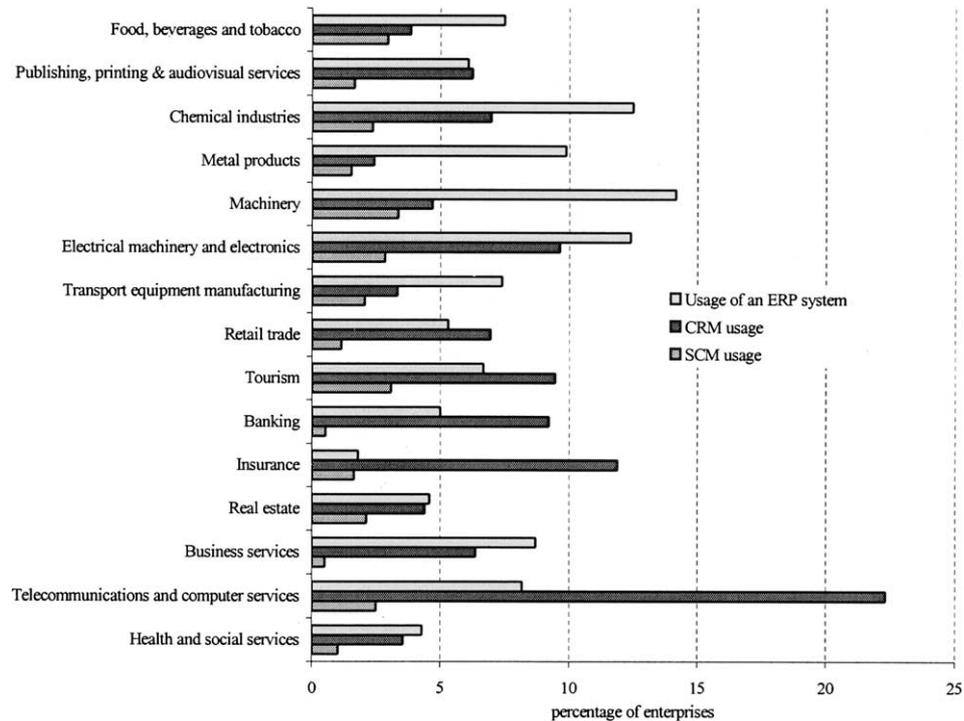
*e-marketplaces*

‘Also called e-Hubs, net marketplaces, and B2B exchanges, e-marketplaces are purely digital meeting

places that provide to their participants two broad categories of service: aggregation and facilitation. Aggregation refers to making available large numbers of potential partners—both buyers and suppliers—along with, in many cases, listings of the goods they want to buy or sell. In many cases, aggregation of suppliers entails creating a comprehensive online catalogue of their wares. Aggregation provides the obvious benefit of liquidity, an important consideration for all traders. Facilitation refers to helping e-marketplace participants interact with each other, before, during, and after their decisions to do business together. Prior to this decision, e-marketplaces facilitate by providing information about potential partners, including certification as to their demonstrated qualities (credit, fulfillment reliability, etc.). e-marketplaces often assist contracting and partnership decisions by conducting auctions, reverse auctions, and other dynamic pricing events. Finally, many e-marketplaces also offer post-partnership facilitation services such as arranging credit and logistics services, and in some cases taking responsibility for order fulfilment (McAfee, 2000).’

### 2.6. *Productivity effects of ERP systems*

There is a small but growing literature on the impact of ERP systems on performance and productivity. However, the majority of these studies are interviews, case studies or a collection of case studies and industry surveys mainly for US data (see the literature reviews provided by Gattiker and Goodhue, 2002; Hitt et al., 2002). None of these articles empirically tests the impact of ERP systems using a representative dataset. McAfee (1999, 2002) studies the impact of ERP systems on self-reported company performance. Based on a survey of 101 US implements of SAP R/3 packages, the author finds that participating companies reported substantial performance improvement in several areas as a result of their ERP implementation, including their ability to provide information to customers, cycle times, and on-time completion rates. Hitt et al. (2002) investigate the relationship between adopting ERP systems and firm performance. The authors use data on firms that have purchased licences for the SAP R/3 system from which they confirm some important conjectures about the business value of ERP system implementation. Besides explaining the business impact of the implementation on a wide variety of performance measures, the authors empirically test for the productivity and business performance effects of ERP on firms that adopted ERP versus those that did not, and on firms before, during, and after the implementation to assess performance over time. They find that ERP adopters exhibit a consistently higher performance than non-adopters across a wide variety of measures. Most of the gains occur during



Graph 1. Incidence of e-business practices in the EU-4. Source: e-business w@tch sector database (2002).

the implementation period, although the authors do find some evidence of a decline in business performance and productivity shortly after the completion of the implementation. This result is in contradiction to the theoretical expectation that productivity should increase after the successful completion of the ERP implementation.

Using data on 5000 US manufacturing firms, Mabert et al. (2000) find that the top three ERP performance outcomes include: (i) quicker information response time; (ii) increased interaction across the entire enterprise; and (iii) improved order management/order cycle. The top three areas benefiting from ERP include: (i) availability of information; (ii) integration of business; (iii) operations/processes.

### 3. New business practices and productivity performance<sup>3</sup>

#### 3.1. Incidence of the use of e-business practices

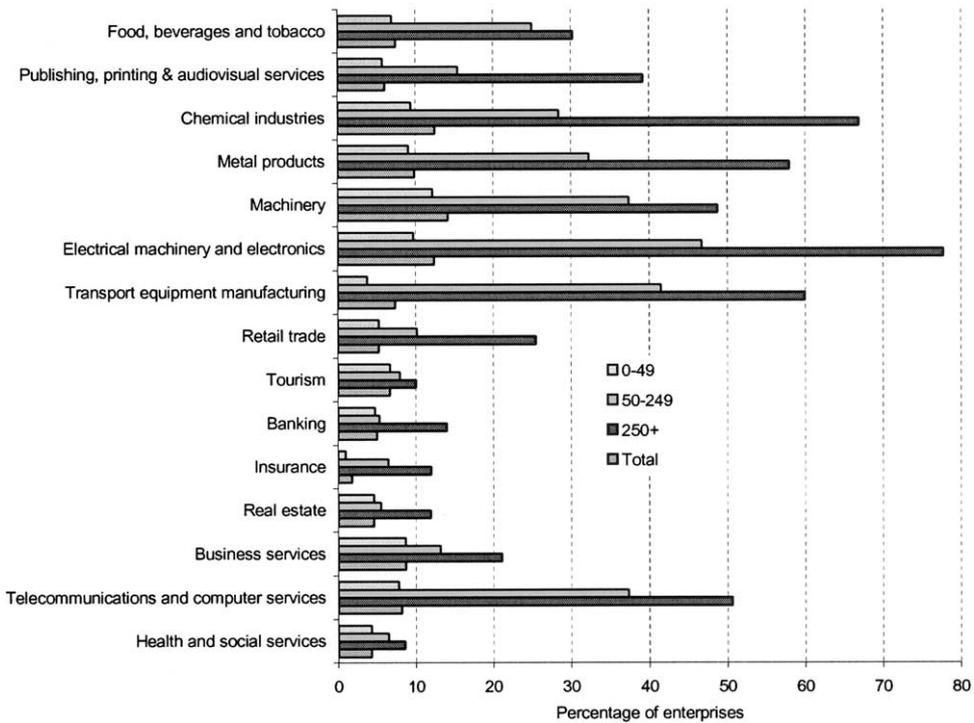
Our analysis of the incidence and consequences of e-business practices heavily draws on the e-business w@tch sector database. These data provide the first cross-country and industry information on this issue, covering up to 15 industries in the manufacturing and service sector.

<sup>3</sup> This section heavily draws on the e-business w@tch sector impact studies as well as the e-business w@tch sector database (2002). Findings presented in the report are based on data weighted by enterprises.

The analysis is based on data for EU-4 (Germany, France, Italy and UK) in 2002.<sup>4</sup> The e-business w@tch data indicate that in the EU-4, the percentage of firms using ERP systems is much higher than the percentage of firms using SCM (see Graph 1). CRM is also important, particularly in telecommunications and computer services as well as in banking and insurance. Overall, CRM systems are used by 22% of firms in the ICT service sector as compared to 7.5% on average in the non-ICT service sector (see Graph 1). In manufacturing, ERP is the most frequently used e-business practice followed by CRM and SCM. The chemical industry, transport equipment as well as the electrical industry have the highest share of enterprises using ERP. Overall, only few firms use SCM with an EU-4 share of less than 5%. The low share of ERP and SCM in some service industries is due to the low importance of intermediate materials such as raw materials and energy.

When comparing survey results across firm size, we observe that e-business practices are used by a majority of large companies (see Graph 2 for ERP systems and Graph 3 for SCM). The percentage of firms with ERP systems in large manufacturing companies (>250 employees) ranges from 30% in food and beverages to almost 80% in the electrical goods industry. This is consistent with Hitt et al. (2002) stating that ERP systems have been implemented in

<sup>4</sup> For Germany, France, Italy and UK information for each of the 15 industries is available. For Austria, Belgium, Denmark, Luxembourg and Portugal the E-business w@tch sector database covers three industries. For Finland, the Netherlands, Spain and Sweden we have information for five industries.

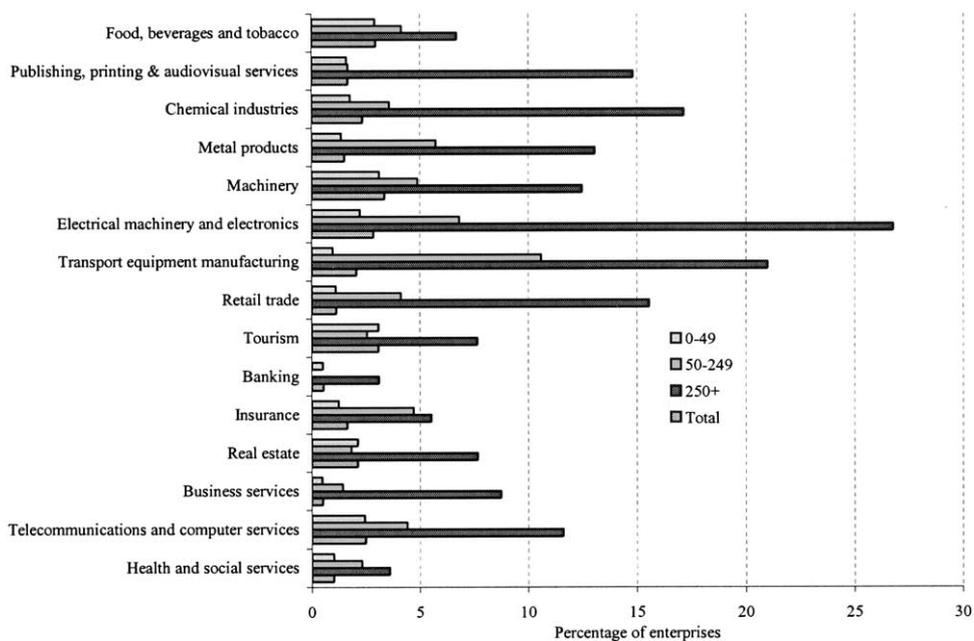


Graph 2. Usage of ERP-systems in EU-4 by industry and firm size. Source: e-business w@tch sector database (2002).

more than 60% of multinational firms. Turning to plans to use an ERP system in the future, we again observe that larger firms are more likely to adopt ERP systems. Among large firms, the percentage of firms that will implement ERP systems in the next months is highest in metal products, followed by insurance, banking, computer services, and the food industry.

With regards to ERP diffusion in different countries, we find that Italy is above average in all service industries.

UK is below average and France and Germany are in the middle range. In chemicals, French enterprises reported the highest level of ERP (35%). Enterprises from Italy reported the highest level in machinery, insurance and telecommunications sectors. UK firms are again below average in all manufacturing industries. In the ICT sector, companies from the Netherlands and the UK in particular make extensive use of CRM systems (see e-business sector reports; Table 2).



Graph 3. Usage of SCM-systems in EU-4 by industry and firm size. Source: e-business w@tch sector database (2002).

Table 2  
Usage of various e-business practices across selected EU-states

	Germany			France			Italy			UK		
	CRM	ERP	SCM	CRM	ERP	SCM	CRM	ERP	SCM	CRM	ERP	SCM
Food, beverages and tobacco	0.4	2.4	1.7	0.0	4.2	0.1	10.4	15.8	6.9	2.7	2.3	2.0
Publishing, printing and audiovisual services	4.6	7.5	1.8	3.7	3.9	0.0	1.5	8.7	3.0	10.2	5.1	1.7
Chemical industries	8.8	11.6	1.6	5.5	35.5	0.8	7.1	13.3	2.1	6.3	3.2	3.6
Metal products	1.9	11.7	0.6	0.1	5.8	1.6	2.7	13.8	2.7	3.7	2.4	0.2
Machinery	1.6	7.9	2.2	5.7	17.0	0.7	6.7	22.9	6.6	3.8	3.3	0.5
Electrical machinery and electronics	10.6	18.6	6.3	3.3	12.4	0.8	8.5	12.7	3.6	12.1	8.2	0.4
Transport equipment manufacturing	3.3	7.2	3.0	0.4	9.1	0.4	7.4	16.3	4.2	2.5	2.7	1.2
Retail trade	6.7	5.1	0.0	1.6	1.7	1.6	9.9	8.5	1.4	6.8	1.8	1.8
Tourism	13.3	10.0	3.3	3.3	0.0	0.0	10.7	10.7	5.3	8.4	3.3	3.3
Banking	17.5	6.0	0.0	7.1	4.0	1.7	12.4	11.6	0.2	7.0	1.8	0.0
Insurance	14.4	3.9	3.5	10.5	3.5	0.0	35.4	22.3	10.1	10.7	0.3	1.2
Real estate	0.0	3.4	0.0	4.9	4.9	3.3	8.6	9.9	1.2	8.3	1.7	5.0
Business services	5.3	3.5	0.0	0.1	11.6	0.0	8.2	16.4	0.0	8.4	3.4	1.7
Telecommunications and computer services	22.3	12.9	3.4	18.8	14.2	1.8	12.9	17.2	0.0	26.9	1.8	3.4
Health and social services	1.7	5.0	0.0	1.7	3.4	1.7	10.2	8.5	3.4	3.4	0.0	0.1

Source: e-business w@tch sector database (2002).

Turning to the complementarity hypothesis, we find that certain business practices are complementary to each other. In particular, the use of SCM and ERP are highly correlated with a correlation coefficient of 0.87 (see Table 3).

On the basis of e-business W@tch data, we find that e-procurement seems to be one of the most widely used application. In EU-4, the percentage of companies currently taking advantage of e-procurement is approximately 37% (unweighted average across EU-4 industries). Procuring online is more common in skill-intensive service industries such as telecommunications and computer services and business services (see Graph 4). Unreported results show that online procurement is more common in Germany and in the UK (with unweighted means of 57 and 44%) followed by Italy and France with 27% (see e-business W@tch sector impact studies). Furthermore, the use of online procurement does not differ across firm size. Small firms lag behind but the difference is less pronounced than for other e-business applications such as ERP-systems (see e-business W@tch sector impact studies).

Table 3  
Correlations between different types of e-business activities, EU-4

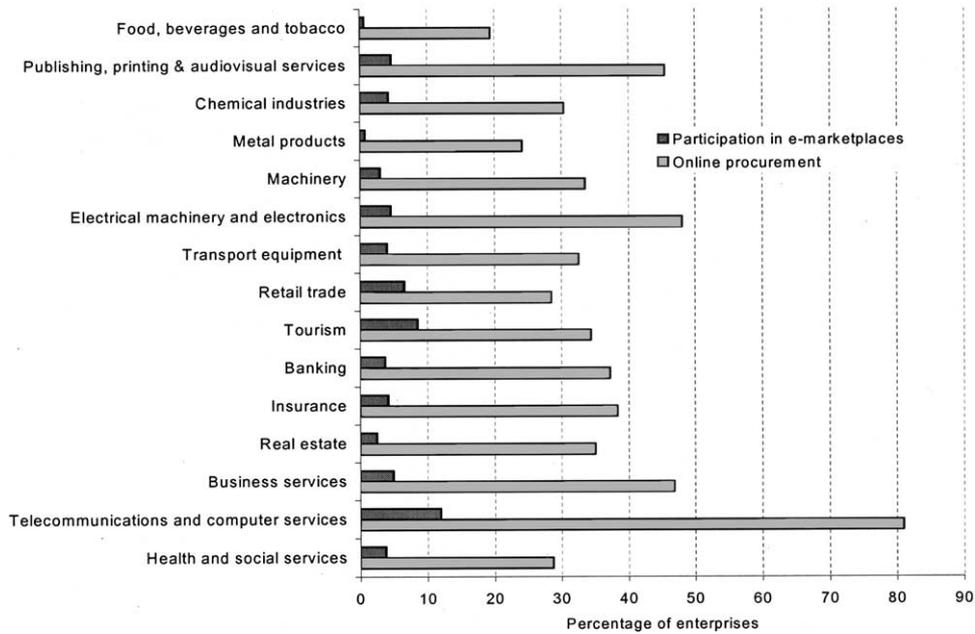
	ASP	CRM	ERP	Knowledge Management Solution
CRM	0.78 (0.00)	1		
ERP	0.33 (0.03)	0.56 (0.00)	1	
Knowledge Management Solution	0.58 (0.00)	0.68 (0.00)	0.32 (0.03)	1
SCM	0.46 (0.00)	0.60 (0.00)	0.87 (0.00)	0.42 (0.00)

p-value in parentheses. Number of observations: 45 (15 sectors×3 firm size classes). Source: e-business w@tch sector database (2002). Own calculations.

Although the incidence of online-procurement is relatively high, the volume shares are still low. In the EU-4, the share of firms with less than 5% of their online purchasing volume is highest in manufacturing industries, such as metal products, machinery and transport equipments (see Table 4). Conversely, firms with a high share of online purchasing (50% or more of their purchasing volume) can be found in business services, telecommunications and computer services and retail trade. In the EU-4, the percentage of firms participating in e-marketplaces is still small with an unweighted average of 4.5% (see Graph 4). e-marketplaces are more frequently used by large firms (see Graph 5).

### 3.2. Relationship between e-business practices, sectoral labour productivity growth and performance

Table 5 shows the correlation coefficients between various e-business practices in 2002 and the average annual change in labour productivity between 1995 and 2000



Graph 4. Participation in e-marketplaces and online procurement, EU-4. Source: e-business w@tch sector database (2002).

Table 4  
Share of online procurement in total procurement, EU-4

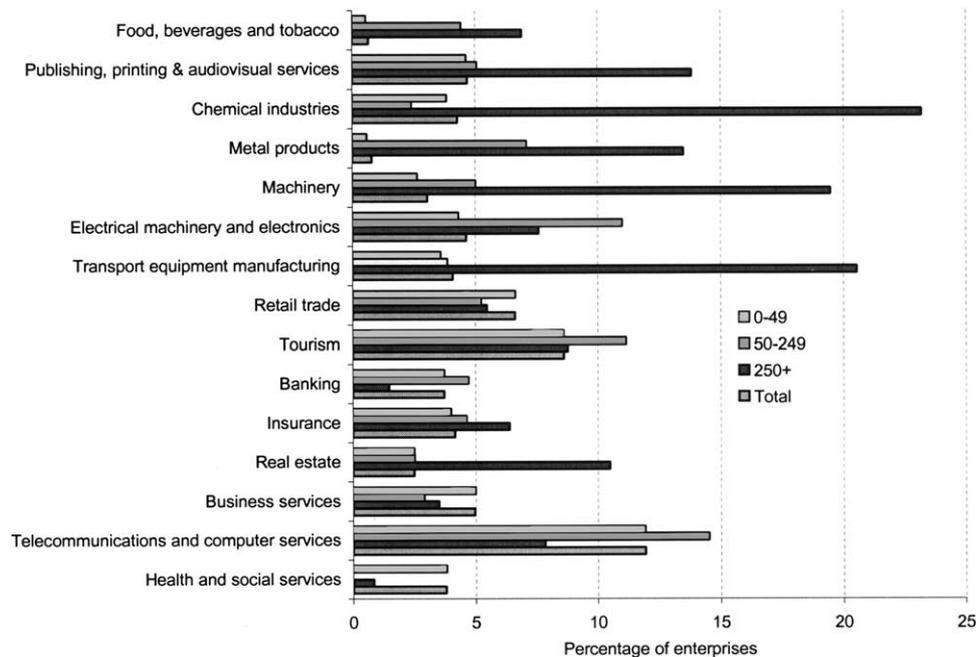
	Online share of total procurement <5%	Online share of total procurement: 5–10%	Online share of total procurement: 11–25%	Online share of total procurement: 26–50%	Online share of total procurement: >50%
Food, beverages and tobacco	43.8	32.6	22.7	0.9	0.0
Publishing, print and audiovisual services	41.0	27.0	21.0	8.6	2.3
Chemical industries	43.3	41.6	10.3	3.1	1.8
Metal products	49.4	36.0	9.7	2.6	2.4
Machinery	52.0	31.8	12.5	1.8	1.9
Electrical machinery and electronics	39.0	29.3	14.1	8.5	9.0
Transport equipment manufacturing	57.1	22.5	12.5	6.6	1.3
Retail trade	33.7	19.0	19.6	13.9	13.8
Tourism	48.0	26.6	10.1	10.9	4.4
Banking	41.2	30.8	17.5	5.6	4.9
Insurance	41.4	28.7	18.9	5.1	5.9
Real estate	41.1	32.6	17.6	8.7	0.0
Business services	34.8	17.9	23.6	8.6	15.1
Telecommunication and computer services	61.1	19.2	23.2	21.5	20.0
Health and social services	35.1	39.6	19.6	4.5	1.2

*p*-value in parentheses. Source: e-business w@tch sector database (2002).

(or 1995–1999 for France) based on EU-4 industry data. The correlation is calculated based on data for the individual EU-4 countries. We find a significant correlation between the change in labour productivity in the past and ERP use (with a *p*-value of 0.077).<sup>5</sup> This means that industries with a higher productivity growth rate are more likely to implement ERP

systems. We also present an XY-plot in order to illustrate the relationship between the percentage of firms with ERP usage and labour productivity growth (see Graph 6 based on data for individual countries and Graph 7 based on (aggregated) EU-4 data). Both graphs show that industries with a higher proportion of ERP use have had a higher productivity growth in past. However, the direction of causality may be ambiguous or open to interpretation. Since the time period referred to the past rather than the productivity growth in

<sup>5</sup> The significance is even greater when the correlation is based on robust standard errors corrected for heteroskedasticity (*p*-value: 0.04).



Graph 5. Participation in e-marketplaces by industry and firm size, EU-4. Source: e-business w@tch sector database (2002).

the future period, the most likely interpretation is that the causality runs from labour productivity growth to ERP usage. However, we might have the causality reversed. This reverse causality running from ERP usage to labour productivity growth may arise because the change in ERP usage is likely to be correlated with its level. There are several reasons we might expect that the change in ERP use would be correlated with its level. One reason is that ERP systems were developed in the 1990s and have grown rapidly since the mid-1990s. If this is the case, the direction of causality goes in both ways. A higher level of ERP usage may have influenced labour productivity growth and a high labour productivity growth lead to a higher level of ERP use.

Furthermore, the correlation coefficients between the other types of e-business practices and change in labour productivity are also positive in most of the cases but are not significant at the 5% level. Using aggregate data for EU-4, we find a significant correlation between CRM usage and past productivity growth (see Graph 8). The insignificance of the relationship between SCM and change in labour

productivity may be due to the fact that the usage of SCM is more pronounced in specific resource-intensive industries.

Table 6 shows the correlation coefficients between the percentage of firms using online procurement and the change in labour productivity between 1995 and 2000 (or 1995–1999 for France) based on EU-4 industry data. In order to investigate whether the improvement in labour productivity is mainly due to labour shedding, we also present correlations for value added growth. Furthermore, we also plot the percentage of firms using online procurement and labour productivity growth (see Graph 9).

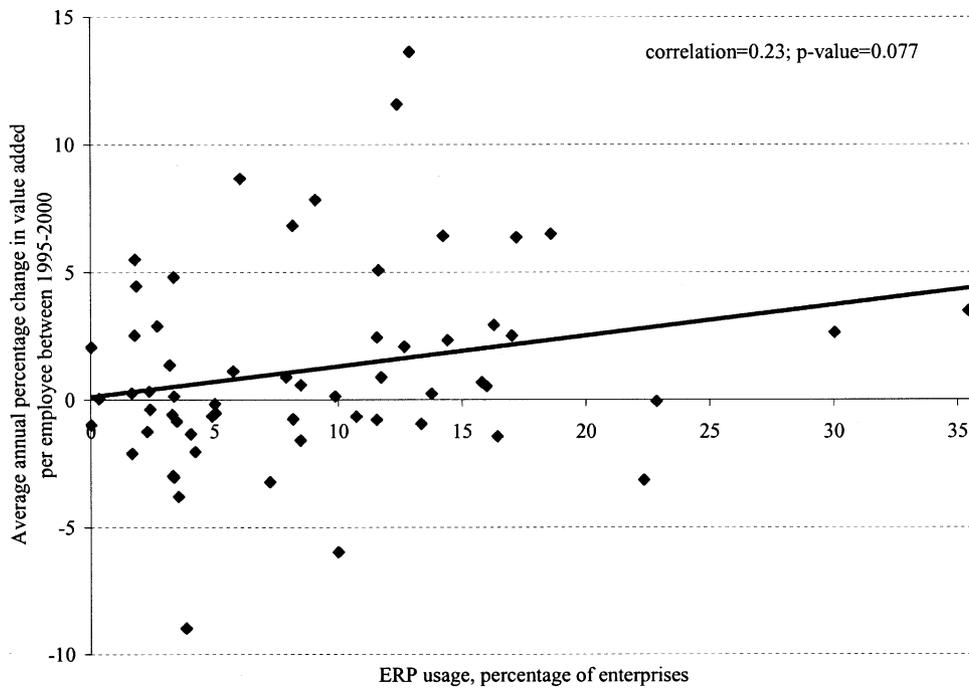
We find a significant correlation between change in labour productivity in the past and actual use of online procurement. The results are robust with respect to the measurement of online procurement (percentage of firms, or alternatively the percentage of firms with an online procurement share of 25% or more). This means that industries with a higher productivity growth rate are more likely to use online procurement. Furthermore, the correlation coefficient between participation in e-marketplaces

Table 5

Correlation coefficients between various e-business practices and labour productivity growth, EU-4

	Usage of an Asp	CRM usage	Usage of an ERP system	Usage of a Knowledge Management Solution	SCM usage
Change in value added constant prices per employees	+0.21 (0.11)	+0.19 (0.15)	+0.23 (0.08)	+0.18 (0.17)	−0.10 (0.46)
Change in value added in constant prices	+0.32 (0.01)	+0.17 (0.19)	+0.07 (0.59)	+0.18 (0.18)	−0.20 (0.12)

*p*-value in parentheses. Number of observations is 60 (15 industries for each of the following countries: Germany, France, Italy and UK). Average annual change in value added refers to the period 1995–2000 (UK, Italy and Germany) and 1995–1999 (France). Source: Stan Database, e-business w@tch sector database (2002), own calculations.



Graph 6. ERP usage and labour productivity growth, EU-4 (disaggregated). Notes: The graph contains data for individual countries (EU-4). The number of observations is 60. Source: Stan Database, e-business w@tch sector database (2002), own calculations.

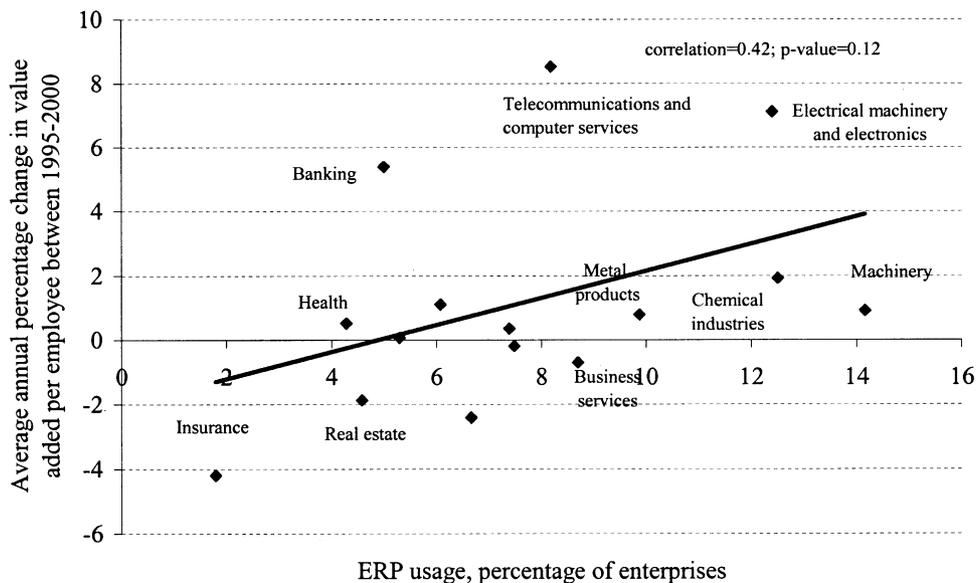
and labour productivity growth is also positive but not significant at the 10% level (see also Graph 10).

The e-business w@tch data also allow us to investigate the impact of e-procurement. Firms were asked to express their subjective opinion on the impact of e-procurement on procurement costs. The majority of firms express a highly or fairly positive opinion of the impact of e-procurement on procurement costs. This confirms the results obtained from the correlation between labour productivity and e-procurement. The sectors where procurement has had the highest

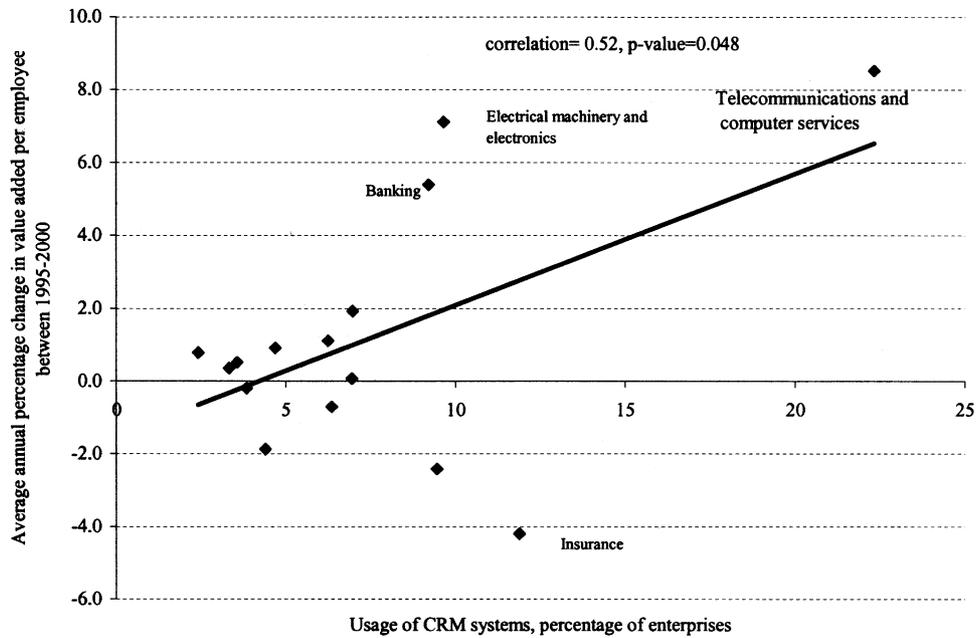
impact are telecommunications and computer services, business services, insurance and tourism (with shares between 62 and 65% for both categories ‘very positive’ and ‘fairly positive’) (see Table 7).

3.3. Relationship between e-business practices and organizational change

Table 8 shows the percentage of firms reporting that e-business has significantly changed different aspects of



Graph 7. ERP usage and labour productivity growth, EU-4(aggreated). Notes: The graph contains data for EU-4. The number of observations is 15. Source: Stan Database, e-business w@tch sector database (2002), own calculations.

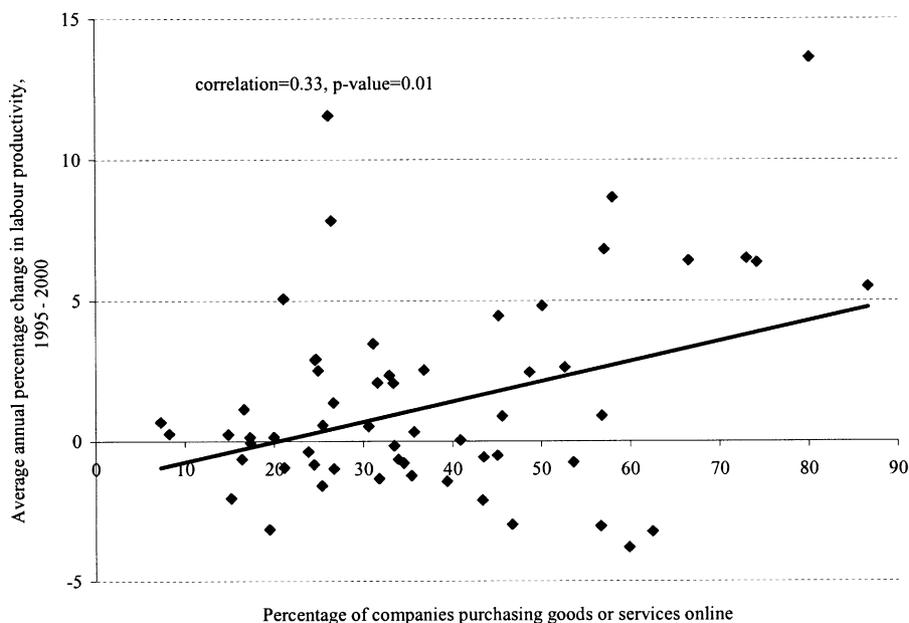


Graph 8. CRM usage and labour productivity growth EU-4. Notes: The graph contains data for EU-4. The number of observations is 15. Source: Stan Database, e-business w@tch sector database (2002), own calculations.

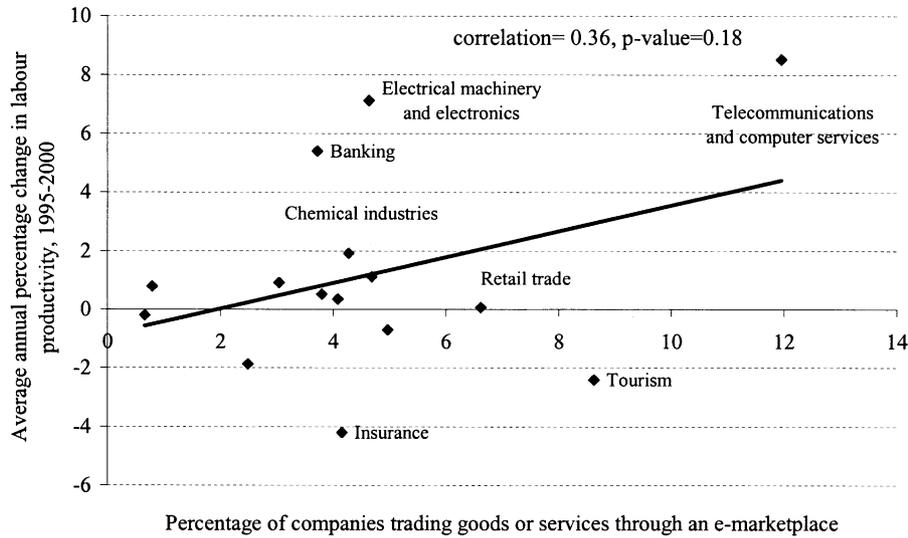
Table 6  
Correlation coefficients between online procurement and e-marketplaces usage and labour productivity growth, EU-4

	Percentage of companies trading goods or services through an e-marketplace	Percentage of companies purchasing goods or services online	Percentage of companies that procure more than 26 of the goods/services online
Change in value added constant prices per employees	+0.16 (0.22)	+0.33 (0.01)	+0.30 (0.02)
Change in value added in constant prices	+0.26 (0.05)	+0.38 (0.00)	+0.38 (0.00)

Number of observations is 60, *p*-values in brackets. Source: e-business w@tch sector database (2002), own calculations



Graph 9. Participation in online procurement and labour productivity growth, EU-4. Notes: The graph contains data for individual countries (EU-4). The number of observations is 60. Source: e-business w@tch sector database (2002).



Graph 10. Participation between e-marketplaces and labour productivity growth, EU-4. Notes: The graph contains data for EU-4. The number of observations is 15. Source: e-business w@tch sector database (2002).

the organisation of the firm in EU-4 (only firms with 250 or more employees). Overall, the largest change can be observed for internal work processes, followed by changes in the organisational structure and relationships to suppliers. The largest impact e-business had on the internal work process can be observed in telecommunications and computer services, followed by publishing and multimedia.

In machinery, the electrical industry and transport, between 6 and 9% of firms state that e-business has significantly changed their organisation. The impact of e-business on internal work processes is more pronounced: Between 8 and 15% of the firms in these industries reported that e-business significantly changed their internal work processes.

Correlations between different types of organisational change indicate that changes in the organisational structure

of a company and changes in internal work processes go hand-in-hand (see Table 9 based in all enterprises). This confirms the theoretical predictions that e-business changes the organisational structure, responsibilities and internal power structures simultaneously.

### 3.4. Determinants and barriers to e-business practices

There are a number of factors determining the use of e-business practices. Firstly, rapid advances in computer and software technologies combined with the explosive growth of the internet have led many companies to rethink their business practices, to put a greater emphasis on their use of IT, and to invest more in enterprise organization (Mendelson, 1999). It is well-known that adoption of new technologies involves significant costs in terms of learning.

Table 7  
Impact of procuring online on procurement costs, EU-4

	Very positive	Fairly positive	Neither	Fairly negative	Very negative
Food, beverages and tobacco	6.9	36.1	49.8	3.7	3.5
Publishing, printing and audiovisual services	12.5	44.0	43.5	0.0	0.0
Chemical industries	8.8	45.6	41.2	2.5	1.8
Metal products	7.7	35.5	55.2	0.0	1.6
Machinery	7.0	46.1	2.2	43.7	1.1
Electrical machinery and electronics	5.3	48.4	5.2	37.3	3.9
Transport equipment manufacturing	15.6	44.7	4.6	35.0	0.0
Retail trade	11.0	36.6	0.8	51.5	0.0
Tourism	22.3	41.5	32.9	2.4	0.9
Banking	12.2	37.0	48.9	1.7	0.1
Insurance	10.8	54.5	31.4	3.4	0.0
Real estate	10.0	51.3	1.7	37.0	0.0
Business services	13.4	51.7	3.2	31.7	0.0
Telecommunications and computer services	17.2	44.9	34.1	2.7	1.1
Health and social services	6.2	48.4	42.9	1.3	1.2

Source: e-business w@tch sector database (2002), own calculations.

Table 8

Companies reporting a significant change in organisational structure and practices due to e-business, EU-4 (large firms)

	Organisational structure of company		Internal work processes		Relationship of suppliers	
	Significant	Somewhat	Significant	Somewhat	Significant	Somewhat
Food, beverages and tobacco	4.4	15.7	2.5	34.2	3.1	18.4
Publishing, printing and audiovisual services	11.7	30.9	17.8	40.1	2.4	46.3
Chemical industries	1.8	21.4	2.8	42.7	1.8	28.4
Metal products	1.6	14.8	0.0	21.3	0.0	8.4
Machinery	6.9	16.7	15.2	19.5	7.1	15.9
Electrical machinery and electronics	9.1	27.8	10.1	38.3	13.0	15.6
Transport equipment manufacturing	9.7	9.4	9.0	18.1	6.9	23.4
Retail trade	12.9	16.2	15.1	20.2	4.2	36.7
Tourism	13.4	29.5	23.8	33.2	15.7	13.8
Banking	5.9	33.2	9.8	37.1	4.8	18.8
Insurance	6.4	37.0	13.8	44.5	3.7	30.6
Real estate	2.3	11.9	0.0	24.7	4.5	19.4
Business services	6.7	22.5	12.6	32.3	6.2	25.4
Telecommunications and computer services	21.0	19.6	14.5	38.3	8.9	31.2
Health and social services	6.8	15.7	14.9	16.1	0.9	27.4

Source: e-business w@tch sector database (2002).

Using US data, Bartel and Lichtenberg (1987) find evidence that educated workers have a comparative advantage in implementing new technologies because they assimilate new ideas more readily. Since better educated workers enjoy a comparative advantage in implementing new technologies, the diffusion of e-business practices should be higher in skill-intensive industries such as computer services and business services. Furthermore, since various e-business practices are enabled by information technologies, it is likely that the diffusion of e-business practices is positively related to the degree of information technology intensity. Table 10 shows the correlation coefficients between various e-business practices and skill/IT intensity. For two countries, Germany and the UK, we match industry level data based on the national labour surveys to the e-business w@tch data. Skill intensity in the UK is measured as the share of workers with a higher level of qualification such as National Vocational Qualification (NVQ) 5 (postgraduate qualification) and NVQ 4 first degree. In Germany, skill intensity is measured as the share

of workers with a university degree. We find that the usage of Knowledge Management Solution (KMS) systems, CRM systems and Application Service Provider (ASP) all are significantly positively related to the sectoral skill intensity (see Table 10).

For the UK, Graph 11 illustrates that industries with a higher share of highly skilled workers have a higher-than-average share of firms using CRM. We also find that KMS systems and CRM systems are significantly positively related to the sectoral IT intensity measured as the share of IT workers (such as computer software engineers, computer systems analysis, programmers, network and computer systems administrators, computer hardware engineers, etc.). However, we do not find a significant relationship between ERP usage and IT intensity.

Table 11 shows the correlation coefficients between IT/skill intensity and both participation in e-marketplaces and use of online procurement. The use of online procurement is significantly related to the skill intensity of the firm, with a correlation coefficient of 0.50. The results are robust when

Table 9

Correlation coefficients for various e-business effects (firms reporting significant effects), EU-4

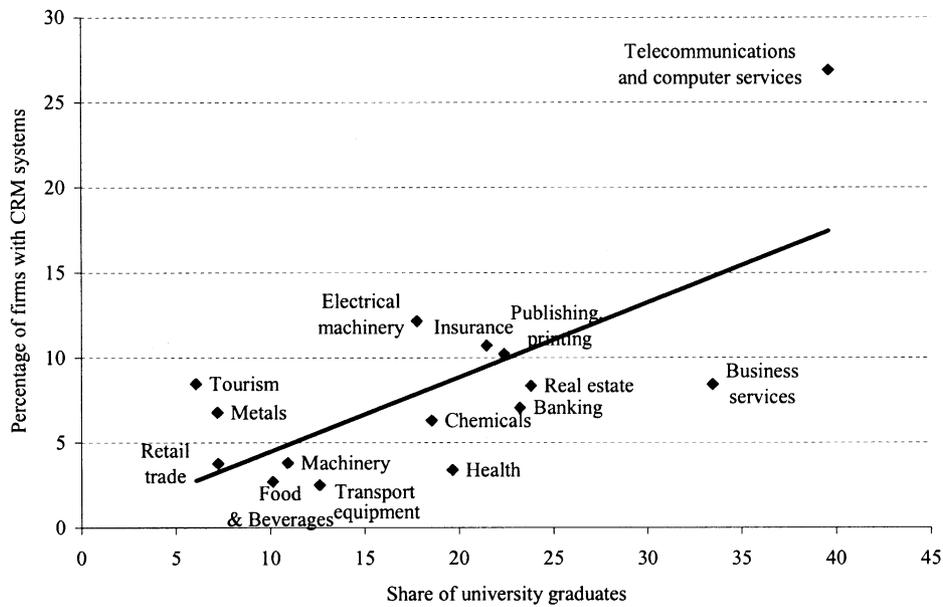
	Organisational structure of company	Internal work processes	Customer relationship	Relationship to suppliers	Offers of products/services
Internal work processes	0.80 (0.00)	1			
Customer relationship	0.69 (0.00)	0.61 (0.00)	1		
Relationship to suppliers	0.72 (0.00)	0.62 (0.00)	0.61 (0.00)	1	
Offers of products/services	0.67 (0.00)	0.62 (0.00)	0.62 (0.00)	0.73 (0.00)	1
Has e-business changed the way of conducting business?	0.67 (0.00)	0.61 (0.00)	0.66 (0.00)	0.73 (0.00)	0.77 (0.00)

Number of observations is 60 (number of sectors x number of countries). All enterprises. Source: e-business w@tch sector database (2002).

Table 10  
Correlation coefficients between various e-business practices and IT/skill intensity

	No. of observations	Usage of an ASP	CRM usage	Usage of an ERP system	Usage of a Knowledge Management Solution	SCM usage
Share of university graduates (based on LFS data)	30	+0.61 (0.00)	+0.48 (0.01)	−0.14 (0.46)	0.65 (0.02)	+0.17 (0.37)
Size of IT-department	60	+0.60 (0.00)	+0.45 (0.00)	−0.05 (0.72)	+0.53 (0.00)	+0.09 (0.51)
Share of IT personnel (based on LFS data)	30	+0.74 (0.00)	+0.73 (0.00)	−0.03 (0.88)	+0.82 (0.00)	+0.20 (0.28)

*p*-value in parentheses. Number of observations: 30 (15 industries for each of the following countries: Germany and UK). Source: UK Labour Force Survey 2000, Micro Census, e-business w@tch sector database (2002), own calculations.



Graph 11. Scatterplot between CRM usage and skill intensity, UK. Notes: Skill intensity is defined as the number of university graduates in 2000. Source: UK Labour Force Survey, e-business w@tch sector database (2002), own calculations.

a quantitative measure, namely the share of online procurement in percent of total procurement is used. Again, we also find a significant relationship between IT intensity, measured as the share of IT-personnel and use of online procurement. The results are robust with respect to the definition of IT-personnel (size of IT-department versus IT-personnel based on the Labour Force Survey).

When looking at the drivers of e-business practices, it is also important to look at the barriers of e-business practices. The principal barrier to the use of online procurement is that many products and services require face-to-face interactions. This barrier is particularly important in some manufacturing industries such as food, metals and machinery. The second most important factor is that suppliers do

Table 11  
Correlation coefficients between participation in e-marketplaces and online procurement and IT/skill intensity

	No. of observations	Participation in electronic marketplaces	Online procurement	Online procurement in percent of total procurement between 26 and 100% <sup>a</sup>
Share of university graduates (based on LFS data)	30	+0.22 (0.25)	+0.51 (0.00)	+0.38 (0.04)
Size of IT-department	60	+0.62 (0.00)	+0.73 (0.00)	+0.66 (0.00)
Share of IT personnel (based on LFS data)	30	+0.36 (0.05)	+0.62 (0.00)	+0.47 (0.01)

Size of IT-department is defined as the number of employees per thousand employees mainly occupied with maintenance of IT and networks. Source: UK Labour Force Survey 2000, Micro Census, e-business w@tch sector database (2002), own calculations.

<sup>a</sup> The categories >50% and 26–50% are added together.

Table 12  
Barriers to procuring online, EU-4 (firms that agreed 'completely')

	Requires face-to-face interaction	Suppliers do not sell online	Concerns about data protection, security issues	Technology is expensive	Suppliers' technical systems are not compatible	Cost advantage is insignificant
Food, beverages and tobacco	49.3	42.9	32.4	20.5	13.8	23.6
Publishing, printing and audiovisual services	37.6	36.8	31.3	25.1	13.5	27.6
Chemical industries	39.4	44.5	27.9	23.5	13.9	20.3
Metal products	48.9	41.3	27.0	23.4	15.5	23.4
Machinery	49.0	45.7	32.9	24.7	14.3	21.4
Electrical machinery and electronics	36.2	36.8	32.5	21.0	12.1	23.0
Transport equipment manufacturing	39.7	44.8	35.0	36.3	18.7	30.5
Retail trade	41.4	34.5	33.5	24.4	17.6	23.2
Tourism	37.1	33.9	27.8	25.3	15.1	21.1
Banking	34.0	25.7	38.5	23.3	11.8	20.5
Insurance	33.4	33.7	45.0	22.9	14.8	20.9
Real estate	36.5	35.1	35.3	28.1	10.6	22.8
Business services	31.0	26.3	25.1	18.6	7.9	17.4
Telecommunications and computer services	20.9	14.8	25.0	12.7	9.7	17.4
Health and social services	40.8	27.2	34.6	27.9	10.6	25.8

Source: e-business w@tch sector database (2002), own calculations.

not sell online. Other barriers concerns about data protection, security issues and compatibility of the suppliers' technical systems are less important (see Table 12).

#### 4. Incidence of organisational change and new management techniques: evidence based on CIS III data

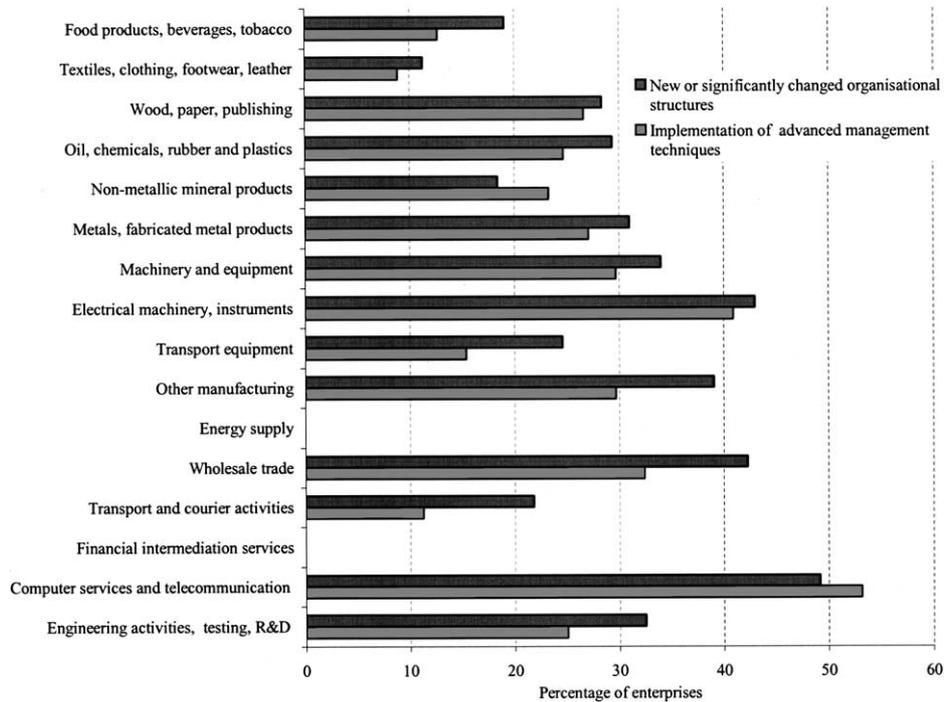
As already indicated in Section 1, various new organisational practices are complementary in the sense that the implementation of one practice (say business or advanced management techniques) is enhanced by the implementation of others (such as changes in the organisational structure). In order to provide a first look at the connection between changes in the organisational structure and the introduction of new management techniques, we calculate the percentage of firms implementing the practices. In the CIS, enterprise were asked whether they had made major changes to their organisational structure or introduced important new management techniques (alternatively referred to as modern management practices or business practices) during the 3-year period 1998–2000. Three areas of business/organisational practices can be distinguished: implementation of advanced management/business techniques within the firm, implementation of new or significantly changed organisational structures and implementation of new or significantly changed corporate strategies. New business/management practices may include Total Quality Management, Business Process Engineering (through ERP and SCM) and lean manufacturing, although this is not clearly defined. Changes in

organisational structure may include the introduction of new profit centres and a flattening of the traditional hierarchical pyramid. The countries we are going to focus on are Finland, Germany, Austria and Sweden.<sup>6</sup>

Graphs 12–15 show the percentage of firms implementing either new management techniques or changes in the organisational structure for selected European countries. Both types of organisational practices seem to be highly correlated with correlations coefficients of 0.92 in Finland (see Graph 16), 0.68 in Germany, 0.79 in Austria and 0.84 in Sweden, all significant at the 1% level. This is consistent with the prediction that management techniques such as ERP lead to significant organisational changes such as streamlining of management structures, flatter, more flexible and democratic organisations (Davenport, 1998).

For Germany, the percentage of firms implementing new management techniques is on average 36% in manufacturing and 31% in services. The percentage of firms reporting major changes to their organisational structure in manufacturing and services is 49 and 44%, respectively. Within the manufacturing sector, machinery, metals and chemicals have higher-than-average shares (see Graph 13). Unreported results show that large firms (>499 employees) are more likely to introduce a major organisational change or new management practices (69% for firms with 500 and more employees versus 44% for firms with less than 500 employees).

<sup>6</sup> Unfortunately, CIS III data for other European countries are not available yet.

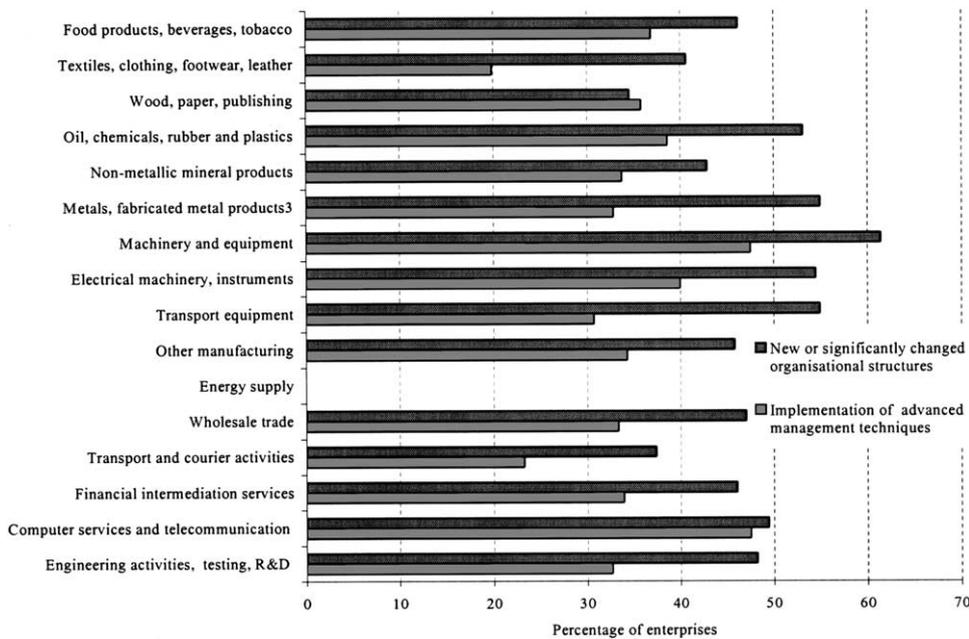


Graph 12. Introduction of new organisational practices and advanced management techniques, Finland 1998–2000. Notes: Energy supply and financial intermediation services are not covered by the survey. Source: CIS 2000 Finland, own calculations.

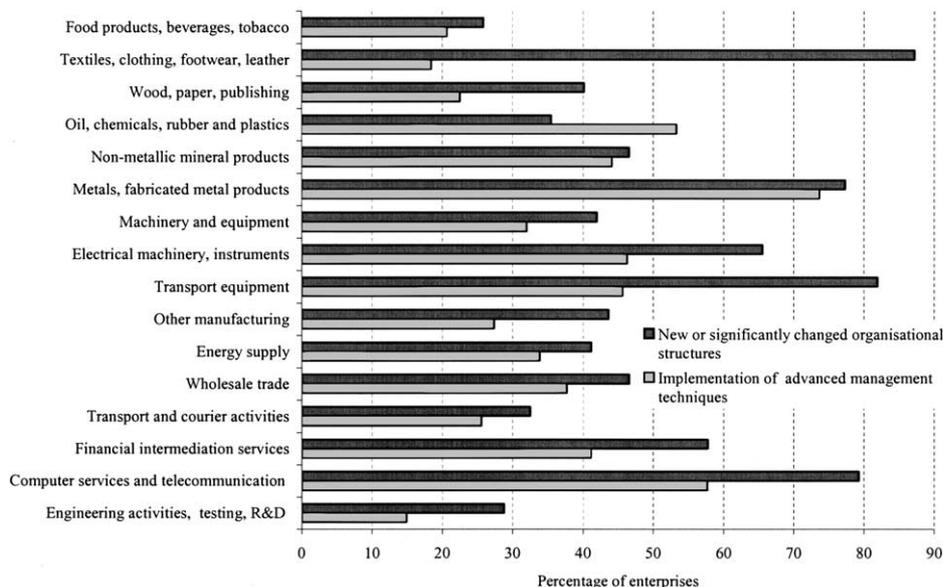
The results for Finland show that telecommunication and computer services have the highest share of firms implementing either new management techniques or changes in the organisational structure. A high proportion of firms with organisational changes can also be found in wholesale trade as well as in electrical machinery (Nace 30–336) (see Graph 12).

In Austria, the telecommunication and computer services industry, and low-skill intensive industries such as textiles, leather and wearing apparel as well as the transport industry have the highest share of firms with new organisational practices (see Graph 14).

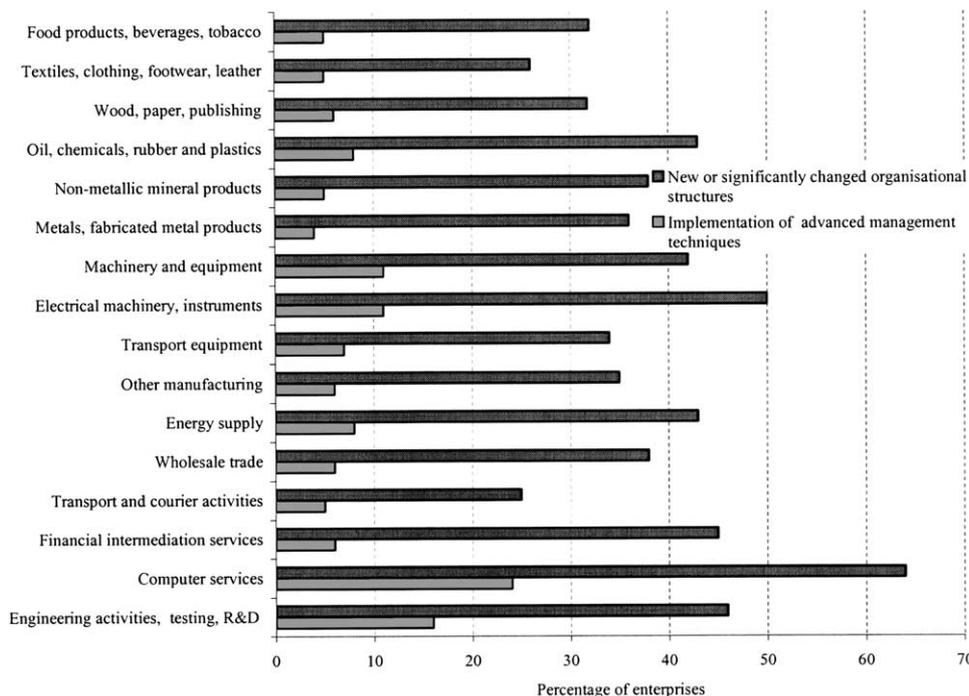
In Sweden, telecommunication and computer services have the highest share of firms implementing either new



Graph 13. Introduction of new organisational practices and advanced management techniques, Germany, 1998–2000. Notes: Energy supply is not covered by the survey. Source: CIS 2000 (Germany). We would like to thank Christian Rammer (ZEW) for providing us with the cross-tables.



Graph 14. Introduction of new organisational practices and advanced management techniques, Austria 1998–2000. Source: CIS 2000 (Austria), statistic Austria, own calculations.

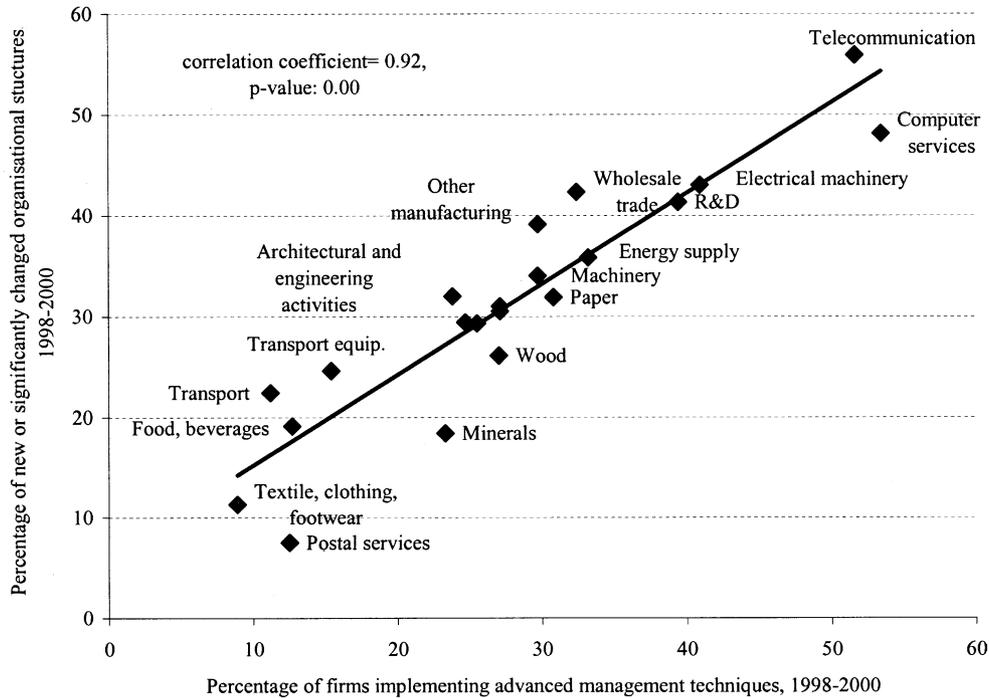


Graph 15. Introduction of new organisational practices and advanced management techniques, Sweden 1998–2000. Notes: Transport and courier services include telecommunication. Data for computer services should be interpreted with caution due to small sample size. This also holds for the category 'organisational change' in other manufacturing, energy supply and minerals. We thank Maria Säfsström for her advice on the data interpretation. Source: CIS 2000 (Sweden), Statistics Sweden, own calculations. We would like Maria Säfsström (Statistiscs Sweden) for providing us with the cross-tables.

management techniques or changes in the organisational structure (see Graph 15). A high proportion of firms with organisational changes can also be found in electrical machinery. Engineering activities, testing, R&D, machinery and electrical machinery have higher-than-average shares of firms implementing new management techniques.

Overall, the results suggest that ICT intensive industries such as telecommunications and computer services are more likely to introduce organisational changes.<sup>7</sup> Note that

<sup>7</sup> Since ICT investment data at the two digit level are not available for Finland it is possible to correlate ICT investment shares with the percentage of firms with organisational changes.

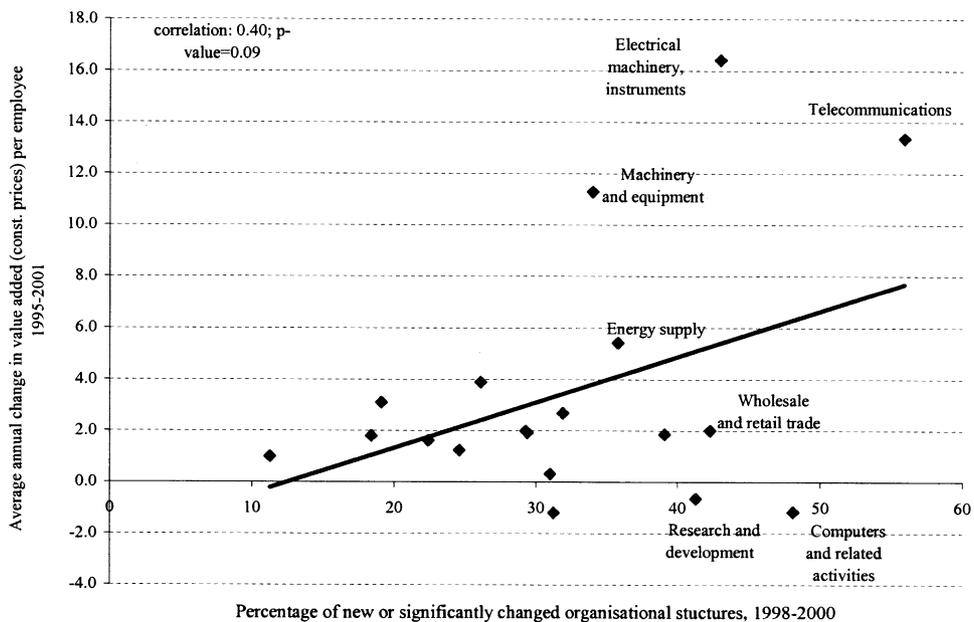


Graph 16. Scatterplot between change in organizational structure and advanced management techniques, Finland, 1998–2000. Source: CIS 2000 (Finland), own calculations.

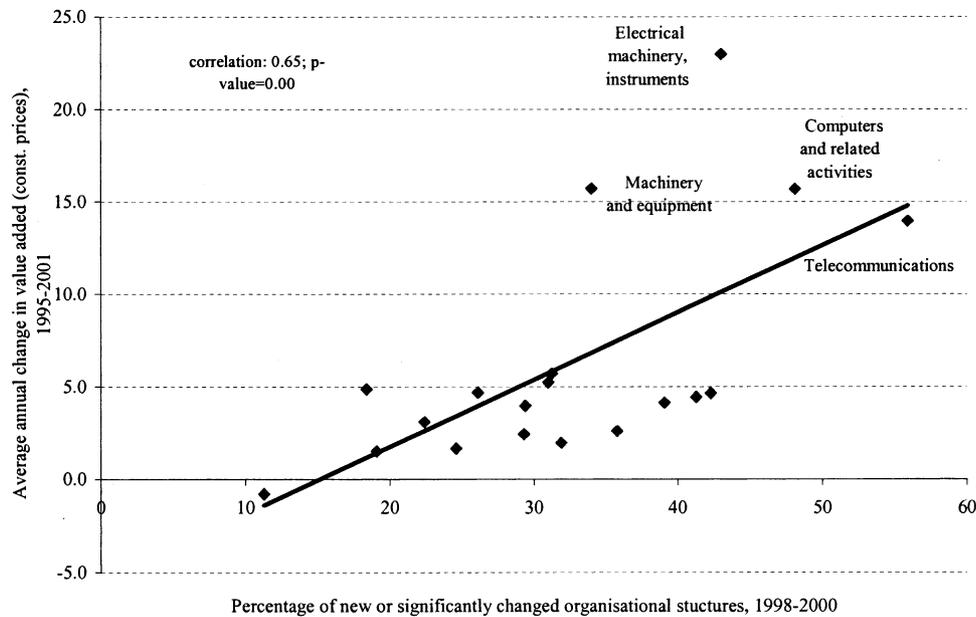
the ICT-intensive industries also employ more educated workers. Furthermore, R&D-intensive industries such as machinery or electrical machinery are also more likely to introduce organisational changes.

Graph 17 plots labour productivity growth and the percentage of enterprises with new or significantly changed organisational structures based on industry data for Finland. Industries such as telecommunication services, electrical machinery (including computer hardware, telecommunications

equipment) can be identified as the industries with an above-average growth rate of labour productivity. It is surprising that computer services experienced a negative productivity growth between 1995 and 2001. This may be partly due to measurement problems in the ‘unmeasurable sector’ (financial sector, market services such as computer services) (Griliches, 1992). For instance, in many service industries information on inputs (such as labour income) is used as a proxy of output (Van Ark, 2001). Furthermore, it is difficult to split the change in output value into



Graph 17. Organisational change and labour productivity growth, Finland. Source: CIS 2000 Finland, OECD Stan data base, own calculations.



Graph 18. Organisational change and change in value added, Finland. Source: CIS 2000 Finland, OECD Stan data base, own calculations.

a quantity and a price component (Van Ark, 2001). This problem may be more severe in industries that are affected by changes in the quality of services. Van Ark (2001) pointed out that the difference in the labour productivity change between the measurable sector and unmeasurable sector is highest in Finland. This suggests that measurement problems may be more acute in Finland than in other European countries.

Furthermore, a correlation coefficient was computed in order to statistically determine the relationship between the change in labour productivity and the percentage of firms with changes in the organisational structure. We find that the correlation coefficient is positive of about 0.40 and significant at the 9% significance level. Excluding the outlier computer services, the correlation between organisational change and labour productivity is highly significant ( $p$ -value=0.02).

In order to investigate whether the positive relationship between organisational change and labour productivity growth is mainly due to labour shedding, we look at the relationship between employment growth and the percentage of firms with organisational changes. Again, we find a positive correlation. Finally, we plot the average annual growth rate of value added in constant prices and organisational change (see Graph 18 for Finland). Again, we find a positive correlation of 0.65 that is highly significant ( $p$ -value=0.00). This means that the percentage of firms with organisational changes is significantly higher in fast growing industries. This indicates that organisational change is accompanied by a higher labour productivity growth achieved mostly through output growth rather than labour-shedding.

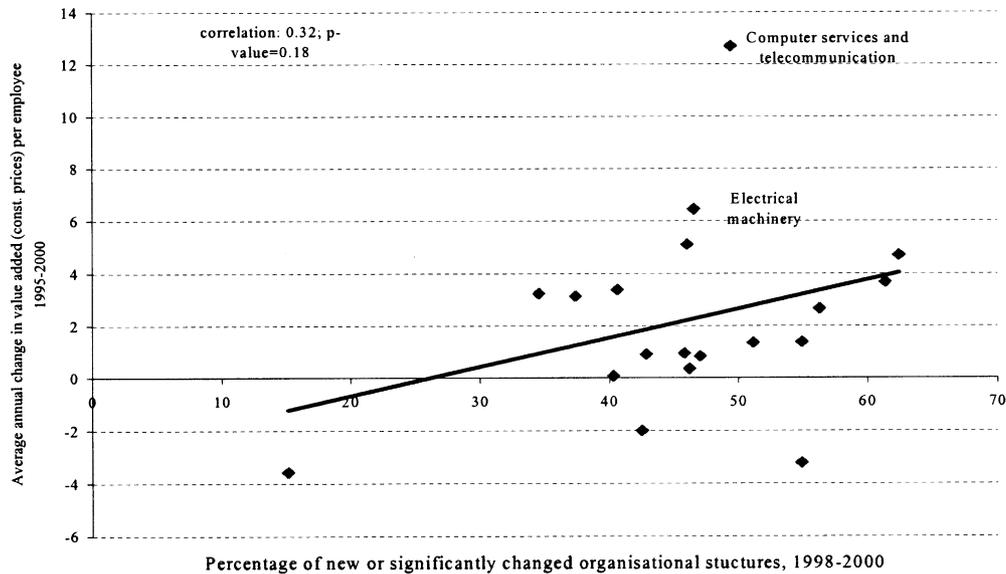
For Germany, we also find a positive relationship between the proportion of firms with organisational changes

and labour productivity, but the correlation is not significant at the 10% level (see Graph 19).

## 5. Summary and conclusions

The results from the empirical analysis at the industry level can be summarised as follows: Firstly, we find that the actual use of ERP and online procurement is positively related with labour productivity growth in the past based on EU-4 data (Germany, France, Italy and UK). Secondly, we find that certain e-business applications, such as KMS systems and CRM systems are significantly positively related to either the sectoral skill intensity or the information technology intensity. Finally, we find evidence that the introduction of e-business applications changes the organisational structure, responsibilities and internal power structures simultaneously. The results from the empirical analysis based on CIS data confirm the hypothesis that the introduction of business practices and new organisational practices are highly correlated. Furthermore, there is a significantly positive relation between labour productivity growth and the percentage of enterprises with new or significantly changed organisational structures based on industry data for Finland. This indicates that industries with an above-average growth rate of labour productivity, such as telecommunication services and electrical machinery, have a higher share of firms with new or significantly changed organisational structures. However, this relationship is low and not significant for other countries such as Germany.

Given the positive relationship between e-business applications such as ERP systems and labour productivity growth, policies should aim at increasing the firms'



Graph 19. Organisational change and labour productivity growth, Germany. Source: CIS 2000 (Germany), Stan Data, National accounts.

incentives for productivity enhancing investments in e-business solutions. Many e-business applications are widely available but utilisation is not widespread, especially not by SMEs. The [European Commission \(2003\)](#) suggests several issues that should be considered, in particular: (i) to improve the managerial understanding and skills for e-business in SMEs, (ii) to promote the availability of SME-friendly e-business solutions, and to facilitate effective participation of SMEs in electronic marketplaces and business networks. The managerial understanding and skills for e-business in SMEs should be enhanced by an increased knowledge transfer. Furthermore, managers and system users must be fully educated in order to be able to understand the integration of e-business applications into the overall company operation. Thus, firms should increase their investment in training and retraining programmes that give attention to the organisational culture and work organisation. ([EITO, 2003](#)). e-business support networks may provide a way to develop and share knowledge. Some member states such as the UK already established SME business support networks. These typically aim at providing targeted knowledge and practical assistance to SMEs in the various stages of their effort to adopt concepts such as e-business.

Government policy, in general, can take responsibility for the following areas. Given the key role of ICT in the process of organisational change, governments must ensure the provision of an efficient infrastructure, especially including a high-quality ICT infrastructure ([Murphy, 2002](#); [OECD, 2001](#)). Given the positive externalities associated with human capital investment, governments assume a major role in developing human capital. Government support is required in various areas, particularly tertiary education, work training and lifelong learning ([OECD, 2001](#)). EU member states already had begun to implement the e-Europe 2002 Action Plan which identifies actions

around the key objectives of achieving a cheaper, faster, and secure Internet, investing in people and skills and stimulating the use of the Internet. Furthermore, governments can disseminate information on the benefits and costs of ICT-enabled organisational change ([Murphy, 2002](#)). This is particularly important for small and medium-sized firms as well as for firms in industries requiring low skill intensity such as food and beverages and textiles, leather and clothing that seem to be late adopters of e-business practices. Encouraging the further growth of e-business solutions in these industries should be a key issue for policy actions.

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